Exploring the Discourse-Syntax and the Lexicon-Syntax Interfaces in Language Pathology: Evidence from Broca’s Aphasia

by

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## Abbreviations

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<td>ACC</td>
<td>Accusative case</td>
</tr>
<tr>
<td>ACT</td>
<td>Active</td>
</tr>
<tr>
<td>a.o.</td>
<td>among others</td>
</tr>
<tr>
<td>AgrP</td>
<td>Agreement Phrase</td>
</tr>
<tr>
<td>Anticaus.</td>
<td>anti-causative</td>
</tr>
<tr>
<td>CL</td>
<td>clitic</td>
</tr>
<tr>
<td>CLLD</td>
<td>Clitic Left Dislocation</td>
</tr>
<tr>
<td>CMLP</td>
<td>Cross-modal lexical priming</td>
</tr>
<tr>
<td>CP</td>
<td>Complementizer Phrase</td>
</tr>
<tr>
<td>CVA</td>
<td>Cerebro-vascular accident</td>
</tr>
<tr>
<td>DAT</td>
<td>Dative case</td>
</tr>
<tr>
<td>D-linked</td>
<td>Discourse-linked</td>
</tr>
<tr>
<td>DP</td>
<td>Determiner Phrase</td>
</tr>
<tr>
<td>D-structure</td>
<td>Deep structure</td>
</tr>
<tr>
<td>FEM</td>
<td>Feminine gender</td>
</tr>
<tr>
<td>FOC</td>
<td>Focus</td>
</tr>
<tr>
<td>FUT</td>
<td>Future Tense</td>
</tr>
<tr>
<td>GEN</td>
<td>Genitive case</td>
</tr>
<tr>
<td>IMPERF</td>
<td>Imperfective Tense</td>
</tr>
<tr>
<td>INF</td>
<td>Inflection</td>
</tr>
<tr>
<td>IP</td>
<td>Inflectional Phrase</td>
</tr>
<tr>
<td>L1</td>
<td>First Language</td>
</tr>
<tr>
<td>L2</td>
<td>Second Language</td>
</tr>
<tr>
<td>LDTs</td>
<td>Lexical Decision Times</td>
</tr>
<tr>
<td>LF</td>
<td>Logical Form</td>
</tr>
<tr>
<td>msecs</td>
<td>Milliseconds</td>
</tr>
<tr>
<td>n</td>
<td>Raw number</td>
</tr>
<tr>
<td>NACT</td>
<td>Non-active</td>
</tr>
<tr>
<td>NEUT</td>
<td>Neuter gender</td>
</tr>
<tr>
<td>NP</td>
<td>Noun Phrase</td>
</tr>
<tr>
<td>NegP</td>
<td>Negation Phrase</td>
</tr>
<tr>
<td>NOM</td>
<td>Nominative case</td>
</tr>
<tr>
<td>NSL</td>
<td>Null Subject Language</td>
</tr>
<tr>
<td>ORCs</td>
<td>Object Relative clauses</td>
</tr>
<tr>
<td>OVS</td>
<td>Object-Verb-Subject</td>
</tr>
<tr>
<td>p</td>
<td>Value indicating the level of significance (&lt; .05)</td>
</tr>
<tr>
<td>PASS</td>
<td>Passive</td>
</tr>
<tr>
<td>p.c.</td>
<td>Personal communication</td>
</tr>
<tr>
<td>PERF</td>
<td>Perfective Tense</td>
</tr>
<tr>
<td>1/2/3 pl</td>
<td>First/second/third person plural</td>
</tr>
<tr>
<td>POSS</td>
<td>Possessive case</td>
</tr>
<tr>
<td>PP</td>
<td>Prepositional Phrase</td>
</tr>
<tr>
<td>PRS</td>
<td>Present Tense</td>
</tr>
<tr>
<td>REC</td>
<td>Reciprocal</td>
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<td>REFL</td>
<td>Reflexive</td>
</tr>
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<td>REV</td>
<td>Role reversal</td>
</tr>
<tr>
<td>RTs</td>
<td>Reaction Times</td>
</tr>
<tr>
<td>1/2/3 sg</td>
<td>First/second/third person singular</td>
</tr>
</tbody>
</table>
Specifications

SPEC = Specifier
SPMT = Sentence Picture Matching Task
SOcLV = Subject-Object Clitic-Verb
SVO = Subject-Verb-Object
qtd = quoted
S = Sentence
SD = Standard Deviation
S-structure = Surface structure
TBI = traumatic brain injury
TopP = Topic Phrase
TP = Tense Phrase
Unerg = unergatives
yrs. = years
VoiceP = Voice Phrase
VP = Verb Phrase
UG = Universal Grammar
*=ungrammaticality index
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Abstract

The present thesis is an examination of eight Greek-speaking aphasic speakers with non-fluent speech following a focal lesion or a haemorrhagic episode in the left hemisphere. Our study re-examines the notoriously problematic competence-performance issue from a novel perspective that focuses on the agrammatic processing of the interfaces. Thus, the explanatory framework we adopt considers the language faculty to incorporate interfaces between distinct components of the grammar, so that agrammatic deficit may not be strictly localized on the subcomponents of the syntax, the morphology, or the lexicon.

A series of both on-line and off-line experiments was run across both the comprehension and the production modality, with the aim of circumventing processing to linguistic structures conditioned at the discourse-syntax and the lexicon-syntax interface. More specifically, the aphasic group (along with the fifteen language-unimpaired control subjects matched with the aphasic patients along age and educational level) were administered two on-line tests checking the interpretation of null and overt subject pronouns in referentially ambiguous intra- and inter-sentential contexts, as well as a sentence-picture matching, an elicitation, a repetition, and a cross-modal lexical priming task checking the production and processing of reflexive, transitive and (both active and non-active) anti-causative verbs in Greek. The results of these experiments show selective difficulty (i) with the integration of discourse information regulating the interpretation of the overt subject pronoun, and (ii) with accessing lexicon-filtered information regulating the anti-causative sub-categorization of active intransitive verbs. The data also reveals the extensive use of compensatory and heuristic strategies on behalf of both the controls and especially the eight aphasic patients, primarily aiming at offsetting the computational cost under deep processing conditions. The parsing preference of subject prominence, the non-active morpheme serving as a cue to transitivity changes in verbs, and animacy heuristics were among the most popular parsing strategies found to be employed during off-line and (mainly) on-line sentence processing. We speculate on these findings in terms of both performance (vs. competence) limitations related to the
properties of interface-conditioned information, as well as a conceptualization of Broca’s aphasia through both linguistic and cognitive/executive dysfunctions.
Part I
AIMS OF THE THESIS
Chapter 1 Aims of the Thesis

According to Chomsky’s (2000) theoretical architecture of the linguistic model, the language faculty is defined as the manifestation of several neural networks specified for distinct linguistic computations, such as the lexicon, the morpho-syntax, pragmatics and phonology. Although the exact mechanisms are hotly debated, the evidence suggests that the language subsystems are not immune to each other but information coming from a distinct, dedicated processing resource (linguistic ‘submodule’) interfaces with variables specified in (an)other submodule(s). As such, interface-conditioned processing differs from ‘normal’ sentence processing in that the computations involved in the former are more ‘enriched’ involving the generation/perception of meaning that is not exclusively represented morpho-syntactically. Besides providing further support for a less modular, more interactive language network, current findings further suggest that the processes of encoding and decoding grammatical structures between two or more submodules interfacing with each other also require that the linguistic object is well-formed and, thus, legible by (at least) both the two submodules critically implicated in its derivation. Such a mechanism suggests largely shared processing resources-in particular, a single, joint workshop for grammatical structure formation between two (or more) linguistic submodules during overlapping timespans. The further natural assumption is that the holistic acceptability of an interface-conditioned structure will probably be computationally more demanding than a structure whose derivation takes place in a single submodule.

Research has provided ample evidence that linguistic analysis is considerably influenced by interface-driven constraints. Recent studies in psycholinguistics has focused on the processing costs found when language-unimpaired adult and children populations processed sentences containing expressions that entail the integration of information from more than a single linguistic domain (e.g. Papadopoulou, Plemenou, Marinis & Tsimpi, 2007; Tsimpi, 2006; Fotiadou & Tsimpi, 2008; Reinhart, 2006; Sekerina & Trueswell, (submitted)). Especially children have been found to be particularly
sensitive to complex interface-based phenomena requiring access to constraints beyond the narrow syntax. More specifically, many of the studies document delayed sensitivity to information derived from multiple sources of information, such that children start with reliable syntactic cues and gradually add other sources of information, like context and prosody, over development. With respect to Broca’s aphasia, Avrutin (2000a) was one of the first to suggest that a proper characterization of the patients’ impairment should be more subtle than a mere ‘narrow syntax’ deficit and that a deficit at the syntax-discourse interface may be more appropriate to account for the patients’ deficient performance in discourse-linked structures (for more details on the problematic nature of the interfaces in Broca’s aphasia see ‘Literature Review’). The experienced delays manifested in the aforementioned populations are usually attributed to the fact that using and comprehending linguistic expressions requiring the selection, application and integration of constraints coming from more than one source in real-time is cognitively more costly and computationally more demanding than processing non-interface-filtered linguistic objects. Most importantly, though, these studies further testify to the importance of studying the various interfaces in psycholinguistics: it is not just that morpho-syntax, once in place, can combine (i.e. merge) lexical items to construct sentences; language derivations seem to be appropriated by other subsystems which can selectively alter the syntactic output by which we come to understand language in the first place.

The present thesis aims at shedding more light into the investigation of interface-conditioned phenomena in patients with Broca’s aphasia, i.e. individuals with damage in an area sensitive to the processing and maintenance of syntactic structure especially in real-time constraints. The overwhelming majority of prior lesion studies have mainly focused on functional elements and the left-hemisphere damaged patients’ characteristic tendency to drop or misinterpret these items in the production and the comprehension modality, respectively. In the present research we chose to focus on the interfaces by examining the nature of potentially predictive relations between interface-based structures and processing difficulty in eight Greek-speaking individuals with Broca’s aphasia. Interfaces
were explored through (i) the investigation of ambiguous subject pronoun resolution, whereby the null/overt pronoun paradigm in the Greek language was manipulated so that the interaction between discourse-level information and grammatical choices could be revealed (the so-called external interface), and (ii) through the study of verbs of alternating transitivity whose processing critically relies upon the retrieval of information at the lexicon-syntax interface (the so-called internal interface). Our main assumption is that access to interface based conditions-and especially those pertaining to the external interface- will induce greater processing cost relative to structures requiring access to a single grammatical component, e.g. narrow syntax. The initially set question is addressed within the larger framework of the notorious competence/performance dilemma in Broca’s aphasia, hypothesizing that if the aphasic subjects fail to perform in a target-like manner in linguistic phenomena lying at the interfaces this will constitute strong evidence in favor of a performance rather than a competence limitation.

More specifically, proponents of the competence account have argued that the selective vulnerability of particular aspects of grammar consequent to brain damage directly reveals the functional and (by extension) neuroanatomical organization of language; thus, the mapping from surface etiology to underlying architecture is relatively straightforward (the “transparency hypothesis;” Caramazza, 1986; Geschwind, 1972). If subjects have difficulty with a particular syntactic form, then we can postulate that the cognitive system has some sort of module which performs this operation. In arguing for the transparency hypothesis, Caramazza (1986) cites the selectivity of certain neurological dysfunctions (Hart, Berndt & Caramazza, 1985; Warrington & Shallice, 1984). Agrammatic aphasia has been used as support for a model of brain function wherein Broca’s area is responsible for those aspects of grammar implicated in the agrammatic syndrome. Thus, the traditional clinical view of the syndrome was of a “central syntactic deficit” (Caplan, 1981; Caramazza & Zurif, 1976; Caramazza & Berndt, 1985) in which syntactic knowledge is lost, affecting both production and comprehension. That is, in this view agrammatism is “a limitation on language use and language knowledge”, and “when
syntactic features are absent on the level of spontaneous speech they are unlikely to be preserved at other levels of language” (Caramazza & Zurif, 1976: 290).

However, later research indicated that agrammatics can make grammaticality judgments with above-chance accuracy, including many of the same sentence types that present serious problems for comprehension (Linebarger, Schwartz & Saffran, 1983; Shankweiler, Crain, Gorrell & Tuller, 1989; Wulfeck & Bates, 1991). This finding has considerably challenged the central syntactic deficit or “loss of knowledge” account of agrammatic symptoms. The question set by the performance-account proponents was very simple: How can a patient who has lost his syntactic knowledge make accurate judgments of grammaticality, the sine qua non of modern linguistic theory? Other problems for central agrammatism came from case studies of patients who displayed expressive agrammatism but no apparent comprehensive deficit (Kolk & van Grunsven, 1984; McWhinney, Osmán-Sági & Slobin, 1991; Miceli, Mazzucchi, Menn & Goodglass, 1983; Naeser, Haas, Auerbach, Helm-Estabrooks & Levine, 1984; Nespoulous et al., 1988), as well as reports of individuals and groups of patients who displayed receptive agrammatism but no corresponding expressive deficit (Caramazza, Berndt, Basili & Koller, 1981; Caplan, Baker & Dehaut, 1985; Bates, Friederici, & Wulfeck, 1987a, 1987b; Smith & Bates, 1987). Taken together, these various lines of evidence lead to a model of agrammatism in which impaired access and processing operate over a preserved knowledge base (Bates, Wulfeck & McWhinney, 1991; Friederici, 1988; Prather, Shapiro, Zurif & Swinney, 1991; Wulfeck & Bates, 1991).

The present thesis is inspired by the competence/performance dilemma in Broca’s aphasia, yet, viewed through the minimalist architecture of the language system, and, more specifically, the inherent complexity of interface-conditioned linguistic phenomena. The aim is to analyze the aphasic performance in interface-conditioned structures in order to to show that there is no need either to claim any unique representational source for the deficit or suppose the existence of a syntax-specific structural reduction. We consider that the exact nature of the deficit manifested by a reduction in working memory and attention-allocaional processing resources is a central issue in Broca’s aphasia.
As an example, in the present thesis we present data from the patients' performance at the two interfaces, and we speculate on the procedural nature of the deficit based on a reduction in processing abilities rather than a loss of grammatical knowledge. In fact, we intend to show that the patients' reduced procedural capacities will be differentially manifested on principled grounds, with the aphasic performance being most pervasively compromised (i) in the production modality, and (ii) by the processing of phenomena requiring access to language-external interface constraints, like the disambiguation of pronouns lying at the syntax-discourse interface. More specifically, we assume that the aphasics' difficulty to encode meaning can be traced to capacity/performance limits that ultimately compromise structure choices in production. On the other hand, the aphasics' anticipated improved comprehension patterns are more consistent with the view that the parser receives as input real physical objects, thus, allowing the aphasic individuals to engage in advanced use of lexical, semantic or morphological cues that could compensate for the patients' procedural reduction. With respect to the aphasics' expected lower performance at the syntax-discourse interface, we believe that the integration of discourse constraints might conceivably involve processes which are cognitively more demanding, thus, more costly for the aphasic parser relative to lexical constraints which are assumingly easier to 'read' by the syntax. Overall, we believe that the 'comprehension' vs. 'production' modality, as well as the 'external' vs. 'internal' interface distinctions is an intriguing and challenging topic for investigation in Broca’s aphasia and that it will most decisively establish the (processing vs. computational) nature of the agrammatic deficit.

A secondary aim was to highlight the extent to which the aphasics employed parsing heuristics to appear to have target-like understanding of the referentially and morphologically ambiguous sentences at the two interfaces. A great deal of psycholinguistic work has been devoted to trying to determine how these sorts of syntactic ambiguities are resolved. Both in models of comprehension that assume syntactic priority (Frazier & Fodor, 1978; Frazier, 1979; Frazier & Rayner, 1982, Spivey & Tanenhaus, 1998; McRae, Spivey & Tanenhaus, 1998; Tabor & Hutchins, 2004) and in those
dynamical-system models that allow unlimited interaction among knowledge sources in overlapping time-spans with no special status for syntax (Trueswell, Tanenhaus & Kello, 1993; McDonald, Pearlmutter & Seidenberg, 1994; Stevenson, 1994; Spivey & Tanenhaus, 1998), it is assumed that eventually all relevant sources of information will be consulted and used to arrive at a definitive resolution of structural ambiguities. There are strong theoretical reasons, yet, to believe that the human parser has finite resources and allocates these resources strategically, such that the distribution it places over interpretations of a single structure has an element of random drift (Jurafsky, 1996; Crocker & Brants, 2000; Levy, Reali, & Griffits, 2009). This means that besides the fact that the parsing mechanisms are responsible for delivering accurate representations of the input on the basis of the grammatical module-conditioned rules (i.e. the syntactic algorithms), there is a chance that they work imperfectly showing signs of increased garden-path recovery. Such effects are most frequently encountered in regions of unresolved syntactic ambiguity as well as in structures where the structurally ambiguous region is long enough to increase processing difficulty over disambiguation (the so-called ‘digging in’ effects, see Frazier & Rayner, 1982; Ferreira & Henderson, 1991; Tabor & Hutchins, 2004). Such limited resource models suggested that in cases of prolonged ambiguity the parser might not resolve the ambiguity at all, or it might accomplish its information processing task by arriving at “an interpretation through the use of a small set of fast and frugal heuristics that may challenge the parser when it tries to integrate a more global structure and meaning of the sentence in question” (Ferreira & Patson, 2007: 71).

The idea that people seem to reason effectively or seem to understand utterances completely and correctly, but to a large extent this appearance is based on the skilful application of some fairly superficial heuristics has been widely attested in the relevant literature (Ferreira & Patson, 2007; Tabor & Hutchins, 2004, a.o.). Performance levels of non-impaired adult speakers in stressful situations clearly evince the tendency to minimize processing steps by employing heuristics, which falls out of the assumption that stress decreases the processing capacities of the human mind/brain (Dick, Bates,
Wulfeck, Utman, Dronkers & Gernsbacher, 2001). We argue that a model of parsing that assumes a minimal effort principle for initial parsing reflects Broca's aphasics' linguistic (and possibly cognitive) system as well. As such, we assume that heuristic interpretations will be strongly selected by the aphasic subjects participating in the present study not simply because heuristics become quickly adaptive, but because the agrammatic system has a specific reason for preferring them, i.e. they conform to their non-fully-active or limited cognitive (working memory/allocational) resources (Tompkins, Bloise, Timko, & Baumgaertner, 1994; Wright, Newhoff, Downey, & Austermann, 2003). Given that the agrammatic system is resource limited and that it must make decisions quickly during the unfolding of the sentences in real-time, we expect that it will do better if it relies on heuristics rather than attempting to execute algorithms that consult every potentially relevant piece of information. The further natural assumption is that the use of heuristics will tend to increase in interface-conditioned phenomena and in relevant task conditions which are more costly in terms of cognitive demands. It is important though to stress that the parsing mechanism in the aphasics is claimed to apply in the exact same way as it applies in 'normal' grammars and that extensive use of heuristics on behalf of the patients is driven by extra-linguistic limitations. In fact, this is one of the major points made in this thesis: in a non-trivial sense there is no difference between aphasic and normal grammar; at the relevant level of analysis it makes no sense to speak about agrammatism at all.
Part II
INTRODUCTION
Chapter 2 APHASIOLOGICAL BACKGROUND

This chapter provides a definition of agrammatic Broca’s aphasia, and several older and more recent accounts of agrammatic aphasia. These accounts are used as a background for discussing the aphasic participants’ data described in the following chapters.

2.1 DEFINITION OF APHASIA AND TREATMENT

Aphasia is commonly defined as a language disorder that is caused by brain damage, such as a cerebro-vascular accident (CVA) or a traumatic brain injury (TBI). All language modalities may be impaired in aphasia: speech production and auditory comprehension, as well as the production and comprehension of written language. Problems can arise at such linguistic levels as phonology, morphology, semantics and syntax. Although all patients are different with respect to the kind of symptoms they exhibit and the severity of their language disorder, some syndromes can be distinguished that share several symptoms.

In the literature there are many types of aphasia described, for example, Broca’s aphasia, Wernicke’s aphasia, conduction aphasia and anomic aphasia, but the first two types are the most common ones and the most widely described. In Broca’s aphasia, the brain damage is localized in the frontal lobe (typically Brodmann’s areas 44 and 45), and the resulting speech is non-fluent but language comprehension is relatively well-preserved. This type of aphasia took its name from the neurologist who first described it. Paul Broca, in 1861, described the case of a patient who had ‘lost’ the ability to speak. His language was characterized by non-fluent speech output and relatively intact language comprehension. In non-fluent aphasia, ‘the flow of speech is more or less impaired at the levels of speech initiation, finding and sequencing of articulatory movements, and production of grammatical sequences...The speech is frequently interrupted and often awkwardly articulated with great effort
Definition of Aphasia

(Goodglass & Kaplan, 1983: 75). In the second type of aphasia the brain damage is more posterior (in the posterior part of the superior temporal gyrus, the so-called Brodmann’s area 22), and the resulting language damage is characterized by fluent speech with paraphasias and poor comprehension. The term paraphasia refers to the erroneous production of phonemes, words or phrases (Goodglass & Kaplan, 1983). Two types of paraphasia can be distinguished. First, phonemic paraphasias are errors in the production of phonemes, such as those resulting from the omission, addition, transposition or change of one or more phonemes of a word. Secondly, semantic paraphasias originate from the use of an unintended word which is semantically related to the target word. The fluent type of aphasia took its name from the German neurologist Carl Wernicke who was the first to describe the characteristics of this linguistic deficit. From now on, this work will focus on Broca’s aphasia, and in particular agrammatic aphasia, which is of central interest to the present study.

Aphasia treatment strives to improve an individual’s ability to communicate. The most effective treatment begins early in the recovery process (Thompson, 2007). Major factors that influence the amount of improvement include the cause of the brain damage, the area of the brain that was damaged, the extent of the brain injury, and the age and health of the patient. Additional factors include motivation, handedness, and educational level. Independent evidence from neurolinguistic studies shows that recovery of language in (primarily) agrammatic aphasia follows a “path of linguistic knowledge”. First, sentences with shared linguistic properties recover together; such an improvement becomes evident in both the production and comprehension of the sentence types entered into treatment. Secondly, training more complex structures has been found to result in recovery of less complex, linguistically related structures. These assumptions have been studied extensively in a series of treatment studies mainly conducted in the United States by Thompson, Shapiro, and colleagues. Work in progress by the specific team is recently concerned with the neurobiology of improved language using the two aforementioned doctrines subsumed under the Complexity Account of Treatment Efficacy approach (CATE) (Thompson Shapiro, Kiran & Sobecks, 2003). The outcomes
appear to be very encouraging such that the specific treatment has been shown to result in substantial changes in spontaneous discourse and in real-time processing of trained sentences for the overwhelming majority of the patients recruited. In fact, the treatment gains have been visualized by being mapped onto the patients' brain regions via functional magnetic resonance imaging techniques (fMRI). The specific studies examining the neural correlates of recovery from aphasia suggest that such training influences the neural substrates of (mainly) verb production (Ouden et al. 2010).

2.1.1 Agrammatic Broca’s aphasia: a definition

The term ‘Broca’s aphasia’ has been used for a long time to generally address a language impairment characterized by non-fluent speech production, and relatively spared comprehension. Later on, the term Broca’s aphasia was replaced by the term agrammatism which has been described as a specific type of Broca’s aphasia. The main difference between Broca’s aphasia and agrammatism (which are often used as synonyms) is that even if the main deficits in agrammatism are still detectable in speech production, language comprehension has been shown to be impaired as well (Caramazza & Zurif, 1976; Linebarger, Schwarz & Saffran, 1983; Grodzinsky, 2000, 2004; Luzzatti, Raggi, Zonca, Pitarini, Contardi & Pinna, 2001; Shapiro & Levine, 1990). Agrammatism is in general characterized by poor grammar, a decrease in speech rate, a tendency to drop or to substitute function words such as determiners, complementizers and auxiliaries, and frequent use of uninflected verbs. This co-occurrence of symptoms is often described as ‘telegraphic speech’.

Furthermore, deficits in working memory (WM) constitute a critical subset of non-linguistic deficits reported in agrammatic aphasia (Murray, Ramage, & Hoper, 2001; Wright & Shisler, 2005). Significant differences between WM capacity of individuals with and without aphasia (Tompkins, Bloise, Timko, & Baumgaertner, 1994; Wright, Newhoff, Downey, & Austermann, 2003) and significant correlations between WM and general language measures (Caspari, Parkinson, LaPointe, & Katz, 1998; Wright et. al., 2003; Wright, Downey, Gravier, Love, & Shapiro, 2007) have been demonstrated.
The basic issue of these studies was to determine whether the WM deficits observed in aphasia are specific to language, or they encompass a more general, cognitive domain. Current literature supports linguistic-specific WM subsystems which are devoted to the processing of distinct types of linguistic information (Caplan & Waters, 1999; Caspari, Parkinson, LaPointe & Katz, 1998; Friedmann & Gvion, 2003; Stowe, Withaar, Wijers, Broere & Paans, 2002). For example, Friedmann and Gvion (2003) investigated how WM deficits manifested themselves in participants with agrammatic aphasia. They used tasks that required either phonological reactivation or syntactic/semantic reactivation. What they have concluded on the basis of their results was that “…the type of reactivation required by the sentence, as well as the type of memory overload is crucial in determining the effect of WM limitation on sentence comprehension” (Friedmann & Gvion, 2003: 23). Unfortunately, the study of WM in agrammatism is fraught with methodological limitations, largely due to the difficulty of controlling for potential confounds in the design of WM tasks (the most important being that the tasks employed are not entirely non-verbal) and associated performance measures (Ivanova & Hallowell, 2008).

Last but not least, one of the most well-known aspects of the agrammatic syndrome is the vast within- and between-individual variability in the patterns of agrammatic performance across various languages. Such an extensive inconsistency manifested in the performance(s) of patients as well as within the same agrammatic individual is usually attributable to the variability in the degree of the severity of language impairment (Rossi & Bastiaanse, 2007; Caramazza, Ruml, Capasso & Miceli, 2005; Bastiaanse, Bosje & Visch-Brink, 1995; Bastiaanse, Rispens, Ruigendike, Rabadan & Thompson, 2002; Thompson, Shapiro & Schendel, 1995). Druks and Marshall (1995) claim that different effects on agrammatic performance could be predicted if a perspective is taken whereby different submodules of grammar can be selectively disrupted in different patients. Their assumption followed their finding with respect to the deviant performance of a patient diagnosed as an agrammatic aphasic that displayed better comprehension patterns on passives than on actives. Such a finding
clearly contradicts the results of numerous studies postulating aberrant comprehension performance on structures with non-canonical word order, such as passives.

Given the high degree of variability often attested in scores within group and single-case studies the question arises as to what constitutes the core features of agrammatism that distinguishes agrammatic patients from non-agrammatic aphasics, including Broca’s aphasics. Goodglass (2001) describes agrammatism with the following characteristics:

- Omission and/or within-class substitution\(^1\) of function words
- Substitution of tended forms for verb stems or infinitives
- Reduced use of coordination and subordination
- Fragmentary, incomplete sentences and phrases
- Loss of speech melody
- Loss of comprehension of inflections and function words
- Loss of comprehension of complex syntactic structures, like object-relative clauses, semantically reversible passive sentences and wh-questions (a.o.)

Throughout the present study, the terms agrammatism, agrammatic aphasia, and Broca’s aphasia are used interchangeably to refer to agrammatic Broca’s aphasia. This means that all agrammatic patients that were tested for the present study had Broca’s aphasia and telegraphic output.

\(^1\) In languages in which bare/uninflected forms can not stand on their own (like Greek and Hebrew, for example) omission is not possible and grammatical morphemes are usually substituted (Grodzinsky, 1990, 2000).
2.2 ON AGRAMMATISM: NEUROLINGUISTIC ACCOUNTS

Since the seminal paper by Zurif and Caramazza (1976), a great amount of work has been dedicated to reach a better understanding of the agrammatic deficit. Different approaches have been proposed to deal with this phenomenon and, more generally, with the correct characterization of agrammatism (Avrutin, 2001). Simplifying to a high degree, and leaving aside the many differences between individual approaches, it is possible to divide the whole spectrum of analyses into two major ‘families’: those regarding the deficit as a loss of (part of the) knowledge of grammar (the so-called ‘deficient competence’ account, see Ouhalla, 1993; Hagiwara, 1995; Friedmann, 1998, 2002; Friedmann & Grodzinsky, 1997; Grodzinsky, 1990, 1995(a), 1995(b), 2000, a.o.), and those considering it as the result of a processing deficit compromising the capacity of utilizing grammatical knowledge (the so-called ‘deficient performance’ accounts, see Avrutin, 2006; Caplan & Hildebrandt, 1988; Caplan & Waters, 1999; Carpenter, Miyake & Just, 1994; Haarmann & Kolk, 1991; Hagiwara, 1995; Kolk, 1987, 1998; Pinango, 1999, a.o). While discussing these various approaches in detail is beyond the scope of the present paper, it is important to mention their basic features and show how they oppose to each other.

2.2.1 Competence accounts

The first account arguing in favour of an impairment of all functional elements in agrammatic speech production was proposed by Ouhalla (1993). More specifically, Ouhalla’s proposal has limited agrammatic production to VP constructions. This could be viewed as pruning above the VP node. In Ouhalla’s account functional categories are claimed to form a separate component of Universal Grammar (UG), a UG functional lexicon whose elements serve as the fundamental triggers for
computational processes. Ouhalla argued that this component is impaired in agrammatism, preventing access to the categories in the UG lexicon. According to him, since the functional projections above the VP node are absent in agrammatic speech, the relations and processes associated to these projections (e.g. agreement, case assignment, syntactic movement/merging operations for feature checking, a.o.) would be absent as well.

Another account in favour of a loss of syntax in Broca’s aphasia was proposed by Hagiwara (1995). In the framework of the early Minimalist Program (Chomsky, 1993), Hagiwara proposed that the lower the position of a functional head and its projection in the sentence structure hierarchy, the more accessible it would be to an agrammatic speaker (Hagiwara, 1995: 99). This theory was based on the analysis of spontaneous speech and the results from an acceptability sentence judgment task conducted with four Japanese agrammatic speakers. In the spontaneous speech from the Japanese agrammatic aphasics, some complementizers were omitted, but negation words were spared. On the grammaticality judgment task, two agrammatic aphasics performed better with negation and tense than with the CP-dependent wh-words and complementizers. On the same task a mildly impaired aphasic performed well on all of these functional elements, whereas three severely impaired patients performed poorly on all.

Hagiwara proposes that, in the group of agrammatic aphasics who showed the unequal pattern of impairments, lower functional projections such as T(ense)P and Neg(ation)P were resistant to damage, whereas higher projections, such as Agreement-for-Subject Phrase (AgrSP) and C(omplementizer)P appeared to be unavailable. Specifically, she posits that whereas the grammar of normal adults necessitates “convergence” (Chomsky, 1993) (i.e., successful computation) at the highest functional projection (e.g., the CP for the clause), the agrammatic aphasic's grammar allows

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2 The plausibility of the functional lexicon forming a natural class, distinct from the contentive lexicon is seen in much evidence stemming from language acquisition, language use and pathology (Smith & Tsimpli, 1995; Tsimpli, 1996; Rizzi, 2004).
convergence at lower functional projections (e.g., at Negation). Hagiwara argues that different subjects may converge at different functional heads, explaining *between*-subject differences in severity. However, her proposal is stated in a way that is incompatible with graded (probabilistic) success by individual agrammatics. Rather, an all-or-nothing pattern of performance *within* subjects is predicted. That is, a given patient should be equally (and presumably completely) impaired at all functional categories above this point of convergence, and completely spared below it. Dutch data, though, brought forth a different pattern which contradicted Hagiwara’s account. Dutch agrammatic speakers (Bastiaanse, Rispens, Ruigendijk, Rabadan & Thompson, 2002) were impaired in producing structures at the CP (thus, confirming Hagiwara’s assumption) but, most importantly, they performed poorly in moving the verb to the Inflectional Phrase (IP). Along the lines of Hagiwara’s proposal, the movement to IP should at least be less impaired than the production of CP.

One of the most debated approaches to the syntactic deficit in agrammatic aphasia is the Trace Deletion Hypothesis (TDH) formulated by Grodzinsky (1986a, 1986b, 1990, 1995a, 1995b, 2000) which has attempted to account for agrammatism in terms of the selective impairment of a specific algorithm related to the computation of syntactic traces in the linguistic string. More specifically, the TDH states that traces of referential NPs (i.e. the phonologically empty categories at the tail of a movement chain in the syntactic representation) are deleted from the S-structure representation in agrammatism and their interpretations are not recoverable. As such, deletion of the trace of a moved argument NP makes it impossible to assign the NP its thematic (θ-) role using the standard grammatical mechanism (i.e. chain interpretation). Interpretation is instead assigned through non-grammatical heuristic, which assigns the agent (θ)-role to the first NP encountered [NP1=Agent]. This strategy leads to correct (above chance) performance where the first NP encountered does indeed carry the agent role, as is the case with (unscrambled) actives, subject relatives, and subject clefts. The same strategy, however, does not necessarily lead to the correct interpretation (and thus to chance performance instead) when the
second NP is also assigned the agent role structurally. This should be the case with passives, object relatives, and object clefts.

The TDH has been criticized on both conceptual and empirical grounds. Discussion has focused on two principal issues. The first one, often called the variability debate (Burchert, de Bleser & Sonntag, 2003; Caplan, 2001; Caramazza, Capitani, Rey & Berndt, 2001; Drai, Grodzinsky & Zurif, 2001) is connected to the existence (or not) of a uniform pattern among different subjects. The extent to which variation is actually observed when the data are subject to sophisticated statistical analysis is at the center of an ongoing debate (Drai & Grodzinsky, 2006a, 2006b). The second issue (Avrutin, 2006) is of a more general nature and relates, in fact, to any representational approach and not only to the TDH. The question is how to relate the TDH, or any other theory of aphasia as a loss of part of the knowledge of grammar, with everything else we know about agrammatism. More specifically, this approach to language impairment is not clear about how linguistic information is integrated in the structure, and consequently why traces should have a different nature for agrammatics. The ‘first agent’ strategy applies only to NPs that have not received a thematic role by grammatical analysis. So, a purely syntactic condition (i.e. [-assignment] of a θ-role) implemented beforehand selects the elements to which the strategy applies. In processing terms this means a syntactic analysis must first be made before the application domain of the strategy can be defined, i.e. only after inconclusive thematic role assignment does the possibility of using the strategy arise. On empirical grounds, the opponents of the TDH render the grammatical nature of the specific reasoning inappropriate and claim it impossible to establish a connection between deletion of traces and telegraphic speech, omission of tense.

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3 Grodzinsky (1986a) himself, though, has pointed out that the TDH is not a theory of agrammatism, rather a descriptive generalization based on the “striking correlation between the distribution of a formal construct called trace and the performance types that agrammatic patients exhibit. A statement is then proposed that modifies the linguistic model to account for agrammatism. This statement is claimed to serve as the proper descriptive generalization concerning the data observed” (Grodzinsky, 1986a: 179).
morphology, omission of determiners, and selective problems with the binding of pronouns frequently encountered in agrammatic performance.

The final theory proposed within the impaired competence framework is the Tree Pruning Hypothesis (TPH) set forth by Friedmann and Grodzinsky (1997), and Friedmann (2002). After analyzing several data sets from Hebrew and Palestinian Arabic agrammatic speakers, the authors concluded that the impairment in agrammatic production is highly selective, and lends itself to characterization in terms of a deficit in the syntactic tree. More specifically, it has been claimed that the omission of items from the functional lexicon in agrammatic speech is sensitive to the position of these elements in the syntactic tree. Each of these positions can be defined by its particular set of morphosyntactic features, and such features can be catalogued in virtue of the class they belong to (e.g. argumental, quantificational, temporal, etc.). The TPH was explicitly demonstrated in agreement and temporal dependencies which are similar in the sense that both are related to feature matching. For example, the agreement relation requires the number feature to be copied from the subject onto the verb, and in doing so establishes a configurational agreement relation. In temporal concordance, on the other hand, a temporal adverb and the finite verb must share their tense feature. The two grammatical dependencies though have positional differences which are well attested in the linguistic literature since Pollock’s (1989) Split Inflection Hypothesis. In the tree structure they occupy different syntactic phrases in a parameterized order.

According to the TPH the syntactic tree of agrammatic aphasic speakers is pruned at the Tense node, such that an aberrant performance on the realization of temporal dependencies was expected. Indeed, the specific hypothesis was supported by the dissociation in the omission of verbal inflection demonstrated by Friedmann and Grodzinsky’s (1997) study with Hebrew and Arabic-speaking aphasic subjects: number features in subject-verb agreement were selectively preserved, while temporal morphology was omitted. These data led the two authors to hypothesize a structural reduction of the syntactic tree, with the elements located in high nodes (e.g. TP) of the tree being
impaired, thus, less accessible relative to lower nodes (Subject agreement phrase, AgrP) which were spared\(^4\). Further important evidence in favour of the TPH comes from a number of subsequent studies, e.g. Janssen and Penke’s (2002) study on subject-verb agreement with five German-speaking Broca’s aphasics.

Friedmann and Grodzinsky’s approach directly linked evidence from language processing with evidence from linguistic theory. The different features comprising morphosyntactic information may be differently parsed both in temporal and in spatial terms in line with theoretical evidence from linguistic models advancing sensitivity of the aphasic parser to positional variables. The TPH has also proved a useful tool for the specification of the degrees of agrammatic severity and the description of the stages of linguistic recovery. A milder impairment, or improvement in agrammatism, manifests itself in the ability to access higher nodes of the syntactic tree. Crucially, the theory predicts that in no case will we observe a deficit with elements associated with lower projections in the absence of any deficit for higher ones.

Nevertheless, recent empirical evidence seems to contradict this assumption, indicating that other factors are plausibly linked to the selective omission of functional categories in agrammatic aphasia. Bastiaanse & Thompson (2003) have tested two different types of sentences - declarative sentences, where the auxiliary was in the Inflectional phrase (IP), and yes/no questions, where the auxiliary had to move to the Complementizer phrase (CP). They did not find a significant difference in the production of auxiliaries in these two types of sentences. Following the TPH instead, the expectations would be of a better performance for the sentences where the verb stays in its base-generated position, i.e. a lower position in the tree. Furthermore, Garraffa (2004, 2007) has shown that

\(^4\) A distinction between Tense and Agreement dependencies was also found in a recent study on sentence processing with adults speakers (De Vincenzi, et al., 2006). In an ERP experiment on morphosyntactic feature matching, agreement violations were detected in an early phase while violations of temporal morphology were detected in a successive temporal window. This could be an indication of a sequential parsing model where purely formal syntactic operations, such as subject-verb agreement, precede post-syntactic analyses, such as the interpretation of incongruent temporal features.
there is an asymmetry in agrammatic performance with different elements occupying the left periphery of the clause. More specifically, she has analyzed the data from two Italian agrammatic patients and showed that the CP level is selectively impaired and not completely inaccessible. Garraffa has also tested the production of argument and adjunct wh-elements. She found that the patients tended to produce wh-in-situ for wh-arguments, which is in line with the TPH. However, elements like why (which is most probably base-generated in the left periphery of the clause (Rizzi, 2001)) were correctly placed at the beginning of the sentence. This is clearly problematic for the TPH which does not predict any effect on the availability of the CP level on the basis of different kind of wh-elements. On a similar vein, Garraffa and Grillo (2008) have recently shown that the deficit in the production of wh-movement is highly selective: wh-movement seems to be impaired in the case of animate < who >, but it is relatively spared in the case of inanimate < what >. All these facts, at the very least, necessitate a revision of the assumptions behind the TPH and crucially an abandonment of the idea that an underspecified node cannot project any higher.

In sum, both Hagiwara’s (1995) theory and Friedmann’s (2001, 2002) TPH constitute pure representational accounts of grammatical disorders. Both claimed that not all the functional lexicon is necessarily damaged in agrammatic aphasia, indicating that distinctions may be made in this category determined by the position of the functional elements in the syntactic tree. Moreover, both accounts suppose the existence of a modality-specific structural reduction, such that the aphasics’ deficit is exclusively evident in the comprehension modality. The difference between the two theories is that while the former implies a hierarchy in the representational deficit, the latter implies a sharper duality and an exact location within the syntactic tree for the deficit.

As one can see, competence approaches are not exempt from problems. A central issue in competence-based accounts is their failure to replicate cross-linguistically attested patterns of performance in certain agrammatic populations. More specifically, we know on independent grounds that some patients’ production and comprehension performance on the relevant functional projections
assumed to be lost in agrammatism was above chance level. As such, the competence-based accounts failed to provide the flexibility needed to account for the wide variety of constructions found in agrammatic production; they can account for neither the between-individual nor the within-individual variability found in agrammatic data. This observation required going back to linguistic representations in order to reach a proper understanding of the underlying factor(s) compromising the linguistic, representational, and syntactic properties of those elements in the agrammatic syndrome. To this end, much work has been done on the basis of the intuition of the existence of a processing limitation compromising the performance of agrammatic patients’ otherwise intact grammatical systems.

### 2.2.2 Performance Accounts

Grillo (2003, 2005) has recently hypothesized that a (temporal or permanent) reduction in processing capacity could lead to an underspecification of the morphosyntactic feature sets normally associated with the functional heads in the syntactic tree in agrammatic subjects. Selective effects could be expected to arise as a natural consequence of this underspecification.

The idea that a reduction in processing capacity can generate underspecified syntactic structures is closely related to another idea, widely accepted in the psycholinguistic field, that even in normal situations, the human mind/brain is ‘lazy’ and this ‘laziness’ leads to a postulation of the minimal possible structures compatible with a given syntactic environment (De Vincenzi, 1991; Frazier & Rayner, 1988; Fodor, 1998; Inoue & Fodor, 1995). In case the processing cost is high, the system is even prone to error and even more so in linguistically impaired subjects due to the latter’s abnormal syntactic computation, especially in structurally complex environments. A slower than normal activation of the syntactic information present in lexical items (Zurif, Swinney, Prather, Solomon & Bushell, 1993), a slowed-down building-up of this information into well-formed syntactic constituents, or a faster than
normal decay of syntactic representations (Haarmann & Kolk, 1991; Kolk, 1995, 1998; Pinango, 1999) can be at the base of this impoverishment.

More specifically, the processing approach elaborates the idea that the module responsible for syntactic structure building is weakened/slowed down in agrammatism, as proposed by Haarmann and Kolk (1991), Pinango (1999), and Avrutin (2006). The main assumption of the specific works, forming the background of the deficient performance characterization in agrammatism, investigates the nature of this slowed-down component and the way it influences aphasics’ performance on a range of syntactic structures. Taking this assumption as a starting point, a specific processing deficit is claimed to lead either to a problem in activation, or to a fast decay of part of the morphosyntactic feature arrays associated with syntactic structures in grammatical representations. In this sense, the relevant works managed to build a connection between the underlying intuition behind the TDH (that selective disruption of chain construction is one of the fundamental characteristics of agrammatic Broca’s aphasia) and the processing accounts developed in the last decade.

The limited performance accounts have further argued in favour of a graded difficulty in accessing morphosyntactic feature sets normally associated with functional projections in agrammatic aphasia. More specifically, the processing theories claim that formal features of a certain class, e.g. operator- and scope–discourse related features, and, more generally, those related to prominent functional shells in the upper periphery of the clause and of the vP (such as wh-items and clefted sentences), are more likely to be compromised in cases of a processing deficit. Previous studies on agrammatic wh-question production generally acknowledge that wh-items are indeed impaired in agrammatism. Different aspects of question production have been studied extensively, like the distinction between argument and adjunct questions (Thompson & Shapiro, 1994; Thompson et al., 1996), as well as between wh-questions and yes/no questions (see Friedmann, 2002 in Hebrew and English; Ruigendijk, Kouwenberg & Friedmann, 2004 in Dutch; Neuhaus & Penke, 2003 in German; and van der Meulen, 2004 in French).
The better fit between the limited performance approach and the graded severity characterizing agrammatic linguistic symptomatology is based on different considerations. First, it is assumed that the underspecification in agrammatic syntactic representations follows a particular order: the representation of features that are accessed later in the derivation is more likely to be compromised as a consequence of a slower than normal activation/faster than normal decay of syntactic representations. Independent evidence for the order of activation of syntactic features also comes from the fixed hierarchical order of the positions of the functional projections in the syntactic tree as it emerges from cartographic studies. Secondly, as already mentioned, there is substantial evidence from the work of Friedmann (1998, 2002), and Friedmann and Grodzinsky (1997) indicating that material (features) associated with the left periphery of the clause is more problematic for agrammatic aphasics to access than that lower down in the syntactic tree, e.g. Agreement information (see TPH).

Another argument in favour of the limited performance account and its assumptions for the factors underlying the quantitative heterogeneity registered for the agrammatic populations comes from Sergey Avrutin’s studies subsumed under his Weak Syntax approach. Avrutin builds upon the Primitives of Binding (PoB) approach developed by Reuland (2001) in which the representation of purely syntactic dependencies is shown to be less costly relative to dependencies that require the interface between narrow syntax and extra-syntactic information, like discourse-derived cues. Avrutin’s claim is that agrammatic aphasia is characterized by a weakened syntax, a specific reduction of syntactic processing capacities which changes the hierarchy of PoB making the use of means other than the syntactic ones more economical for agrammatic patients. Support for these claims comes from different studies of production focusing on the omission of tense and determiners, as well as from agrammatic patients’ comprehension performance patterns in the processing of wh-movement and pronoun binding (Avrutin, 1999; 2000a, 2000b; Hickok & Avrutin, 1995; Ruigendijk, Vasic, & Avrutin, 2006; Vasic, 2006; Vasic, Avrutin & Ruigendijk, 2006). The results of these studies are interpreted as additional evidence for a problem with the syntactic representation of functional heads in agrammatism.
related to either a slowed-down access or an abnormally fast decay of the relevant morpho-syntactic feature arrays.

The various studies postulating a capacity limitation of processing resources in agrammatic aphasia have also tried to account for aphasics' comprehension asymmetries observed in canonical vs. non-canonical sentences. Non-canonical structures are the ones with non-standard linear word-order whose correct interpretation is made critically dependent upon the correct computation of syntactic chains. Since Caramazza and Zurif's work (1976), impairment in assigning the correct thematic roles during the comprehension of sentences with non-canonical word order, such as passives, object relatives and object clefts has been robustly attested. On the other hand, the comprehension of actives, subject relatives and subject clefts was found to be relatively more preserved. In Caramazza and Zurif's study the aberrant performance on sentences with non-canonical word order was defined as asyntactic comprehension and the deficit was related to restricted access to syntactic-like algorithm processes which are damaged in Broca’s aphasics. The reversible passive sentence in (1), for example, is supposed to place a heavy burden on aphasics’ syntactic mechanism, since its meaning can not be inferred from lexical-semantic information alone; both NPs are [+animate], thus, equally appropriate as candidates for the Agent role, such that their thematic disambiguation should rely on syntactic cues like the medio-passive suffix authorizing the derived status of the syntactic subject and the by-phrase denoting the Agent of the action portrayed by the verb.

5 Studies on agrammatic comprehension with Greek-speaking patients (Peristeri, 2002; Plakouda, 2001) have revealed that the agrammatic subjects' performance in passives significantly improved in sentences where the [±animacy] distinction could help the system assign the thematic roles of the agent and the patient through a heuristic-based procedure (i.e. the inanimate NP is prototypically identified with the Patient and the animate NP with the Agent).

(1) To karotsaki sernete apo ton kirio
the-NOM carrier-NOM draw-PASS-PRS-3sg by-the-ACC man-ACC

“The carrier is drawn by the man.”
Adopting the processing account in such cases has many advantages, like avoiding the stipulation of any independent mechanism differentiating the knowledge of agrammatic subjects (like the TDH proposed by Grodzinsky). Most importantly, though, it allows us to deal with variability in agrammatic performance which, as far as we know, has rarely been shown to display an opposite pattern to the one predicted, i.e. that canonical structures are more problematic than non-canonical ones. As such, according to the limited performance account, differences in the severity of the deficit could be easily translated into differences in the availability of processing resources. We know on independent grounds (Carpenter et al., 1994) that non-canonical structures are more complex than others to process. Moreover, the natural assumption that non-canonical structures require additional processing resources and may thus be out of reach of an impaired system, would make it possible (at least on principled grounds) to attribute different patterns of comprehension and production to the same source.

Some speculation regarding the processing-based direction can also be found in some studies of agrammatism with respect to the binding theory and the unsuccessful application of its constraints on

(1) I Kiria agaliastike apo ti giagia
the-NOM lady-NOM hug-PASS-PERF-3sg. by-the ACC old woman-ACC

“The lady was hugged by the old woman.”

Besides Greek, the results of the overwhelming majority of the studies (e.g. Berndt et al., 2004; Gahl, 2002; Wayland et al., 1996, a.o.) exploring the interpretation of reversible passives by agrammatic aphasics cross-linguistically support the idea that lexical-semantic information contributes to an improvement of the agrammatic comprehension of reversible structures in which the basic word order of the arguments has been inverted.
behalf of aphasics. A great amount of empirical work (Pinango & Burkhardt, 2001; Burkhardt, 2004; Avrutin, 2006; Vasic, 2006; Vasic et al., 2006) has attempted to combine the doctrines of the processing deficit approach with the Primitives of Binding framework of Reuland (2001). Much the same intuition was expressed in Hickok, Zurif and Canseco-Gonzalez (1993) who claimed that some sort of processing limitation was implicated in the deficient establishment of long distance chains in agrammatic patients; “it seems that when two elements that need to be associated are separated by lexical material, comprehension is poor” (Hickok et al., 1993: 387). The same line of reasoning was adopted in a very recent study of chain formation in agrammatism (Garaffa, 2006). The specific study has captured the patient’s selective deficit in the production of interrogative sentences by means of an avoidance strategy, such that the patient avoided constructing a long chain (more specifically, object who-questions) in favour of a less costly structure (i.e. subject who-questions). Moreover, the same study has yielded ample evidence of difficulties with object-extraction in D-linked interrogative questions (such as quale libro/which book’) which was attributed to an increase in the processing cost necessitated by the extraction of D-linked (vs. non-D-linked) wh-elements (also see De Vincenzi, 1991; Guasti & Rizzi, 2002; Hickok & Avrutin, 1995). Such experimental evidence lends support to the hypothesis that the linguistic deficit in agrammatism is an impoverishment of procedural capacities. This impoverishment is grammatically driven, and it manifests itself in reduced syntactic structures. Most interestingly, the processing-based nature of the accounts proposed so far was also extended to explain similar patterns displayed by different populations such as children (Avrutin, 2000a, 2000b) and unimpaired adult speakers tested under constrained processing conditions and in stressful situations (Dick et al., 2001).

To sum up, according to the processing limitation account a neurological event can generate a reduction in syntactic processing. This reduction is assumed to be visible in the non fully-attained activation of part of the formal feature arrays involved in (mainly the higher) layers of syntactic
representations (or in their faster than normal decay) especially under conditions inflicting overwhelming computational cost.

Processing approaches are not exempt from problems on a theoretical level. First, a central issue in processing based accounts is the correct definition of complexity. As already mentioned, sentences with non-canonical word order, like passives and object-relative clauses, are more difficult for aphasics to parse than canonical structures, like subject relative and active transitive clauses, because they rely more heavily on syntactic processing components. This observation may well allow one to draw up a scale of complexity that can be used to check hypotheses and reach a proper description of the facts. It will not, however, necessarily lead us very far in understanding the deeper mechanisms that are disrupted in agrammatic aphasia, nor the linguistic and cognitive mechanisms that make a sentence more complex than another one. In other words, if our goal is to understand why certain structures are more complex than others, then the issue requires going back to linguistic representation and, something which is far from trivial, reaching a proper understanding of the representational properties and the cognitive demands of those structures. Besides the definition of complexity, the processing approaches may also be criticized on their inadequacy of accounting for the lack of a qualitatively uniform pattern among different agrammatic subjects with relatively the same degree of severity of impairment. The extent to which qualitative variation is actually observed when the data are subject to sophisticated statistical analysis is at the centre of an ongoing debate (Drai & Grodzinsky, 2006a, 2006b). Without addressing these two questions, our quest for proper understanding of agrammatism will lead us to little more than an interesting collection of curious accidental phenomena albeit elegantly connected.

On a par with the competence account, the limited performance approach to agrammatism was doubted on empirical grounds as well. More specifically, Burkhardt, Pinango, & Wong’s (2003) study with two English-speaking agrammatic patients points out that late re-activation of the antecedent instead of total absence of it in anti-causative verbs could be taken as evidence against the processing
account that proposes an impoverishment of the morphosyntactic features in Broca’s aphasia. Crucially, Burkhardt et al.’s finding speaks in favour of intact morpho-syntactic features but delayed automatic syntactic reflexes caused by the anterior lesions to the patients’ left hemisphere. Late reactivation of the complete featural make-up of elements critically contributing to the computation of certain syntactic derivations as proposed by Burkhardt et al. (2003) leaves agrammatic patients’ problems with non-canonical word order structures (detected off-line) unaccounted for.

2.2.3 The interface-based account

As already mentioned, a small number of studies (Avrutin, 2006; Burkhardt, 2006; Grillo, 2008) have recently found that aphasic individuals’ processing resources are especially taxed by the processing of linguistic material necessitating the integration of syntactic information with informational cues derived from other grammatical components, and especially discourse. The interface-based account in agrammatism has gradually become a very important issue, with its supporters even claiming that the deficit in agrammatism may not be internal to the narrow computational system, but may indicate a selective deficit in the projection of those categories computed at the interfaces between the narrow syntax and other grammatical as well as extra-grammatical components.

The insight that the language system contains independent grammatical components, each with its own units and combinatorial principles, is well-represented in the linguistic field (Bresnan, 2001; Goldberg, 1995; Pollard & Sag, 1994). The minimalist architecture (Chomsky, 1995) of the language faculty is one of the strongest instantiations of this idea because it suggests a robust distinction between modular syntactic operations and interface conditions sensitive to the distinct properties of the grammatical components (e.g. semantics, lexicon, discourse, morphology, phonology). According to the interface-based processing models, the information encoded in these components is deployed and manipulated via ‘parallel tracks’ with narrow syntax (Pinango, Mack & Jackendoff, 2006: 49). So far,
such interface-conditioned knowledge has been independently shown to “be active at the very early stages of the interpretational process” (Pinango et al., 2006:50) and was evinced to be part of the mandatory knowledge that is deployed during the comprehension of a wide range of basic linguistic phenomena, such as word-order variations (Hagoort, Wassenaar & Brown, 2003; Grodzinsky, 2000), and anaphora interpretation (Pinango & Burkhardt, 2004; Avrutin, 2001).

The initial assumption in the neurological literature, though, was that syntactic structures at which patients with Broca’s aphasia normally exhibit comprehension at chance level, could be made less taxing if the interface-conditioned properties of the derivations in question were fully exploited. This assumption was primarily based on the stipulation that the locus of the agrammatic syndrome is impaired syntactic algorithms/computations. As such, spared non-syntactic knowledge employed at the interface was predicted to compensate for the impaired processes of combinatorial syntactic mechanisms alone. Nevertheless, a look at cross-linguistic evidence on agrammatic performance patterns in interface-conditioned structures suggests that the latter are the most vulnerable in agrammatism. Indeed, much recent literature on the topic points out that agrammatic aphasics have selective problems with the comprehension of syntactic products that must first be filtered through other grammatical component(s) (Friedmann & Grodzinsky, 1997; Avrutin, 1999, 2006). More specifically, several studies have shown that agrammatic patients have selective problems with assigning reference to pronominals whose interpretation critically lies at the pragmatics-syntax interface (Grodzinsky et al., 1993; Vasic, 2006; Vasic et al., 2006; Ruigendijk et al., 2006; Edwards & Varlokosta 2007). Moreover, Grillo’s (2008) single-case study has revealed an asymmetry in the comprehension of which-NP-type and who- (object) questions which was attributable to the requirement of the former structures to interface the syntax proper with information derived from the discourse. Finally, the satisfaction of a requirement at the syntax-discourse interface was held responsible for aphasics’ below-chance performance in passive constructions as well. Grillo (2008) assumes that passivization (or else, movement of the vP to the VoiceP projection) is triggered by a discourse-related feature responsible for
the change of the event structure of the initially transitive verb. Inability of the parser to satisfy this discourse-related requirement at the syntax-discourse interface is assumed to cause problems in the interpretation of passives by aphasics.

The underlying source(s) of the processing ‘instability’ associated with the interpretation of interface-conditioned structures by agrammatic aphasics has been little explored within the field of aphasiology. As already mentioned, most studies have focused on the syntax-information structure interface suggesting that the most problematic area for aphasic patients is related to the integration of syntactic with discourse-related knowledge. However, no study appears to have explicitly located the source that triggers the underspecification of higher order (scope-discourse related) features computed at the discourse-syntax interface.

In line with previous studies, the present research proposes that there is a positive predictive relation between interface-conditioned structures and processing difficulty in Broca’s aphasic patients. More specifically, we assume full specification of functional features in the syntactic component of the agrammatic system, but less reliable access to the critical features at the interfaces due to the latter’s higher cognitive demands. Our starting point for such an assumption is that lexical entries contain only the feature specifications necessary to ensure their insertion in the correct linguistic environments. If the feature specification of a linguistic element with respect to its interpretation is completely pre-established in narrow syntax (as is the case with the referentially underspecified null subject pronouns in NSLs, and the reflexive/non-reflexive reading distinction in sentences with non-active voice morphology), then the mapping from syntax onto the conceptual-intentional level appears to be the cheapest computational option in a maximally transparent interface between syntax and interpretation. On the other hand, we propose that the functional features implemented at the interfaces are of a highly specified, marked value due to the fact that they serve a distinctive interpretative property that lacks in the unmarked paradigm. This property implements the filtering nature of the interfaces: when
confronted with a feature constrained by a marked interpretive value, the semantic level\(^6\) is ‘obliged’ to construct a semantic representation akin to the marked value of the syntactic representation. A higher expectation regarding the interpretive specialization of the spelled-out constituent should require more processing resources relative to the symmetric grammatical process whereby a formal feature needs to be directly checked within the narrow syntax without being ‘blocked’ by an interface constraint.

Taking these assumptions as a starting point, we hypothesize that the aphasic subjects will face difficulty with the processing of interface-conditioned structures. The present approach derives the interface effects from a capacity limitation of cognitive resources, including working memory and attention allocational resources. By investigating the nature of interface-conditioned configurations in agrammatism we hope to show the extent to which certain characteristics of aphasic speech may be attributed to a possible reduction of cognitive extra-linguistic capacities rather than to a syntactic deficit per se.

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\(^6\) We assume that pronoun ambiguity resolution is carried out when ‘higher’ levels of pragmatic processing (like the contextual appropriateness in the use of overt subject pronouns) are activated, such that the derivation converges at a post-interpretive/post-LF level.
Chapter 3 THE LINGUISTIC FRAMEWORK OF THE STUDY

In this chapter I lay out the theoretical framework in which the analyses of the subsequent chapters will be framed. The main purpose is to make clear how the components of the grammar are intended to fit together in the form of interfaces, and where responsibility for various types of performances of the aphasic patients is intended to lie.

3.1 The Discourse-Syntax Interface

The Minimalist Program (Chomsky, 1993 et seq.) is a derivational model of grammar. There are no representations to which grammar can refer, except at the end of a computation where the grammatical features become relevant to the phonetic and the semantic interfaces, corresponding to the sensori-motor and the conceptual-intentional system, respectively. At both interfaces, a derivation must be fully interpreted (Principle of Full Interpretation). For a derivation to be fully interpreted it should be ‘well-formed’ both phonologically and semantically. The primary requirement imposed by the interfaces between syntax and the neighbouring systems is that all formal features of a lexical item not contributing to the semantic interpretation of that item should get erased, otherwise the derivation crashes.

According to Chomsky, syntax can not inspect a feature and determine whether the semantics will or will not assign an interpretation to it, but can inspect the feature and determine whether it is interpretable or not. As such, Chomsky (1995) makes a critical distinction between two kinds of syntactic features, interpretable versus uninterpretable. Interpretable features are relevant for interpretation at both the semantic and the phonetic interface, i.e. they can be ‘read off’ by the conceptual-intentional and the articulatory-perceptual system of cognition, respectively, while uninterpretable features are not. Interpretable features include phi-features (e.g. person and number)
on nominals, tense features, etc. Uninterpretable features, on the other hand, include the corresponding phi-features on verbs/INFLs as well as case features on determiners, nouns and adjectives, since these are irrelevant for interpretation. Interpretable features need never be checked; they can be checked, but do not delete after checking. In contrast, uninterpretable features must be checked and deleted so as to be unavailable for the rest of derivation. More specifically, once they are checked by entering an Agree relation with their matching interpretable feature, they delete, i.e., they are no longer visible at the semantic or the phonetic level. On this view, the point at which deletion takes place is at the domain of a phase upon its completion; the phases are theoretically postulated to be sub-arrays at the Numeration and they coincide with the CP and the vP constituents, as these objects are propositional in nature (Chomsky, 2000 et seq).

The crucial point in Chomsky’s derivational machinery is that while interpretable features and the Merge operations to which they are subjected are invariant cross-linguistically, uninterpretable features vary across languages. Such an assumption is most prototypically evinced in the cross-linguistic parametrization of the Null Subject Parameter (NSP) which has been stipulated to follow from motivated properties of feature interpretability. More specifically, the presence or absence of an uninterpretable D-feature (realized as the Extended Projection Principle (EPP) feature in previous literature, e.g. Chomsky 1986) on the $T^\circ$ head\(^7\) has been claimed to be the primary reason for distinguishing between null subject languages (NSLs) like Greek from non-NSLs, like English (Alexiadou & Anagnostopoulou, 1998; Holmberg, 2003, a.o.). Following this assumption, languages with five or six distinct agreement morphemes are assumed to have an uninterpretable D-feature on Infl$^\circ$ which is ultimately checked and deleted by a (presumably universally available) fully underspecified (with respect to the possible combinations of person, number and gender features it can take) D-

\(^7\) According to Chomsky (1995), while D-features and phi-features are [+interpretable] within the nominal system, they are [-interpretable] when they occur on verbal heads.
pronoun pro at [Spec,IP] serving as the goal. Once the two features enter an Agree relation, no uninterpretable features are left on the verb and the derivation can converge with pro’s formal features being identified and retrieved under formal licensing and agreement with the Infl˚ head (Rizzi, 1997). The phonological deletion of the feature bundle associated with pro in NSLs is assumed to be the interpretive effect of a parameterized operation taking place at the phonetic interface. On the other hand, in a language with no agreement and obligatory overt subjects, deletion of the pronoun is not licensed under identity, therefore, no checking operation is necessary. Consider the following examples in (2a) and (2b). Greek (2a) allows null subjects in finite clauses whereas English (2b) lacks this option:

(2)

(a) Efige Go-PERF-3sg
“He left.”

(b) *(He / she) left.

Apart from the parametric selection of a phonologically overt subject determined by the specified value of the Infl˚ head across languages, the null subject setting of the NSP has additional effects related to the interpretative component of natural language grammar, i.e. the semantic level of syntactic representations (Platzack, 1999). More specifically, in the present research we focus on the choice of null/overt subject pronominal forms in referentially ambiguous contexts in the Greek language. This is an area of pragmatically-constrained variation where the occurrence of one pronoun type (null/overt) over the other in the relevant syntactic environments appears to integrate properties of language and pragmatic processing, like, first, the assessment of the discourse-contextual conditions affecting the distribution of the two forms, and, second, the native speakers’ parsing preferences.
The existence of two morpho-phonologically distinct subject pronominal forms in NSLs is closely linked to the general anti-optional character of human language and its consequences in terms of hierarchical restriction and parametric selection. According to the global interpretation of economy, grammar is to minimize the number of operations necessary for convergence (Kitahara, 1995). Naturally, the grammar needs to compare two convergent operations and see which has a fewer number of operations applied. Following this scenario, a syntactic derivation spelling out an overt subject pronoun in a NSL would assumingly be less economical relative to null subject pronouns since the former derivation involves additional spell-out at the phonetic interface.

This apparent inconsistency is resolved if one considers that such fine grammatical distinctions related to the possibility of dropping or inserting pronominal material depending on the context are not probabilistic but they are motivated on principled grounds (see, for example, Rizzi (2005) on the possibility of dropping pronouns in restricted structural environments in L1 acquisition; Hamann et al. (2003) for a study on complement pronouns in children with Specific Language Impairment; Friedmann (2002) for the production of interrogatives in aphasia related to different structural layers). These findings are consistent with the proposal that the realization or the dropping of an overt subject pronoun in a NSL follows the requirements imposed by the syntax-semantics interface and supports a grammatical interpretation of the phenomenon. More specifically, since all operations in the Minimalist programme are deemed to be feature-driven, the distribution of null and overt pronouns in a NSL is assumed to be triggered by an [+interpretable] feature checked by the interpretative component of the natural language grammar, i.e. the syntax-semantics interface usually associated with the semantic level of syntactic representations (Platzack, 1999). In spite of the fact that there is not yet full consensus on the exact nature of the feature involved (for Di Eugenio (1998), Dimitriadis (1996), Grimshaw & Samek-Lodovici (1998) the interpretable feature is named [+topic-shift]; for Cardinaletti & Starke (2001) it is associated with the introduction of a ‘referential index’), the bulk of the studies conducted so far agree upon the fact that the grammar of NSLs provides the null/overt subject pronoun
entries and regulates their distribution according to the interpretative constraints imposed by the semantic interface.

Such interpretative distinctions are first evinced in referentially unambiguous contexts (i.e. in contexts wherein the overt pronoun is readily resolved by the distinct formal features of the candidate antecedents), whereby the integration of the overt pronoun secures the contrastive topicalization (3a) or focusing of the subject pronoun (3b). E.g.

(3)

Context: O k. Papadopulos ke i k. Georgiu ergazode sto panepistimio ke se the Mr. Papadopulos and the Mrs. Georgiu work-3pl. in the university and in ena diasimo ekdotiko iko. a famous publishing house

“Mr. Papadopulos and Mrs. Georgiu work at the university and at a famous publishing house.”

(a) Afti tu to protine SHE him-CL-GEN it-CL-ACC suggested-3sg.

“She suggested it to him.”

(i) Parolafta, kathe fititis lei oti aftos den ithele. however each student say-3sg. that HE not wanted-3sg.

“Howeover, each student says that he didn’t want (such a thing).”

Although a potential alternation between an overt subject pronoun and *pro* would be grammatically licit in the above contexts, contrastive topic and focus environments in Greek require an overt pronoun (Tsimpi, Sorace, Heycock & Filiaci, 2004). Furthermore, because one of the referential
antecedents, *Mr. Papadopulos*, is specified for [+masculine] and the other, *Mrs. Georgiu*, is specified for [−masculine], the overt pronoun *afti* ‘she’ or *aftos* ‘he’ is required, depending on whether we want to focus on *Mr Papadopulos* or *Mrs Georgiu*. A null pronoun *pro* would cause ambiguity since it is inherently underspecified for the [±masculine] feature and, therefore, neither of the discourse referents could be contrastively topicalized or focused.

The interpretative distinction between null and overt subject pronouns in NSLs is also evinced in the assignment of reference to subject pronouns in *referentially ambiguous contexts*, i.e. in contexts having two same-gender & number referents. In these linguistic environments pronoun resolution can not be established on the basis of the formal features of the potential antecedents alone. In such cases, a topical subject antecedent is typically favoured as the antecedent of *pro*, while a non-topical non-subject antecedent (most of the times identified with the main clause object) is usually preferred as the antecedent of an overt pronoun with the aim of achieving a shifted interpretation\(^8\) (4).

\[(4)\] O tahidromos-*i* heretise ton papa-*k* otan *pro-*/*aftos-*k* pernuse to dromo

The-NOM postman-NOM waive-PERF-3sg the-ACC priest-ACC when *pro/he* cross-IMPERF-3sg the-ACC street-ACC

“The postman-*i* waived at the priest-*k* when *pro-*/*he-*k* was crossing the street.”

\(^8\) According to Tsimpli et al. (2004) the shifted interpretation achieved by the use of the overt subject pronoun does not presuppose a focused meaning assigned to the subject pronoun. As such, no heavy stress needs to be carried by the pronominal. In case it does, the shifted interpretation is retained, yet, the stressed pattern has extra effects on the interpretation, with the subject pronoun acquiring additional deictic properties (along with the already established contrastive ones).
This example is consistent with the proposal that overt subject pronouns in typical (at least) NSLs are considered a ‘marked’ option, regulated by a number of discourse factors. In fact, the use of the overt subject in sentences such as (4) without a ‘topic-shift’ has been judged as being infelicitous (but not ungrammatical) by native speakers of Greek and Italian (Tsimpli & Sorace, 2006). Though the exact nature of the external pragmatic conditions claimed to regulate the distribution of null and overt subject pronouns in NSLs is hotly debated, the evidence suggests that the acceptable use of overt subject pronouns in two potential antecedent contexts always involves a shifting of the discourse topic from the matrix subject to the matrix object (Grimshaw & Samek-Lodovici, 1998; Tsimpli et al., 2004; White 2008). More specifically, pronominal interpretation in such contexts is claimed to involve an additional ‘external’ syntax-discourse interface that exploits the parametric options offered by the grammar and has interpretive effects only with regard to the overt subject pronouns. The latter are claimed to be regulated in the pragmatics by features like [+topic-shift] and [+focus]. In fact, the use of overt subject pronouns in [+change-reference] contexts was recently found to develop much earlier than the use of null pronouns in [+maintain-reference] contexts in a group of 8-10 year-old Spanish-speaking monolingual children (Shin & Cairns, 2007). The discourse-dependent uses of overt pronouns are also reflected in syntactic theories claiming that most overt (pre-verbal) subjects are clearly located in the left periphery, either in topic position when presenting new information or in a focal position when encoding contrastive emphasis (Ordonez & Trevino, 1999; Goodall, 2002; Suner, 2003).

What appears to differentiate ‘internal’ from ‘external’ interfaces is the greater processing cost inflicted by the latter. Unlike narrow syntax which is an autonomous and encapsulated system, the linguistic discourse is a dynamic open system that interfaces with general cognitive and processing abilities and as such it is prone to be affected by them. Understanding other people’s mental states with the aim of evaluating the relevant discourse conditions and establishing the correct pronoun-antecedent dependencies in real-time language use requires the simultaneous co-ordination and integration of multiple types of information. As such, the ‘external’ discourse-syntax interface appears to
be more costly and computationally more demanding than the computation of the syntax-semantics interface-conditioned properties of the two pronoun-type entries (Sorace, 2005). The greater cost and processing limitation inflicted by the incremental access to discourse knowledge ‘read’ by the conceptual/intentional system of cognition has been repeatedly registered in monolingual native speakers (especially monolingual children) who have been reported to make a greater effort when integrating syntactic information with discourse-derived cues (Roberts, Gullberg & Indefrey, 2008; Hopp, 2007).

There are strong theoretical reasons to believe that the human parser in cognitively plausible models of sentence comprehension tend to limit the number of structural interpretations entertained simultaneously under conditions of excessive processing load (Jurafsky, 1996; Crocker & Brants, 2000). Such processing models can be thought of as having finite resources available to allocate to possible structural interpretations. This means that in a region of unresolved syntactic ambiguity, there is a chance that one of the possible interpretations will be lost entirely. Following this line of reasoning, we presume that in cases of referential ambiguity the human parser, having to proceed under time pressure and being subject to working memory constraints, wants a clear indication of the nature of the elements to link in a co-referential dependency relation. When the discourse/pragmatic context constraints are not explicit enough, the system is most likely to resort to a shallow, least effort parsing strategy.

The evidence for the application of such a compensatory strategy relevant to the syntax-discourse interface discussed in the present study is that a wide range of referentially ambiguous sentential contexts (like (4)) are resolved in favour of the most cognitively prominent antecedent when other antecedent selection cues are uninformative (Ariel’s assessibility hierarchy 1988; 1990; Delle Luche, Van Gompel, Gayraud, & Martinie, 2006; Gordon, Hendrick, Ledoux, & Yang, 1999; Comish, Garnham, Cowles, Rigalleau, Fossard, & Andre, 2005; Grosz, Joshi, & Weinstein, 1983). In fact, biased selection towards the most prominent (and ultimately preferred) antecedent is claimed to be a prevalent
parsing routine attested cross-linguistically and assumed to be driven by the parser’s tuning with
previous parsing choices in encounters with comparable ambiguities (Dussias & Sagarra, 2007:103).
Different types of linguistic prominence have been suggested to have the common effect of increasing
the perceptual prominence of discourse referents, like topicalization of a potential antecedent through
left dislocation, and focus achieved through contrastive prosody, among others. Nevertheless,
subjecthood has been reported to be the most influential factor biasing the parser towards the preferred
antecedent. No consensus, yet, has been reached with respect to whether the cognitive prominence of
subjects stems from their grammatical function signalled by nominative structural case marking or from
their usually pre-verbal topical position in the syntactic tree (see Sturgeon, 2006 for Czech; Miltsakaki,
2002, and Dimitriadis, 1996 for Greek; Carminati, 2002 for Italian a.o.). Some studies argue that
grammatical subjects rank higher than grammatical objects independently of their information status as
topics (Kaiser & Trueswell, 2008 (for Finnish); Miltsakaki, 2002 (for Greek); Carminati, 2002 (for
Italian)), while others claim that the prominence effect is mainly driven by the information (topic-) status
of the critical antecedent rather than by its grammatical role as a subject (Arnold, 1998; Gordon, Grosz
& Gilliom, 1993; Almor, 1999; Cowles, 2003 (for English); Sturgeon, 2006 (for Czech)). Regardless of
this on-going debate, all empirical studies appear to agree upon the assumption that subjecthood
(along with recency and position within the syntactic frame) is a very influential factor in increasing the
accessibility of the referent and, consequently, in biasing the parser to make the final antecedent
choice.

To sum up, competent resolution of subject pronouns in NSLs is claimed to involve the following
three interacting components:

1. correct syntactic licensing at the level of mental representations of grammatical knowledge
   (i.e. null and overt pronoun entries),
2. availability of specific processing strategies and efficient computational resources at the discourse-syntax level that will allow the evaluation of the relevant pragmatic conditions of contextual appropriateness and the establishment of the correct pronoun-antecedent dependencies, and, finally,

3. a fully active parser picking the subject antecedent as a compensatory, ‘default’ choice under conditions of increased referential complexity driven by the interpretational ambiguity of contexts whose potential antecedents are morphologically matched with the critical pronoun in subject position.

From this perspective, it is highly probable that the resolution of the overt subject pronoun in NSLs will be prone to fluctuation in the presence of prolonged syntactic ambiguity or/and limited processing resources. More specifically, whereas the computation of entries for null and overt pronouns in the ‘internal’ syntax-semantics interface is consistent with the parametric structure of the NSL, overt pronoun resolution in the ‘external’ discourse-syntax interface is governed by non-syntactic factors (like, the variations in the discourse/mental models construed by individual speakers/comprehenders). Moreover, exceeding the processing resources available to the human parser favours the ‘default’ choice of the topical subject as the most felicitous antecedent, thus, disregarding the interface-based antecedent assignment principles for overt subject pronouns.

The interplay of these factors inevitably renders the antecedent preferences of overt subject pronouns more flexible relative to null subject pronouns. Indeed, it is attested that the establishment of null pronoun-topical subject co-referential links is never less optimally realized than overt pronoun-non-subject links cross-linguistically (see ‘Literature Review’). More specifically, this effect is visible in configurations such as (4) where the system is more prone to error in structures having an overt pronoun in subject position: the overt pronoun aftos/’he’ may as well be anteceded by the topical subject o tahidromos/’the postman’. Alternatively, what language-unimpaired comprehenders’ data
have in common is that the topical subject appears to be a stabilizing factor in the computation of referential ambiguities in a maximally transparent interface between reference and structural position (or grammatical role). Neurolinguistic investigation of this non-fixed domain is an interesting issue since it offers us the opportunity to explore the functional weight assigned by agrammatic aphasics to the discourse constraints regulating the distribution of overt subject pronouns in the Greek language.
3.2 The Lexicon-Syntax Interface

Another non-fixed domain subject to interpretational fluctuation in language-unimpaired individuals is that of verbs of alternating transitivity, including passives, reflexives and anti-causatives. Much of the evidence for the interpretational fluctuation registered in these predicates is related to the existence of various distinct readings assigned to the same verbs, which has proved to be a fertile ground for testing hypotheses about the lexicon-syntax interface (Tsimpli, 2006; Fotiadou & Tsimpli, 2008).

In a morphologically rich language like Greek, the interpretation of verbs of alternating transitivity provides an interesting case since transitivity changes are not unambiguously specified on the verb form via voice morphology, but are rather determined through a dynamic interaction between syntax and extra-clausal, semantic and pragmatic components. More specifically, preference for one of the possible readings of the relevant verbs, i.e. passive, reflexive, or anti-causative, is sensitive to a number of distinct factors apart from the morphological marking of the verb with ACT/NACT voice morphology, like the [± animacy] of the syntactic subject, the semantics of the verbal predicate, as well as pragmatic considerations, such as ‘the naturalness, frequency and transparency of the relation between the subject and the event described by the verb’ (Tsimpli, 2006: 27).

The model of language architecture that we adopt here includes a distinct level of syntactic computation, where reflexives are distinguished from non-reflexive derivations (i.e. passives and anti-causatives) in a grammatically-principled manner, and a lexicon-constrained level, where the syntactic output is interpreted via a series of semantic and pragmatic operations (Tsimpli, 2006). The syntactic level is thus the level that generates morpho-syntactically well-formed verbal derivations, while the lexicon is the level of representation responsible, among other things, for the final choice of the preferred interpretation assigned to the verbs of alternating transitivity. Such interface-conditioned knowledge is assumed to be possessed by adult speakers when it comes to the interpretation of the relevant verbs.
More specifically, transitivity alternations have traditionally been characterized by pairs of sentences where the same verb appears with both transitive (5ia, 5iia, 5iiia) and intransitive uses (5ib, 5iib, 5iiib):

(5)

(i) Passive verb derivation:

(a) I ergates evapsan to spiti the-NOM workers painted-ACT-3pl. the house

“The workers painted the house.”

(b) To spiti vaftike apo tus ergates the-NOM house paint-NACT-3sg. by the workers

“The house was painted by the workers.”

(ii) Reflexive verb derivation:

(a) I Maria luzi ta malia tis the-NOM Maria wash-ACT-3sg. the-ACC hair her-POSS-GEN

“Maria washes her hair.”

(b) I Maria luzete the-NOM Maria wash-NACT-3sg.

“Maria washes.”

(iii) Anti-causative verb derivation:

(a) O aeras eklise tin porta the-NOM wind closed-ACT-3sg. the-ACC door

“The wind closed the door.”
(b) I porta eklise apo ton aera.

the-NOM door closed-ACT-3sg. by the wind

“The door closed (*by the wind).”

According to previous theories (Pesetsky, 1995; Reinhart & Siloni, 2004), there is only one basic entry for each verbal concept in the lexicon and the different thematic realizations of the same concept are assumed to be derived from the same basic entry via thematic arity (i.e. valency-changing) operations on argument structure. Although predicates such as passives and anti-causatives are assumed to be derived by the same kind of operation universally, the considerable cross-linguistic variation they exhibit results from the level wherein these operations apply according to a parametric choice. Reinhart & Siloni (2004) suggest that UG arity operations, which affect the syntactic valency of a verb, can apply in the lexicon or in the syntax, as formulated by the following parameter (6).

(6) The Lex-Syn Parameter (Reinhart & Siloni, 2004:191)

UG allows thematic arity operations to apply in the lexicon or in the syntax.

According to the specific parameterization, passives have been analyzed as the outcome of an argument reduction process in the syntax (called ‘saturation’) whereby “the accusative case feature of the originally transitive verb is suppressed by existential closure with no yet corresponding reduction in the number of theta roles assigned by the v/V head” (Reinhart & Siloni, 2005: 421) (see also Dimitriadis, 2004; Roeper, 1987; Grimshaw, 1990; Chierchia, 1989, 2004; Blevins, 2003 for a similar argument on the derivation of passives). As such, the internal argument is promoted to surface subject position to satisfy the Extended Projection Principle, yet, the syntactically suppressed external argument is assumed to be present at the level of interpretation in the form of an implicit agent. The latter is modified by PPs denoting agents, instruments and causers/causing events, i.e. the three theta-
roles that are also licensed in the corresponding causative constructions (Alexiadou & Anagnostopoulou, 2004).

On the other hand, anti-causatives have been claimed to involve some lexical or feature-based operation (referred to as decausativization, detransitivization, expletivization, or reduction (e.g. Chierchia, 1989; Levin & Rappaport-Hovav, 1995; Reinhart, 1991, 2002; Kallulli 2006) which also reduces the number of expressed arguments by one. External argument reduction in anti-causatives though would differ from saturation in that the reduced role, i.e. the external theta role, is fully eliminated from both syntax and semantics, such that the reduced argument is no longer accessible at the level of interpretation. As a result, the resulting ergative entry would have one case feature and a single theta role to assign. The fact that anti-causatives can not combine with by-phrases, purpose clauses, or agent-oriented adverbs as passives do is taken as evidence that the “binding of the external cause takes place in the mapping from the lexical semantic representation to argument structure thus rendering the anti-causatives the only lexically-reduced verbal structures” (Levin & Rappaport Hovav, 1995: 108). As such, anti-causative verbs completely lack a logical subject and should be analysed as inherently non-agentive. The presence of a cause-denoting PP allowed in the anti-causatives is represented as a true adjunct not linked to a syntactic argument position (7) (8).

(7)
(a) The window was opened by Mary.
(b) The vase was broken on purpose.

(8)
(a) *The window opened by Mary.
(b) *The vase broke on purpose.

Finally, reflexivization has not been claimed to eliminate a theta role from the verb’s theta grid specification. Rather, a theta role is not mapped onto a syntactic argument position present in the
semantics of such predicates. Reinhart and Siloni (2004) argue that when reflexivization applies in the lexicon, it takes two theta roles and forms one complex theta role. They call this operation bundling which is obligatorily applied on the verb's external theta-role (9). This operation associates two theta roles with the external argument. On the other hand, when reflexivization applies in the syntax, the operation is different. Bundling in syntax does not apply to the theta grid of the verb, but to unassigned theta roles. An internal theta role is not mapped onto its canonical position due to the lack of case. Upon the merging of the external theta-role, the unassigned role is bundled with the external role, resulting in the assignment of two roles to the same syntactic argument.

(9) Reflexivization bundling operation

\[ \theta-i \] \[ \theta-k \] \rightarrow [ \theta \cdot -k ], where \( \theta-i \) is the external theta role.

The derivational accounts of the relevant verbal structures in terms of valency-reduction operations were not unproblematic from many perspectives. First, the \[±agentivity\] feature on the verbal head proved not to be a reliable diagnostic for the passive vs. anti-causative verb distinction. Crucial to this claim was evidence provided by Kalluli (2007) demonstrating that agent-oriented adverbs are not totally incompatible with anti-causative syntax as exemplified by the anti-causative verbs cadere/‘fall’ and rotolare/‘roll’ in Italian which continue to exhibit the syntactic behaviour of unaccusativity (i.e. the essere/‘be’ vs. avere/‘have’ auxiliary selection characteristic of anti-causative verbs in many languages) even in the presence of an agent-oriented adverb like ‘on purpose’ (10).

(10)

(a) Gianni e` caduto/*ha caduto apposta.

“Gianni is fallen/has fallen on purpose.”

(b) Gianni e` rotolato/*ha rotolato giu apposta.
“Gianni is rolled/has rolled down on purpose.”

Furthermore, anti-causative verbs of internal causation, such as blossom or glow do not have a causer as an external argument. As such, their derivation can not be explained on the basis of decausativization, thus, lending support to the assumption that a different derivational operation is implicated for the specific set of anti-causative verbs. Finally, the aforementioned proposals prove insufficient to account for the verification of unaccusativity features on verbal predicates morphologically marked with NACT voice morphology in languages with a morphologically rich inflectional paradigm like Greek. In Greek NACT anti-causative verbs, the PP indicating the cause is not treated as an adjunct but it is co-indexed with the NACT morpheme carrying the external theta-feature (11) (Fotiadou & Tsimpli, 2008).

(11) To trapezomandilo lero-thi-ke (apo ta pedhia)
the tablecloth got-dirty-NACT-3sg. (from the children)
“The tablecloth got dirty.”

Crucially, the [+transitivity] property of passive and reflexive verbs in Greek can be easily evinced, as the reduced argument is manifested at the phonetic level through the NACT suffix. In contrast, anti-causative verb derivations may be marked with either ACT or NACT voice morphology (or even have both morpho-phonological forms in [+voice-alternating] anti-causatives). Indeed, an interesting property of anti-causative verbs in Greek is the way in which the suppression of the external θ-feature is realized in the morphological component. More specifically, according to the categorization proposed by Alexiadou and Aanagnostopoulou (2004: 123-127), there are four classes of anti-causatives in Greek:
a. In the first class, the anti-causative verbs have NACT morphology, while in their unmarked, i.e. ACT voice form, they are transitive:

(12) O giatros giatrepse to Gianni. (causative/transitive)
The-NOM doctor-NOM heal-PERF-ACT-3sg. the-ACC Gianni-ACC
“The doctor healed John.”

(13) O Giannis giatrefteikõ (apo thavma). (anti-causative)
The-NOM Giannis-NOM heal-PERF-NACT-3sg. (by miracle-NOM)
“John healed (by a miracle).”

b. The second class consists of anti-causatives which have NACT morphology. Active voice morphology is used with transitive verbs, but there is also a limited number of verbs that are ergatives with ACT morphology:

(14) O Giannis ékapse ti súpa. (causative/transitive)
The-nom Giannis-NOM burn-PERF-ACT-3sg. the-ACC soup-ACC

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8 According to Tsimpi’s (2006) derivational account of NACT verbs in Greek the same verb ‘giatreftike/healed-NACT’ is also prone to a passive (2) or a reflexive (3) interpretation.

E.g.

(2) O Giannis giatreftike apo to giatro (passive)
“John healed-NACT by the doctor.”

(3) O Giannis giatreftike monos tu (reflexive)
“John healed-NACT on his own.”
The Linguistic Framework – Lexicon Syntax Interface

“John burnt the soup.”

(15)  I supa kaike$^{10}$  (anti-causative)

The-NOM soup-NOM burn-PERF-NACT-3sg.

“The soup burnt.”

(16)  I fotia kei/*kegete. (intransitive/ergative)

The-NOM fire-NOM burn-IMPERF-ACT-3sg/burn-IMPERF-NACT-3sg.

“The fire burns.”

c. The verbs in this class are de-adjectival verbs. The anti-causatives have ACT morphology and can only take an inanimate subject. Active morphology is present in transitive variants as well:

(17)  O Giannis adiase ti sakoula. (causative/transitive)

The-NOM Giannis-NOM empty-PERF-ACT-3sg. the-ACC bag-ACC

“John emptied the bag.”

(18)  I sakoula adiase. (anti-causative)

The-NOM bag-NOM empty-PERF-ACT-3sg.

“The bag emptied.”

$^{10}$ According to Tsimpli’s (2006) derivational account of NACT verbs in Greek the same verb ‘kaike’/burnt-NACT’ is also prone to a passive interpretation:

(4)  To spiti kaike apo ton ebristi (passive)

“The house was burnt-NACT by the arsonist.”
d. In this class, all the transitive verbs appear with ACT voice morphology. Anti-causatives optionally appear either with ACT or NACT morphology without the voice change affecting the availability of the anti-causative reading\textsuperscript{11}. Such verbs are labelled as voice-alternating verbs\textsuperscript{12} and they are referred to in

\textsuperscript{11} Increasing evidence from several studies speaks against the interchangeability of the marked (NACT) and the unmarked (ACT) form of the voice-alternating anti-causative verbs. Alexiadou and Anagnostopoulou (2004), for example, argue that the difference in morphological marking induces a difference in interpretation; the ACT form denotes partial change whereas the NACT a complete change-of-state. Nevertheless, Schaffer (2008) cites specific examples where the NACT form of the anti-causative verb in the second conjunct may also express partial change, such that the NACT form may be compatible with both a total and a partial change meaning (5a) (5b).

\textbf{(5)}
\begin{itemize}
\item[(a)] To kti\textit{rio} gremi\textit{se} ena simio alla den gremi\textit{tike/*gremi\textit{se} entelos
the bulding collapsed-ACT in one spot but not collapsed-NACT/*ACT completely
“The building collapsed in one spot but it didn’t collapse completely.”

\item[(b)] To trapezombantilo lero\textit{se} ena simio alla den lero\textit{thike/*lero\textit{se} entelos
the table-cloth dirtied-ACT in one spot but not dirtied-NACT/*ACT completely
“The table-cloth got dirty in one spot but it didn’t get dirty completely.”
\end{itemize}
(Schaffer, 2008: 117)

Following Alexiadou and Anagnostopoulou (2004), Tsimpli (2006) also assumes that the choice between anti-causatives with ACT and NACT morphology in Greek is not a matter of true optionality. She argues instead that there is an interpretive difference between the two, such that the ACT form is used when no indication of a cause or agent argument is intended, whereas the NACT form involves an additional argument albeit implicit. In other words, the ACT form of the verb implies that the speaker is unaware or wants to avoid reference to some cause or agent (animate or inanimate) and opts to refer to the result of the event. Non-active morphology, on the other hand, makes the syntactic argument active although unexpressed in the typical (DP) sense (Tsimpli, 2006: 23).

Finally, Montrul (2000) also underlines a difference in meaning between the two syntactic derivations of unaccusativity in Spanish. Spanish though differs from Greek in that morphological marking is lexicalized not via NACT

(19) O Giannis lerose to trapezomantilo. (transitive)
The-NOM Giannis-NOM dirty-PERF-ACT-3sg. the-ACC tablecloth-ACC
“John dirtied the tablecloth.”

(20) To trapezomantilo lerose/lerothike (apo to krasi). (anti-causative)
The-NOM tablecloth-NOM dirty-PERF-ACT-3sg. / dirty-PERF-NACT-3sg. (by the-ACC wine-ACC)
“The tablecloth got dirty (from the wine).”

voice morphology but via a reflexive clitic ‘se’ attached to the anti-causative verb. Montrul cites linguistic evidence revealing that the presence of the reflexive clitic in Spanish anti-causatives inflicts a change in meaning; it attaches to the verb either when the event contradicts normal expectations or when it purposely marks the point-like manner (telicity) of the action, as shown in (6).

(6) Juan aparecio´ (se) aparecio´ en la fiesta
“Juan appeared at the party.” BUT with ‘se’
“Juan was probably uninvited at the party.”

12 In the overwhelming majority of the studies that focus on transitivity alternations in the English language, the term ‘alternating’ is used instead to denote the verbs participating in the causative/inchoative alternation, such as the verb break (‘John broke the window’/The window broke’).
In case the voice-alternating verb has NACT morphology, its subject may either be animate or inanimate. Given that passives and reflexives in Greek are also marked with NACT voice morphology\(^\text{13}\), when the subject is animate the verb’s meaning is ambiguous between an anti-causative, a reflexive, and a passive reading (21). When the subject is inanimate, the meaning is ambiguous between an anti-causative and a passive meaning (22).

\[(21)\quad I\text{ Maria lerōthike (apo tis laspēs/moni tis/apo ton Kosta).} \quad (\text{anti-causative/reflexive/passive})
\]

The-nom Mary-NOM dirty-PERF-NACT-3sg. (from the-ACC mud-ACC/ by herself-NOM/ by Kostas-ACC)

“Mary got dirty (from the mud/by herself/by Kostas).”

\[(22)\quad Tο\text{ trapezomantilo lerōthike (apo to krasī/apo ton Kosta).} \quad (\text{anti-causative/passive})
\]

The-NOM tablecloth-NOM dirty-PERF-NACT-3sg. (by the-ACC wine-ACC/ by Kostas-ACC)

“The tablecloth got dirty (from the wine/by Kostas).”

Crucially, the apo-phrases\(^\text{14}\) allowed in anti-causative verbs are morphologically identical to the by-phrases used in passives\(^\text{15}\). Yet, such adverbials used to express cause in ACT voice anti-

\(^{13}\) The middle structure in Greek is also morphologically NACT (Tsimpli, 1989; Papastathi, 1999; Sioupi, 1998; Condoravdi, 1989). However, contextual factors, such as the generic interpretation, the arbitrary agent by-phrase and the dynamic modal reading associated with the Greek middle make the middle reading more difficult to test relative to passives, reflexives and anti-causatives. As such, middles are not tested in the present study.

\(^{14}\) This adverbial of cause can also be lexicalized by the phrase da sē ‘by itself’ (Chierchia, 1989) and apo monos tu ‘by-own-his’ (Alexiadou & Anagnostopoulou, 2004).
causatives are not linked to a syntactic argument position and they are treated as true adjuncts. On the other hand, as already mentioned, the apo-phrase in NACT anti-causatives is assumed to be co-indexed with the medio-passive morpheme carrying the external theta-feature (Tsimpli, 2006; Fotiadou, 2007). Some theories even claim that the pragmatic recoverability of the causing events in anti-causatives in cases in which they are not explicitly mentioned in the sentence implicates that the causes of the events portrayed by anti-causatives are present at the predicates’ lexical-conceptual level (Levin & Rappaport-Hovav, 1995; Hale & Keyser, 1993).

Alexiadou and Anagnostopoulou’s (2004) anti-causative verb categorization most explicitly indicates that transitivity alternations in Greek are not unambiguously specified on the verb form via voice morphology. In fact, the high syncretism of NACT voice morphology considerably raises the level of ambiguity related to the interpretation of anti-causative, passive and reflexive predicates.

15 According to Tsimpli (2006), the morphological identity observed between the apo-phrase and the by-phrase in English does not implicate interchangeability. More specifically, the use of an overt agent ‘by-phrase’ is considered marked in Greek, such that it appears to be marginally acceptable even in cases in which the passive reading is unambiguously available. According to Tsimpli (2006: 24), its use is compensated for by mainly discourse-based factors, such as information structure, the pragmatic prominence of the agent and the register. The low frequency of the apo-phrase in Greek is also indirectly accounted for by means of its lexical underspecification; it is used in a number of different types of PPs, expressing source (Danistika to vivlio apo ti Maria/‘I borrowed the book from Mary’), location (I gata pidise pano apo to frahti/‘The cat jumped over the fence’), cause (Anhothika apo vlakia/’I got-stressed from stupidity’). As such, its use to denote either an agent in passives or a causer/causing event in anti-causatives is assumed to be a ‘result of its underspecified semantic features, which increase its compatibility with a larger number of interpretive contexts’ (Tsimpli, 2006: 22).
Crucially, the hypothesis that biases strengthening one’s preferred interpretation of the relevant predicates out of a set of possible readings is likely to originate from extra-clausal properties (besides the distinctions drawn in grammar) has begun to gain more ground lately. Recent theories call for a theoretical model that should frame interfaces between syntax and other grammatical components, like the lexicon and pragmatics. Such a model was recently proposed by Tsimpli (2006) and it was empirically tested on 3-6 year old Greek-speaking children (among other populations). The prediction was that inability to exploit extra-clausal properties (like the semantic and the encyclopedic properties of the verbal predicates, the transparency of the relation between the syntactic subject and the action portrayed by the verb, lexical preferences formulated on the basis of the frequency of the linguistic input, and the [± animacy] of the subject) as well as the increased ambiguity conditions would result in pragmatically infelicitous readings on behalf of the specific population. The children’s not fully-fledged lexicon proved not to be developed enough to allow them an exhaustive interpretative evaluation of the verbal constructions against lexicon-syntax interface-conditioned constraints. Such evidence according to Tsimpli (2006) reveals differences in how young children process morpho-syntactic information that is also lexicon-filtered as opposed to adults who show competence in incremental processing, using information on several different levels to understand subtle linguistic cues.

More specifically, according to Tsimpli’s account of transitivity alternations in Greek (2006), the realization of ACT or NACT voice morphology on anti-causative verbs is related to the absence/presence of Voice projection, thus, supporting a grammatical interpretation of the phenomenon. In ACT anti-causatives the Voice projection is missing and the transitivity alternation is attributed to “a transitivity or agentive feature borne by light v, independently of Voice” (Tsimpli, 2006: 26). More specifically, the causative/anti-causative alternation applies to a specific class of externally-caused change-of-state verbs, like spao/“break”, klino/“close”, anigo/“open” etc. On the other hand, change-of-state verbs with internal cause do not appear to have a causative alternant, e.g. to luludi anthise/“the flower blossomed-ACT”, *o ilios anthise to luludi/“*the sun blossomed-ACT the flower”
(Levin & Rappaport-Hovav, 1995; Theophanopoulou-Kontou, 2001). In the latter verbal set, the internal argument is the only argument that is syntactically active. The subject of ACT voice anti-causative verbs is base-generated as internal argument and either moves to [Spec,TP] position to satisfy the EPP (23b) (see Pelmutter’s (1978) Unaccusativity hypothesis) or it is directly merged in its spell-out position and attracts the internal θ-feature on the V’ head (23c) (Manzini & Roussou, 2000). Following this line of reasoning, the basic distinction between ACT unergative and ACT anti-causative verbs is that the subject of the former is merged in its spell-out position and attracts the external θ-feature on the V’ head.

(23)
(a) To pukamiso lerose.
the-nom shirt dirtied-ACT-3sg.
(b) [TP to pukamiso [vP lerose [dp to pukamiso]]]
(c) [TP to pukamiso [vP lerose [v<θ>]]]

(from Tsimpli, 2006: 26)

With respect to anti-causative verbs marked with NACT voice morphology, Tsimpli (2006) argues that the morphological marking is the reflex of the Voice projection. The latter attracts the verb’s external θ-feature which is left underspecified with regard to its interpretation. On the other hand, the verb’s internal feature is attracted by the internal argument which subsequently moves to subject position to check the uninterpretable nominative case feature of the Tense projection as required (24). Failure of the Voice head to lexicalize the attracted agentive feature forces its interpretation at the LF level where the verb receives its anti-causative reading ‘depending on the semantics of the verbal predicate (change-of-state, situation type), and pragmatic information, i.e. the naturalness, frequency and transparency of the relation between the subject and the event described by the verb’ (Tsimpli,
The same procedure applies to all verbal structures marked with NACT voice morphology in Greek, including passives and middles, except from reflexive structures in which the agent is non-derived and both external and internal theta features are attracted by the DP-agent and get interpreted within the verbal domain (25).

(24) \[ TP \{ v/VoiceP \{ v/\text{Voice} \{ v/ζ1 \} \} \{ v/VP \{ v/V \{ v/ζ2 \} \} \} \} \] Passive/Anti-causative/Middle

(25) \[ v/VoiceP \{ v/\text{Voice} \{ v/ζ1 \} \} \{ v/VP \{ v/V \{ v/ζ2 \} \} \} \] Reflexive

(from Tsimpi, 2006: 27)

Besides this grammatical distinction characterizing the derivation of the syntactic subject in reflexive and non-reflexive (i.e. anti-causative and passive) verbs, individual lexical preferences and real world-knowledge also appear to play a crucial role in the disambiguation of the relevant verbal structures, especially when the NACT verb takes an [+animate] entity in subject position. As can be seen in the examples (26-27) below, in the absence of any disambiguating cues provided by the continuation of the clause, the NACT verb reaches a final reading on the basis of individual lexical preferences.

(26) O antras zestathike.
The-NOM man-NOM warm up-PERF-NACT-3sg.
"The man warmed up." (preferred reading: anti-causative)

(27) O antras kriftike.
The-NOM man-NOM hide-PERF-NACT-3sg.
"The man hid." (preferred reading: reflexive)

The interpretation of verbs on the basis of individual lexical preferences has been accounted for in the literature in terms of a very common principle of access, namely the probabilistic effects of frequency of occurrence encoded in the lexical entries of verbal predicates. Borrowing much from findings in the word-recognition literature, once some verbal predicates are processed it is possible that more than one internal representations are constructed of their meaning which are both briefly activated. The frequency (or probability) of occurrence of each schematic representation in the language at large determines the relative degree of the activation of the candidate meanings. Whichever reading is the most frequent in the input will be the more active. In the present case, for example, it seems that the reflexive reading of krifteke/'hid' in (27) is the one most frequently occurring in the Greek native speakers' linguistic input, thus, its schematic representation becomes activated to a greater degree relative to the anti-causative one and the former is ultimately preferred.

The pivotal role of frequency effects in the assignment of meaning to an ambiguous structure has been underlined by many researchers whose online studies provide evidence that comprehenders form immediate online expectations upon hearing specific verbal predicates. These expectations constrain thematic fits (i.e. the likelihood of a NP to fill a particular argument slot of a verb) via (i) the tracking of semantic contingencies encoded in the verbal event (i.e. people’s intuitions about event knowledge; for example, a woman and a baby are both great agents and patients for the verb hug but if you know the agent of the event is a man and a woman hugging each other, one has a much ‘better’ thematic fit) and (ii) the comprehender’s world knowledge of the distributional profile of typical verbal events (Altmann, 1998; McRae, Spivey-Knowlton, & Tanenhaus, 1998; Bicknell, Elman, Hare, McRae & Kutas, 2008). In fact, Altmann (1998) claims that the assignment of “an argument structure is nothing more than the set of predictive contingencies that hold between a verb and the sentential contexts within which that verb is most frequently experienced. The nature of such contingencies necessarily
makes them sensitive to factors like frequency of occurrence [...] and typicality" (1998: 6). Evidence from priming studies shows the immediacy with which semantic contingencies encoded in event knowledge are activated especially with regard to relations between verbs and their typical filler nouns. This data indicates that native speakers take advantage of event knowledge information to rapidly identify the verbs' typical agents, patients, instruments and locations within 250 ms after the verbs’ onset (Ferretti, McRae, & Hatherell, 2001; Ferretti, Kutas, & McRae, 2007; Bicknell, Elman, Hare, & McRae, 2008), while verbs themselves are ‘predicted’ in the speech stream by their typical agents, patients, instruments, and locations with a similar latency (McRae, Hare, Elman, & Ferretti, 2005).

Overall, on the basis of Tsimpili’s (2006) account, the disambiguation of NACT verbs among an anti-causative, a passive and a reflexive reading seems to be non-fixed as it is dependant on pragmatic factors as well as on the [±animacy] of the subject variable, while the classification of ACT intransitive verbs as anti-causatives is strictly lexically-constrained. As already stressed, when the subject is inanimate, the interpretation of the NACT verb could be either passive, i.e. with an agent by-phrase, or anti-causative. On the other hand, when the syntactic subject is animate, the NACT verb may receive one of the three following readings: reflexive, passive, or anti-causative.

Animacy though appears to be relevant in the processing of ACT anti-causative verbs as well. Several event-related potential (ERP) studies (Hoeks, Stowe & Doedens, 2004; Kuperberg, 2007) have found that the co-occurrence of an inanimate subject with a transitive verb resulted in a P600 effect, despite the sentence being syntactically well-formed. Such findings evince that animacy and verb types modulate structural choices, with animate entities being preferentially mapped onto subjects/Agents and inanimate entities onto objects/Themes. Given that ‘unaccusativity-compatible’ ACT verbs allow speakers to construe the subject as an underlying object and that adult speakers are sensitive to the syntax of anti-causative constructions, inanimate derived subjects (28) are assumed to be processed more easily than animate subjects (29). Psycholinguistic investigation of these domains is an interesting issue since it offers us a method for investigating both the effects of the subject [±animacy]
and the lexicon-syntax interface on the parsing of anti-causative verbs in Greek, with partial insights into the computational demands that shape these parsing procedures.

(28) To trapezomantilo lerose
The-NOM tablecloth-NOM dirty-PERF-ACT-3sg.
“The tablecloth got dirty.”

(29) To moro lerose
The-NOM baby-NOM dirty-PERF-ACT-3sg.
“The baby got dirty.”

Furthermore, the interplay between ACT and NACT morphological realization of unaccusativity in Greek offers us a precise domain in which to evaluate performance on morphological distinctions filtered by the lexicon. Active voice anti-causatives involve a relatively cost-free derivation, since no external argument is syntactically active, though, it may be expressed through an adjunct phrase. The fact that the specific verbs are morphologically unmarked necessitates that they are filtered by lexical constraints in order for their unaccusativity features to be verified. In case lexical specifications are not met and in the absence of an adjunct apo-phrase denoting a causer, it is highly likely that ACT anti-causatives are misidentified with unergative verbs which are morphologically the same (i.e. they are morphologically unmarked). On the other hand, NACT anti-causative verbs are derived by the same computational procedure that yields passives further implicating that their disambiguation exclusively rests on extra-clausal effects. Disambiguating NACT anti-causatives from reflexives though is both grammatically and pragmatically determined, since the subject of reflexives is non-derived\(^\text{16}\).

\(^{16}\) The specific comparison exclusively refers to NACT anti-causatives having an animate subject, since the non-derived subject in reflexive verbs is obligatorily animate.
Furthermore, the possibility of some ACT voice-alternating anti-causative verbs to appear with NACT voice morphology suggests that their access triggers the activation of a morphological alternant which may facilitate unaccusativity valuation processes as a result of rendering the transitivity alternation property of the relevant verbs more explicit (see the verbs ‘ditipias’ in Greek).

What all those analyses have in common is that the lexicon-syntax interface is a very important factor in the processing of verbs of alternating transitivity. The exploration of lexicon-syntax conditioned syntactic derivations becomes all the more interesting in morphologically rich languages like Greek in which there is hardly any transparency between the verbs’ morpho-phonological form and meaning, as such interpretive resolution highly rests on extra-clausal informational cues. Data from a series of tests on both comprehension and production with language-unimpaired and agrammatic aphasic Greek-speaking individuals are going to be presented and discussed in light of the interface-based proposal.
Chapter 4 LITERATURE REVIEW

As already mentioned, one of the major goals of the present thesis is to investigate the subtle properties of the discourse-syntax and the lexicon-syntax interface as these are manifested in the expressive and receptive capacities of eight Greek-speaking agrammatic patients with Broca’s aphasia. Despite the fact that a great amount of work has been dedicated to reach a better understanding of agrammatic Broca’s aphasics’ linguistic symptomatology, only a trickle of research has pursued the observations of up-to-date linguistic trends that allocate much of the linguistic deficiencies in pathological grammars to interface-conditioned limitations evident in the parsing and production of structures whose computation involves more than one linguistic module (see Burkhardt, Pinango & Wong’s (2003), and Stavrakaki, Katsarou, Bostanjopoulou & Alexiadou’s (2006) studies on the lexicon-syntax interface in English and Greek, respectively, as well as Obler et al’s (1999) study on the phonology-morphosyntax interface in English). Moreover, the few data collected so far from aphasics’ processing of interface-conditioned structures has been abstracted mainly from off-line techniques that prevent us from gaining a deeper insight into the computation of the relevant configurations in real time.

The goal of this chapter is to offer an overview of the relevant studies conducted up-to-date. We first cite studies on the processing of subject pronouns in NSLs with language unimpaired populations. Unfortunately, except from few studies on the interpretation of pronouns and reflexives by agrammatic speakers in several languages, no study up until now exists that has explored the interpretation of null and overt subject pronouns by Broca’s aphasics. As such, we will restrict ourselves to a summary of the studies conducted with adult and children populations. Then, we present a series of studies investigating the processing of verbs of alternating transitivity by Broca’s aphasics mostly conducted in the English language. We show over the course of this chapter how the conceptualization of the interfaces in the field of aphasiology allowed researchers to account for a number of patterns of performance of agarmmatic subjects that were problematic under the general syntactic deficit approach.
4.1 REVIEW OF THE STUDIES ON THE PROCESSING OF SUBJECT PRONOUNS AT THE DISCOURSE-SYNTAX INTERFACE

As already mentioned, the bulk of previous research has only focused on the performance levels of aphasics in the interpretation of referentially dependent NPs within the limits of condition B of Chomsky’s Binding Theory (1981). The studies that have focused on these dependencies have provided evidence that reference assignment is selectively impaired in Broca’s aphasia. More specifically, the results of off-line studies indicate that the interpretation of reflexives in this population was less problematic than the interpretation of pronouns (e.g. Grodzinsky, Wexler, Chien, Marakovitz, & Solomon, 1993; Vasić, Avrutin & Ruigendijk, 2006). Each of the studies has tried to account for the observed asymmetry between pronouns and reflexives in terms of their distinct levels of representation that substantiate different ways of processing: pronouns were argued to be resolved at the discourse-syntax interface while reflexives at the syntax-semantics interface. The distinct constraints on the interpretation of pronouns and reflexives were claimed to impose diverse demands on the agrammatic subjects’ parser and processing resources. More specifically, the integration of discourse information in pronoun resolution was argued to be more costly than the computation of semantic dependencies between NPs and reflexives on the assumption that semantic knowledge is relatively spared in agrammatism. On the other hand, on-line studies (Ruigendijk, Vasic & Avrutin, 2006; Love, Nicol, Swinney, Hickok, & Zurif, 1998; Choy & Thompson, 2005) provided evidence in favor of a general global disruption in agrammatic aphasia that affects both pronouns and reflexives to an equal extent.

As already stressed, none of the up-to-date studies has investigated agrammatic Broca’s aphasics’ processing of null and overt subject pronouns in NSLs. The specific goal, though, was extensively pursued with neurologically intact populations mainly consisting of adults and children in a wide range of NSLs.
One of the most influential approaches to the distributional properties of null and overt pronouns in subject position was proposed by Carminati (2002) for Italian. According to her, null and overt subject pronouns have distinct discourse functions manifested in their distinct biases for choosing antecedents in different syntactic positions. More specifically, what she argued was that the existence of both null and overt subject pronouns reflects a division of labor with respect to anaphora resolution in that pro prefers to link to syntactically prominent antecedents more than its overt counterpart does at least in intra-sentential contexts. Carminati claimed that the prominence scale is one of structural nature and that the [Spec, IP] position is the most prominent one in the syntactic structure of the sentence. As such, the null pronoun in Italian intra-sentential anaphora will prefer to take the argument in the [Spec, IP] position as an antecedent, while the overt pronoun will prefer to take an antecedent in a lower syntactic position normally identified with the verb’s syntactic object. Her hypothesis is referred to as the Position of Antecedent Hypothesis (PAH) cited below:

(30) Position of Antecedent Hypothesis for intra-sentential anaphora.

\( pro \text{ prefers to retrieve an antecedent in the (highest) [Spec, IP] position being normally occupied by the preverbal subject of the sentence, whereas overt pronouns prefer an antecedent in a lower syntactic position.} \)

(Carminati, 2002: 108)

Carminati (2002) tested the PAH in a series of off-line and on-line experiments with adults. The off-line questionnaire task clearly showed that there was a strong preference to interpret null pronouns as having subject antecedents and overt pronouns as having object antecedents (see Table 4.1.).

| Table 4.1. Antecedent preferences (%) from Carminati’s (2002) questionnaire task. |
|---------------------------------|---------------------------------|-------------------------------|
| Null pronoun condition          | Subject antecedent (%)          | Object antecedent (%)         |
|                                 | 80.72                           | 19.28                         |
| Overt pronoun condition         | 16.67                           | 83.33                         |
What is of greater interest is Carminati’s online self-paced reading antecedent identification experiment run to empirically test the prediction that the processor’s strong commitment to the specific configurationally-defined strategy (i.e. PAH) will increase or decrease the processing cost depending on the context. Her assumption was that if the verbal predicate was pragmatically construed to contradict the PAH, reanalysis would be necessary and this would incur a measurable processing cost in her Italian-speaking participants. This experiment tested the specific assumption with regard to intra-sentential reference in complex sentences consisting of a subordinate clause followed by a main clause. The subordinate clause introduced two individuals of the same gender, one in [Spec,IP] and the other in object position. The main clause, which started with either a null or an overt pronoun, was pragmatically biased to refer to one of the two referents in the preceding subordinate clause. The four experimental conditions of the self-paced reading antecedent identification task are exemplified below:

(31)

(a) Condition 1: Subject Bias + Null Pronoun
Dopo che Giovanni ha messo in imbarazzo Giorgio di fronte a tutti, [null] si `e scusato ripetutamente.
“After Giovanni embarrassed Giorgio in front of everyone, [null] apologized repeatedly.”

(b) Condition 2: Subject Bias + Overt Pronoun
Dopo che Giovanni ha messo in imbarazzo Giorgio di fronte a tutti, lui si `e scusato ripetutamente.
“After Giovanni embarrassed Giorgio in front of everyone, he apologized repeatedly.”

(c) Condition 3: Object Bias + [null] Pronoun
Dopo che Giovanni ha messo in imbarazzo Giorgio di fronte a tutti, [null] si `e offeso tremendamente.
“After Giovanni embarrassed Giorgio in front of everyone, [null] was very offended.”
(b) **Condition 4: Object Bias + Overt Pronoun**

Dopo che Giovanni ha messo in imbarazzo Giorgio di fronte a tutti, lui si è offeso tremendamente.

"After Giovanni embarrassed Giorgio in front of everyone, he was very offended."

The results of the task can be seen in Table 4.2. below, where the ‘% correct’ column contains the percentage of replies wherein subjects understood the pronoun as referring to the pragmatically biased antecedent.

<table>
<thead>
<tr>
<th><strong>Table 4.2. Reading times (msecs) from Carminati’s (2002) self-paced reading antecedent identification experiment.</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Condition</strong></td>
</tr>
<tr>
<td>Condition 1: subj + null</td>
</tr>
<tr>
<td>Condition 2: subj + overt</td>
</tr>
<tr>
<td>Condition 3: obj + null</td>
</tr>
<tr>
<td>Condition 4: obj + overt</td>
</tr>
</tbody>
</table>

The average reading times for the main clause were computed for each of the four experimental conditions. Positive numbers in the ‘Difference’ column mean that reading times were slower than expected, while negative numbers mean that reading times were faster than expected. As one can see from Table 4.2 above, reading times were significantly faster for main clauses with null pronouns (Conditions 1 & 3) relative to clauses with overt pronouns (Conditions 2 & 4), which was expected because clauses with null pronouns are always shorter than clauses with overt pronouns. In addition, there was a significant antecedent by pronoun interaction: null subjects in main clauses biased
towards a subject antecedent (Condition 1) were read faster than sentences biased towards the object (Condition 3), while the opposite performance pattern was true for sentences with overt subject pronouns, i.e. overt subjects in main clauses biased towards an object antecedent (Condition 4) elicited shorter reading times than sentences biased towards the subject antecedent (Condition 2).

Along with subject pronouns incorporated in intra-sentential referentially ambiguous contexts, Carminati (2002) has also attempted to test inter-sentential anaphora cases. What she observed was a similar set of biases to those found intra-sententially, i.e. (i) null pronouns were preferentially interpreted as referring to a syntactically prominent referent and (ii) overt pronouns were preferentially interpreted as referring to a syntactically non-prominent referent. Nevertheless, the biases were milder in the separate sentence studies for both types of pronoun and especially for the overt subject pronouns. This finding made Carminati argue that intra- and inter-sentential anaphora must be studied separately on the assumption that antecedent identification in inter-sentential anaphora probably involves extra factors other than those implicated in the resolution of intra-sentential anaphora.

Carminati’s PAH has been tested by a number of subsequent psycholinguistic studies in several NSLs that have mainly criticized PAH with respect to its deterministic configurational constraints imposed on the antecedent preferences of overt subject pronouns. As will be elaborated below, the overwhelming majority of these studies appears to agree with Carminati’s PAH that the choice of the subject by null subject pronouns in referentially ambiguous contexts represents the default choice and probably reflects the instantiation of parsing heuristic aiming at offsetting the processing cost inflicted by the structural ambiguity. This assumption seems to be mainly validated by on-line studies evincing that the null pronoun-main clause subject referential preference represents the cheapest option for the parser in terms of the processing cost inflicted relative to the rest of the parsing choices. On the other hand, most of the studies provide supporting evidence in favour of a more flexible behaviour of overt subject pronouns, in the sense that overt pronoun interpretation does not obey strict grammatical
constraints; as such, it is not always the case that they refer to the structurally less salient entity of a sentence but their antecedent preference is rather optional in nature.

Frana (2007) has recently offered experimental evidence in Italian against Carminati’s (2002) predictions, proposing an alternative, more discourse-oriented conceptualization of PAH (referred to as the Discourse-Prominence Hypothesis of Antecedent Assignment-(DPH)). According to Frana’s DPH, a null subject pronoun is preferentially anteceded by the most prominent discourse referent available which is not necessarily identified with the subject in [Spec,IP] position. As such, the DPH claims that Carminati’s findings are not exclusively driven by a syntactic position effect but merely correlate with syntactic position, as [Spec,IP] is the preferred location of the most prominent discourse referent, i.e. the topic. More specifically, Frana (2007) found that in sentences such as (32) wherein the clitic pronoun “la” promotes the entity it refers to as the current topic, the preference for the entity in [Spec, IP] is overridden and the null subject pronoun is preferably linked to the Topic-DP in object position, rather than the non-Topic-DP in [Spec,IP]. These results according to Frana (2007) constitute strong evidence against a purely syntactic/configurational account of referential ambiguity resolutions and support the idea that it is information about the prominence status of discourse referents that mainly guides the processor in referential ambiguities and not just structural constraints.

(32) La signora Rossi è una persona molto maleducata che non merita alcun riguardo. Quando Maria la incontra per strada, Ō fa sempre finta di non vederla.

“Mrs Rossi is a very rude person that does not deserve any regard. When Mary her-sees in the street, Ō pretends not to see her.”

Sorace and Filiaci (2006) have also studied the resolution of null and overt pronominal anaphora in native and (near-native) speakers of Italian by using a picture-verification task. The most intriguing part of their research was the manipulation of the position of the two candidate antecedents in
the sentence by including testing sentences of backward anaphora (where the subordinate clause including the subject pronoun precedes the main clause) and forward anaphora (where the main clause precedes the subordinate clause). As Sorace and Filiaci note (2006: 349), the backward type of anaphora “poses certain requirements for the processor that are of particular interest. Since the pronoun linearly precedes its potential antecedents, there are no prior discourse constraints that are imposed on the resolution in advance”. Their results provide fine-grained observations as to the differences between forward and backward anaphora with respect to the processing of pronouns. More specifically, for null pronouns they found that while in backward anaphora there was a clear overwhelming preference for subject antecedents as Carminati’s PAH has predicted, this preference did not exist in forward anaphora. In the latter condition, native speakers’ antecedent preferences were equally divided between the subject and the complement of the matrix clause. Thus, when the null pronoun was used, the one wearing the coat was more likely to be the ‘mother’ in (33a) while in (33b) it was as likely to be the ‘mother’ as it was the ‘daughter’.

Backward Anaphora condition:

(33)

(a) Mentre lei/Ǿ si mette il capoto la mamma d’ha un bacio alla figlia

while she/Ǿ wears the coat the mother gives a kiss to the daughter

“While she/Ǿ is wearing her coat, the mother kisses her daughter.”

Forward Anaphora condition:

(b) La mamma d’ha un bacio alla figlia mentre lei/Ǿ si mette il capoto

the mother gives a kiss to the daughter while she/Ǿ wears the coat

“The mother kisses her daughter, while she/Ǿ is wearing her coat.”
With respect to the overt pronoun experimental items, Sorace and Filiaci (2006) have also found different preferences for the anaphor and the forward/backward cases. In forward anaphora cases, native speakers significantly preferred the complement over the subject as well as the extra-linguistic referent. In (33b) above, that translates to preferring ‘lei’ to refer to the ‘daughter’ rather than the ‘mother’. In the backward anaphora cases, however, a strong preference towards an extra-linguistic antecedent was found, followed by the complement as a distant second choice, and the subject as an even less likely possibility. Hence, in (33a), people were more likely to understand ‘lei’ as referring to an extra-linguistic antecedent, then the ‘daughter’, and very infrequently the ‘mother’. As Sorace and Filiaci note “it is quite surprising and not clear why the extra-linguistic antecedent was so acceptable in that context that it superseded the complement antecedent” (Sorace & Filiaci, 2006: 359).

Meridor (2006) has also investigated the likelihood of different subject pronouns being resolved to different antecedents in referentially ambiguous contexts in Hebrew. What should be stressed though is that Hebrew is a partial pro-drop language as it generally allows null pronouns only in 1st and 2nd persons, in tensed clauses (past and future). However, although Hebrew generally does not allow pronoun dropping in third person, the phenomenon is quite prevalent in certain complex structures and specifically, in sentences involving subordinate clauses. On the basis of these specifications, Hebrew should not be treated as a prototypical pro-drop NSL.

Adults in Meridor’s (2006) study were presented with twenty-four two-sentence discourses including cases of both forward and backward anaphora where the subject pronouns (null vs. overt) were resolved to one of the two potential same-gender antecedents. Subjects’ antecedent preferences were rated by means of the magnitude estimation technique, such that each one of the participants was asked to rate the likelihood of each discourse context resolving the anaphor either to the main clause subject or the main clause object. The two examples below are representative of the discourses utilized in Meridor’s (2006) study:
Forward anaphora condition:

(34)
(a) Dana wrote to Nina when Ø was in Scotland. Dana was in Scotland
(b) Dana wrote to Nina when she was in Scotland. Dana was in Scotland.

Backward anaphora condition:

(35)
(a) When Ø was in Scotland Dana wrote to Nina. Dana was in Scotland.
(b) When she was in Scotland Dana wrote to Nina. Dana was in Scotland.

The results partially support Sorace & Filiaci’s (2006) findings for Italian pronouns. More specifically, the null pronoun showed a strong preference towards the subject antecedent in both forward and backward anaphora conditions. The specific finding evinces that Hebrew null subject pronouns behave differently from their Italian counterparts, since the latter showed no marked preference in forward anaphora. Instead, Meridor’s results offer supporting evidence in favour of Carminati’s hypothesis of a universal preference for the establishment of null pronoun-subject reference co-indexation links. On the other hand, the Hebrew overt subject pronouns revealed a complex bias which was dependent on the anaphora direction. More specifically, participants’ performance at the backward anaphora trials has revealed an effect similar to the one demonstrated by the null pronoun trials, i.e. overt pronouns exhibited a preference towards the subject antecedents thereby contradicting Carminati’s (2002) finding that overt pronouns exhibit a robust tendency to be resolved towards the main clause object. By contrast, in the forward anaphora trials the overt pronoun revealed no marked preference.

Overall, the specific results obtained from Meridor’s (2006) study suggest that the overt pronoun in Hebrew behaves more similarly to the Hebrew null pronoun than to the Italian overt
pronoun. Meridor accounted for the specific pattern in terms of the partial pro-drop property of the Hebrew language. More specifically, Meridor hypothesizes that the idiosyncratic behaviour of null subject pronouns in Hebrew ‘forces’ the overt pronoun to behave more along the lines of non-NSLs by assuming functions otherwise served by null subject pronouns (Meridor, 2006: 35-36).

Papadopoulou, Plemenou, Marinis & Tsimpi (2007) have recently employed the experimental stimuli of Tsimpi et al.’s (2004) ‘Attrition project’ in the forward anaphora condition to test pronoun ambiguity resolution in Greek intra-sentential contexts with two different populations, namely adults and children. Their aim was to investigate how discourse-level information interacts with grammatical choices in pronoun ambiguity resolution and how this interaction is differentiated between the two experimental groups whose language processing models are admittedly distinct with regard to the processing resources employed during on-line sentence processing (Arnold, Novick, Brown-Schmidt, & Trueswell, 2001). Greek-speaking adults’ and children’s interpretations of the subject pronouns have been tested with a self-paced listening sentence-picture matching experiment. Restricting our attention to the adults’ performance on the task, the results showed that they preferred to interpret the overt subject pronouns as referring to the main clause object. This preference was evident in the matching data as well as in the reaction times of the subordinate verb. With regard to null subject pronouns, adults showed a preference for the main clause subject reference.

Greek-speaking subjects’ referential preferences in ambiguous inter-sentential contexts were extensively investigated by Miltsakaki (2003) who has extended previous studies by integrating additional parameters assumed to affect inter-sentential anaphora resolution besides the type of the subject pronoun variable.

The impetus for Miltsakaki’s first off-line experiment, which took the form of an antecedent identification questionnaire, was to investigate the effect of two unexplored till that moment parameters, namely word-order and definiteness of the grammatical subject, on inter-sentential null subject pronoun resolution in Greek. Miltsakaki’s main working hypothesis was that if the interpretation of the null
pronoun changed according to the surface position of the subject, it would be taken as an indication that word order affects the salience of entities in Greek. If, on the other hand, the null subject pronoun in both SVO and OVS conditions was anteceded by the grammatical subject, this would be taken as an indication that grammatical function determines salience in Greek with subjects ranking higher than objects irrespective of the position they occupy within the sentential frame. Furthermore, the definiteness of the grammatical subject parameter was controlled in order to check Rambow (1993) and Strube & Hahn’s (1999) prediction that DPs introduced by an indefinite article exhibit milder discourse salience than grammatical objects. As such, in the first condition (discourse 36) the subject appeared in the preverbal position; in the second condition (discourse 37) the object has been fronted by means of CLLD and the subject appeared post-verbally, and in the third condition (discourse 38) the topicalized object remained but the grammatical subject was replaced by a masculine DP introduced by an indefinite article and appeared post-verbally. The results showed that the dropped subject was interpreted as the subject of the preceding question across all three conditions. Miltsakaki (2003) deemed the specific finding as implying that what is relevant to pronoun resolution in Greek is not syntactic position in the clause but grammatical function signalled by structural case with syntactic subjects being more salient than objects.

(36)

(a) I prosfati diefthetisi-ı tha veltiosi tin ikonomiki politiki-j?

the recent arrangement will improve the economic policy

“Will the recent arrangement improve the economic policy?”

(b) Ohi, Ô ine aneparkis

No, Ô is inadequate

‘No, it is inadequate.’
Furthermore, the distributional properties of null and overt subject pronouns in Greek were explored by means of an antecedent identification questionnaire in which the data consisted of native Greek speakers’ interpretational responses as to the identity of the subject of the second clause in discourse sets like those in (39). The results of the task revealed that the object was never available for
the interpretation of the dropped subject pro\textsuperscript{17}, while reference to the syntactic object was achieved either with a full NP (more specifically, a proper name, like in (39b)) or with a strong pronominal in subject position (like in (39c)). Miltsakaki observes that the specific behaviour is reminiscent of the Promotion Rule proposed in Turan (1998: 147) for Turkish. The Promotion Rule states that in order for the grammatical object to be realized as a null subject in subsequent discourse it first needs to be promoted to the pre-verbal position as a full NP. Miltsakaki assumes that the same rule holds in Greek except that promotion of the object to a discourse prominent position can be achieved with any strong form besides proper names, e.g. strong or demonstrative pronouns.

(39) O Yianis-\textit{i} proskalese to Yiorgo-\textit{j}

the Yianis invited the Yiorgo

“John invited George.”

(a) null-\textit{i} tu-\textit{j} prosfere ena poto

(Ø) CL-him offered a drink

“He-\textit{i} offered him-\textit{j} a drink.”

(b) O Yiorgos tou prosfere ena poto

the George him-\textit{i} offered a drink

\textsuperscript{17}A possible methodological issue Miltsakaki has not considered and might have influenced her results lies in the choice of the experimental materials. As one can attest from the discourse sets cited in the present paper, the choice of verbal predicates like proskalese/"invite"-ACT-PERF-3sg. does not seem to be intuitively pragmatically neutral; rather it induces the comprehender to resolve the subject pronoun towards the agent of the event in topic position irrespective of the form of the pronoun in subject position.
“George offered him-\textit{i} a drink.”

(c) Ekinos-\textit{j} tou prosfere ena poto  \hspace{2cm} STRONG PRONOMINAL SUBJECT
he-strong him-\textit{i} offered a drink

“He-\textit{j} offered him-\textit{i} a drink.”

Miltsakaki’s assumptions with respect to the systematic mapping between overt subject pronouns and less salient antecedents in referentially ambiguous inter-sentential contexts in Greek were further confirmed by the findings of a sentence-completion task (Miltsakaki 2007) performed by one-hundred native speakers of Greek. In the specific task the subjects were asked to read an SVO sentence introducing two characters carrying the same gender and an action verb. The agent was in subject position and the patient in object position. A second sentence was given starting with a demonstrative pronoun in subject position. In the second version of the experiment the strong pronoun was omitted so the participants were free to continue any way they felt natural.

(40) I daskala agaliase ti mathitria. Ekini/Ø…
The teacher-FEM-NOM hugged the student-FEM-ACC. SHE/Ø…

“The teacher hugged the student. She-(demonstrative)/Ø…”

In the first version of the task, Miltsakaki (2007) found that in 94\% of the continuations the preferred interpretation for the demonstrative pronoun was the object-patient as predicted. In the second task, it was found that the patient-object continued to be referenced (58\%) with a strong pronoun even though participants were not prompted to continue using a strong pronoun thus implying that the patient was perceived as a salient entity in the prior discourse. Miltsakaki accounted for this salience in terms of the semantics encoded in the verbal predicates used; all of them belonged to the
action verb class that tends to bring into focus the entity associated with the patient role (Miltsakaki, 2007). Conversely, when the subject-agent was referenced (42%), in over 99% of the continuations it was referenced with a dropped subject. Based on the specific data, Miltsakaki (2007) confirmed her conclusions from her previous research; dropped subjects in Greek appear to prefer salient antecedents in subject position while when a semantically salient antecedent appears in object position then a strong pronoun is preferred.

In an earlier paper Miltsakaki (2002) stresses though that the referential dependencies established in inter-sentential contexts in Greek are qualitatively different from those in intra-sentential contexts in which the main clause is followed by a subordinate like in (42) below. More specifically, the author claims that the resolution of an ambiguous null pronoun in subject position in cases of intra-sentential anaphora is rather calculated on the basis of the preferences projected by the semantics of the verbs and the connectives, instead of by the higher ranking of subjects over objects in terms of discourse prominence.

(41)

(a) O Gianis-i htipise ton Kosta-i
‘John hit Kostas’

(b) Ō-i ferthike ashima.
“He behaved in an ill manner.”

(42)

o Gianis-i htipise ton Kosta-j giati Ō-j ferthike ashima
“John hit Kostas because he behaved in an ill manner.”
More specifically, according to the PAH the antecedent of the null subject in (41b) would be identified with the highest structural role in the first clause which is the ‘John’ antecedent. Miltsakaki (2002) though claims that the specification of the entity referred to by the null subject pronoun in contexts like (42) is not determined on the basis of structural focusing along the lines proposed by Carminati’s (2002) PAH but on the basis of the focusing preferences of the verbal predicate ‘behave’ and the semantic properties carried by the connective ‘because’. As such, the pronoun’s felicitous antecedent in (42) should be ‘Kostas’ instead of ‘John’. Indeed, Miltsakaki (2002) offers empirical evidence for her argument by reporting that native speakers of Greek made the pragmatically felicitous choice in intra-sentential contexts like (42) (i.e. they identified the pronoun’s antecedent with the main clause object) 51% of the times (55/108). On the other hand, in contexts like (41) where a main clause is followed by another main clause, the pronoun’s antecedent was identified with the grammatical subject (i.e. ‘John’) in 92% (81/88) of the cases, thus, implying that Carminati’s model applies more robustly in inter-sentential contexts like (41) relative to intra-sentential ones like (42).

Filiaci (2008) has also tested Carminati’s predictions with respect to the referential preferences of null and overt subject pronouns in Spanish. To this end, she adapted and translated Carminati’s experimental materials into Spanish to obtain comparable data under the same experimental conditions. The first experiment replicated Carminati’s results for Italian but only with respect to the null pronoun; the results yielded a strong null subject pronoun bias towards the subject antecedent but lack of any bias for the resolution of overt pronouns. Filiaci’s conclusion was that unlike other Romance languages, Spanish overt pronouns do not encode a topic change or reference to a non-salient antecedent and that its use is rather restricted to referentially unambiguous sentential contexts in which overt pronouns’ morphophonological features, such as gender and number, contribute to the rapid identification of the referent.

An older off-line study conducted by Alonso-Ovalle, Fernández-Solera, Frazier and Clifton (2002) has demonstrated that the PAH makes the correct predictions beyond Italian and it correctly
foresees the behaviour of Spanish pronouns inter-sententially. Especially interesting for the purposes of the present work is the fact that Alonso-Ovalle et al. have replicated Carminati’s antecedent identification questionnaire in inter-sentential contexts. They found that, if the second sentence contained a null pronoun, it was mostly interpreted as referring to the previous subject (73.2%), while if it contained an overt pronoun this percentage dropped to 50.2% with the difference being statistically significant. These results evinced that the overt pronoun in Spanish did not show a robust referential preference in contrast to the null subject pronouns which were clearly biased towards the syntactic subject.

Alonso-Ovalle et al.’s (2002) results were recently contradicted by a number of on-line studies in Spanish. Mayol’s (2008) study has replicated Alonso-Ovalle et al.’s (2002) task in Spanish by integrating the same experimental stimuli in an on-line self-paced reading antecedent identification task. The task’s results evinced a strong preference to interpret null pronouns as having subject antecedents and overt pronouns as having object antecedents. As such, the overt pronoun did not show the unruly behaviour reported for Spanish by Alonso-Ovalle et al., but rather a robust preference towards the object antecedents.

Spanish sentences containing overt pronouns that referred to syntactically salient antecedents were read more slowly than corresponding sentences with null pronouns in Gelormini Lezama & Almors on-line study (2008). The same finding was replicated in a recent study conducted by Gelormini Lezama and Almor (2009) that examined the processing of overt subject pronouns in emphatic, contrastive Spanish contexts. Once the overt pronoun referred to a non-salient antecedent, the processing delay observed in Gelormini Lezama & Almor’s task was eliminated. Gelormini Lezama and Almor (2009) attributed the lack of processing delay in their experiment to the satisfaction of the pragmatic function of overt subject pronouns which are used in Spanish to denote disjoint reference.

The processing and interpretation of null and overt subject pronouns in inter-sentential contexts has been also explored by Callahan, Nicol, Love & Swinney’s (2007) study in Chilean Spanish. The
tasks consisted of an antecedent identification questionnaire and a self-paced reading experiment both of which presented experimental subjects with referentially ambiguous sentence pairs whose second clause contained an embedded clause. The embedded subject was varied among a null pronoun, an overt pronoun, and a proper name in subject position (43). In the antecedent identification questionnaire, participants interpreted both null and overt subject pronouns as referring to the topic slightly more often than the other less prominent referents but the form of the pronoun had no effect\(^\text{18}\) (Null pronoun: 56.2% reference to the topic, Overt pronoun: 54.5% reference to the topic). On the other hand, the self-paced reading task revealed processing difficulty associated with the presence of overt subject pronouns which was manifested in the increased reading times in the region following the inflected verb (Null pronoun: 1238ms, Overt pronoun: 1320ms). According to the authors, these data suggest that even when the form of the subject pronoun (null vs. overt) does not affect the final

\(^{18}\) Callahan, Nicol, Love & Swinney’s (2007) study has raised few objections concerning the choice of the experimental material used. The first methodological misfit observed is that all anaphor resolving sentences constituting the second part of the sentence pairs featured a stative verb which has biased subjects towards the subject. The specific assumption is based on research (e.g. Meridor, 2006) indicating that statives are less inclined to a topic-shift than the rest of the verbs. The need to establish a continuity transition would thus make it more likely for subject pronouns of stative verbs to be resolved by the more salient antecedent (i.e. the subject) relative to the rest of the candidate antecedents. This might provide an explanation as to why the gap between the subject and the object reference in the overt pronoun condition has not reached statistical significance. Furthermore, some of the experimental sentences in Callahan et al.’s study cannot be regarded as being purely pragmatically neutral. Consider example (7) below. Regardless of the type of the pronominal integrated in the second sentence one is inclined to resolve it by picking the object antecedent, i.e. ‘Elena’ rather than ‘Maite’. The specific evidence makes us speculate whether the experimental subjects’ referential preferences in Callahan et al.’s study were a by-product of the parsing mechanisms determining pronoun resolution inter-sententially or were instead an artefact of the experimental materials chosen.

(7) Maite entretuvo a Elena. Ō/Ella est´a cansada.

“Maite entertained Elena. She is tired.”
interpretation, overt pronouns are harder to process than null pronouns probably due to the latter’s richer feature endowment relative to null subject pronouns.

(43) Sam trabaja cada día hasta las ocho. Juan cree que (Ø/el/Sam) debería ir de vacaciones.
"Sam works every day until eight o’clock. Juan thinks that ([Ø/he/Sam] should go on vacation."

Furthermore, Costa, Faria & Kail (2004) have investigated subject pronoun resolution in two-referent contexts containing subject-oriented and direct object-oriented Implicit Causality Verbs (ICVs) in European Portuguese. Their study was initiated by Chomsky’s Avoid Pronoun Principle (1981) according to which the null subject pronoun-main clause subject co-indexation link represents the default choice in referentially ambiguous contexts in the sense that the specific chain inflicts the least computational cost and increases interpretational feasibility. Costa et al.’s aim was to explore how the specific principle functions under pragmatically-biasing conditions that direct subjects’ preferences either towards the main clause subject or the main clause object. Such conditions may be established by ICVs. As such, the ICVs employed in the specific study were divided into two categories: subject-oriented verbs biasing pronoun resolution towards the main clause subject and direct object-oriented verbs biasing pronoun resolution towards the main clause object. The following sentences are representative of the four testing conditions in Costa et al.’s sentence continuation experiment.

(44)
(a) João-1 desiludiu o Pedro-1 porque Ø-1 não o deixou copiar no exame de matemática.
"John-1 disappointed Peter-1 because Ø-1 didn’t let him copy in the maths exam."
(a) João-i desiludiu o Pedro-j porque ele-i não o deixou copiar no exame de matemática.

SUBJECT ORIENTED & OVERT SUBJECT PRONOUN

“John-i disappointed Peter-j because he-i didn’t let him copy in the maths exam.”

OBJECT-ORIENTED & OVERT SUBJECT PRONOUN

‘John-i hated Peter-j because he-j didn’t let him copy in the maths exam’.

(a) João-i detestou o Pedro-j porque ele-j não o deixou copiar no exame de matemática.

OBJECT ORIENTED & NULL SUBJECT PRONOUN

“John-i hated Peter-j because Ô-j didn’t let him copy in the maths exam.”

(from Costa et al., 2004: 46)

The off-line sentence continuation task involved one hundred direct transitive verbs with half of them exhibiting implicit causality semantic information on the main clause subject and the other fifty on the main clause object. Each of the sentences was printed till the causative connective porque/"because". All subjects were asked to read attentively each initial part of the causal sentence and to proceed to complete it as fast as possible in a plausible manner. As one may guess the main interest of the particular experiment focused on the type of pronoun used to refer to the subject of the subordinate clause. The statistical data showed that 95% of the sentences with subject implicit causality took the null pronominal form as subject of the subordinate clause. On the other hand, 75% of the implicit causality of the object verbs took an overt pronoun as the subject of the subordinate clause. However, almost 20% of these verbs also occurred with a null pronoun in the sentence completion task. On the basis of such data the authors concluded that reference fixation chains in Portuguese are established in a relatively non-ambiguous manner: subject-oriented verbs opt for a null subject pronoun.
in the subordinate and object-oriented verbs opt for a ‘stronger’ referential form, yet, permitting some flexibility with regard to the allowance of a null pronominal in subject position.

Costa et al. have also investigated the subject pronoun effect on the processing level by running a visual probe task that involved the complete sentences as experimental stimuli. The probe word appeared at the offset of the subordinate verb and indicated either a proper name/NP1 identified with the main clause subject or a proper name/NP2 identified with the main clause object. As soon as the probe word appeared on the screen, the subject had to decide as fast as possible by pressing a button if the specific word had or had not already been shown in the sentence being read. The results showed a clear dominance of NP1 over NP2. More specifically, whenever the probe word designated the NP1 of the main clause, the subjects’ reaction times were shorter across all experimental conditions, thus, indicating that structural conditions overruled any semantic informational cues provided by the object-oriented verbs. Moreover, the presence of an overt pronoun in subject-oriented verbs (44b) gave rise to statistically significant longer reaction times, thus, implying that an overt pronoun impinged an overcharge to the processor. An unexpected result though was the considerably slower reaction times raised by the overt pronouns in object-oriented verbs (45a) in contrast to the researchers’ expectation that the specific condition would be as easy to resolve as the null pronoun-subject probe condition in the subject-oriented verbs. The authors attributed such a pattern to the fact that the verb biases and the [+Topic-shift] effect driven by the overt pronoun failed to converge in a uniform interpretive direction due to a delay in the on-line integration of the semantic force of the relevant verbs.

Geber’s (2006) study of subject pronouns in Romanian offer extra evidence against PAH’s applicability to NSLs at least with respect to the structural constraints specifying the preferred antecedent of overt subject pronouns intra-sententially. The specific study is especially interesting since it tested PAH in non-canonical contexts, namely in contexts involving dative quirky subjects. Quirky
subject constructions are sentences characterized by a dative logical subject occupying the [Spec,TP] position and a nominative logical object in post-verbal position like the one illustrated in (46).

(46) Pentru că lui Ion îi displice Robert, Ø / el se plâng la director
because John-DAT CL-DAT dislikes Robert-NOM, Ø/he complains-REFL to director.
“Because John dislikes Robert, Ø/he complains to the director.”
(from Geber, 2006: 52)

Geber’s assumption was that quirky subjects are the preferred antecedents for null rather than overt pronouns irrespective of the structural case marking of the verb’s arguments in the subordinate. This prediction was empirically tested by means of off-line questionnaires that tested PAH in diverse quirky constructions, retaining the methodological design of the questionnaire formulated by Carminati (2002). The results demonstrated that the PAH holds for non-canonical contexts in Romanian. However, the proportion of choosing the object as antecedent for the overt pronoun in two-referent contexts involving a subordinate (vs. a co-ordinate) clause was smaller relative to the participants’ preference for the subject in null pronoun trials.

Finally, the only study up-to-date that has argued against the predictions of the PAH with regard to the configurationally-constrained interpretation of both the null and the overt subject pronouns is the one conducted by Bunting (2008) in Slovak. Bunting (2008) used an off-line measure, namely an antecedent identification questionnaire, which was answered by seventeen native Slovak-speaking speakers. The questionnaire consisted of a main clause followed by two complement clauses with two sentence-internal antecedents marked with the same gender (47). The crucial point that differentiates Bunting’s study from the rest is that both candidate antecedents were in subject position with the first antecedent though being situated in a structurally higher [Spec,IP] position in the clause. In each test item the subject of the (lower) complement clause was either a null or an overt pronoun. Participants
were asked to identify the antecedent that co-referred with the anaphoric pronoun by answering a “who” question.

(47)
(a) Štefan pochybuje, že Ján povedal, že Ø dobre spieva.
(b) Štefan pochybuje, že Ján povedal, že on dobre spieva.

“Štefan doubts that Ján said Ø/he sings well.”

The results of Bunting’s study pose a challenge to the PAH since neither the null nor the overt pronoun demonstrated the behaviour predicted by Carminati’s (2002) hypothesis. More specifically, null pronouns demonstrated no particular bias with respect to their preferred antecedent, while overt pronouns tended to prefer the antecedent in the highest [Spec,IP] position. What follows is Table 4.3. that summarizes all the aforementioned studies’ compliance (or not) with Carminati’s (2002) PAH across the following variables: direction of reference (backward vs. forward), context-type (intra-sentential vs. inter-sentential) and methodology (off-line vs. on-line).

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19 One viable explanation for such a finding in Bunting’s (2008) study is that Slovak may not be a prototypical NSL, such that overt subject pronouns may not be discourse-marked as is the case with Greek or Italian. Further evidence in favour of such an assumption is provided by Russian (a language very close to Slovak in terms of grammatical properties), which presents an interesting combination of properties from null and non-null subject languages. Specifically, Russian has both null and overt subject pronouns; in this respect it is similar to Italian and Greek. However, overt subject pronouns in Russian need not be discourse-marked as is the case with typical NSLs. Instead, they resemble English subject pronouns and as such, the use of an overt subject pronoun is not marked compared to a null subject (Franks, 1995; Avrutin & Rohrbacher, 1997; Gordishevsky & Avrutin, 2003). Following these findings, we may assume that the non-typical behaviour of null and overt subject pronouns in Slovak may be attributed to the fact that Slovak is not a NSL in the typical pro-drop sense.
Table 4.3. Summary of results from the studies investigating the interpretation of null and overt subject pronouns cross-linguistically.

<table>
<thead>
<tr>
<th>Null Subject Languages</th>
<th>Carminati’s (2002) PAH predictions</th>
<th>Direction of reference</th>
<th>Context type</th>
<th>Methodological design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italian (Sorace &amp; Filiaci, 2006)</td>
<td>√</td>
<td>backward anaphora</td>
<td>INTRA</td>
<td>offline</td>
</tr>
<tr>
<td></td>
<td>secondary pronoun</td>
<td></td>
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<tr>
<td>Chilean Spanish</td>
<td></td>
<td>forward anaphora</td>
<td>INTRA</td>
<td>offline</td>
</tr>
<tr>
<td>Callahan, Nicol, Love &amp; Swinney, (2007)</td>
<td></td>
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<tr>
<td>Spanish Alonzo-Ovalle et al., (2002)</td>
<td>√</td>
<td>forward anaphora</td>
<td>INTER</td>
<td>offline</td>
</tr>
<tr>
<td>Spanish Mayol, (2008)</td>
<td>√</td>
<td>forward anaphora</td>
<td>INTER</td>
<td>online</td>
</tr>
<tr>
<td>Spanish Filiaci, (2008)</td>
<td>√</td>
<td>forward anaphora</td>
<td>INTRA</td>
<td>offline</td>
</tr>
<tr>
<td>Spanish Gelormini, Lezama, &amp; Almor, (2008)</td>
<td>√</td>
<td>forward anaphora</td>
<td>INTER</td>
<td>online</td>
</tr>
<tr>
<td>Spanish Lezama &amp; Almor, (2009)</td>
<td>√</td>
<td>forward anaphora</td>
<td>INTER</td>
<td>online</td>
</tr>
<tr>
<td>Romanian Geber, (2006)</td>
<td>√</td>
<td>forward anaphora</td>
<td>INTRA</td>
<td>offline</td>
</tr>
<tr>
<td>European Portuguese</td>
<td>√</td>
<td>forward anaphora</td>
<td>INTRA</td>
<td>online &amp; offline</td>
</tr>
<tr>
<td>Costa, Faria, &amp; Kail, (2004)</td>
<td></td>
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<td></td>
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<tr>
<td>Greek Miltsakaki, (2003)</td>
<td>√</td>
<td>forward anaphora</td>
<td>INTER</td>
<td>offline</td>
</tr>
<tr>
<td>Greek Miltsakaki, (2007)</td>
<td>√</td>
<td>forward anaphora</td>
<td>INTER</td>
<td>offline</td>
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<tr>
<td>Greek</td>
<td>√</td>
<td>forward anaphora</td>
<td>INTRA</td>
<td>online</td>
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Table 4.3. Summary of results from the studies investigating the interpretation of null and overt subject pronouns cross-linguistically.
As one can see, the strength of the subject antecedent bias revealed for the null subject pronoun trials in the majority of the studies discussed so far implies that dropped subjects across NSLs share homogeneous structural properties. In fact, Carminati (2002) notes in her study that “the systematic connection of the null pronoun with a highly salient referent might well be a universal feature or, to put it differently, that null pronouns exhibit a structural saliency-marking function which is typical of highly grammaticalized linguistic elements” (qtd. in Meridor, 2006: 12). Nevertheless, the universal principles presumed to motivate the PAH predictions with regard to the antecedent bias of null subject pronouns do not appear to hold for overt subject pronouns which exhibit a rather unruly behaviour cross-linguistically, ranging from biases towards less-prominent antecedents (e.g. Papadopoulou et al., 2007, for Greek) to displaying no noticeable bias at all (e.g. Alonso-Ovalle et al., 2002, for Spanish). The fact that many NSLs, e.g. Spanish (Alonso-Ovalle et al., 2002; Filiaci, 2008), Romanian (Geber, 2006), European Portuguese (Costa, Faria, & Kail, 2004) and Hebrew (Meridor, 2006), allowed a greater relaxation of PAH with respect to the antecedent preferences of the overt subject pronoun suggests that these languages may vary with respect to the extent the [+Topic-shift] feature (assumingly encoded in overt subject pronouns) has been grammaticalized in their linguistic systems. We might as well conceptualize the grammaticalization process of the [+Topic-shift] feature as a continuum between two extremes represented by Greek and Hebrew; if we wanted to compare the overt subject pronouns of these two languages in a continuum of grammaticalization, the fact that the Hebrew overt pronoun displays no marked preference towards the subject or object suggests that it is

<table>
<thead>
<tr>
<th>Language</th>
<th>Anaphora Type</th>
<th>Antecedent</th>
<th>Placement</th>
</tr>
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<tbody>
<tr>
<td>Hebrew</td>
<td>√</td>
<td>forward</td>
<td>INTER</td>
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<td>offline</td>
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<tr>
<td>Slovak</td>
<td>√</td>
<td>forward</td>
<td>INTRA</td>
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<td></td>
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<td>offline</td>
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</tbody>
</table>

situated at the initial stage of grammaticalization. On the other hand, the overt pronoun in Greek according to the results of Papadopoulou et al.’s (2007) study systematically signals disjoint reference which places it at the opposite end of the continuum\textsuperscript{20}.

Furthermore, what should be stressed is the existence of another important factor that has been shown to affect the referential preferences of null and overt subject pronouns in NSLs, namely, the direction of the anaphor in a sentence. The reader is reminded of the changes inflicted upon the antecedent preference patterns in both the null and the overt pronoun trials in Sorace & Filiaci’s (2006) and Meridor’s (2006) studies once the direction of the anaphora variable was integrated in their experimental designs. The specific factor is argued to be closely related to processing issues; the direction of the anaphor changes the order in which the pronoun and its potential antecedents are encountered by the human parser, and it also affects the recency of the referents which has been found to significantly affect anaphora resolution to a great extent (Gernsbacher, Hargreaves & Beeman, 1989, Bever & Townsend, 1978).

Besides the studies evincing the variant interpretation of overt subject pronouns by language-unimpaired adults, interface areas such as syntax and other conceptual/intentional cognitive systems (e.g. semantics and pragmatics) were also found to be particularly vulnerable to processes such as second language acquisition (Lardiere, 2000; Prévost & White, 2000; Sorace & Filiaci, 2006), L1 attrition (Tsimpli, Sorace, Heycock & Filiaci, 2004), bilingual first language acquisition (Serratrice, 2005), and developmental dyslexia (Fiorin & Vender, 2008). According to Sorace (2004), this is because interface areas “are more complex than narrow syntax and more inherently difficult to acquire”\textsuperscript{20}

Another viable explanation for the referential flexibility of the overt subject pronouns registered in a number of NSLs could be that there is competition for the object antecedent by other overt pronominal forms existing in the same NSL that may serve (among others) the same referential functions as the overt subject pronouns. In Greek, for example, the pronoun ‘o *idhios*’ can be found in syntactic subject position and may also be anchored to object antecedents. In fact, the only property that differentiates *idhios* from the overt pronoun *aftos/he* is that the former can not be used deictically, i.e. it can not be used to refer to an extra-sentential entity (Varlokosta & Hornstein, 1993).
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(Sorace, 2004: 143). A large body of these studies has especially concentrated on the developmental optionality existing in the subjects’ developing grammars and its apparent contradiction with the fundamental claim of the Minimalist Programme that syntactic optionality is excluded within the computational system because of economy principles which require an “optimal realization of interface conditions” (Chomsky, 1995: 171). The specific claim yet has been refuted by experimental data. More particularly, the overwhelming majority of the studies investigating cases of native speakers of non-NSLs learning a NSL indicate that while advanced L2 grammars can achieve native-like competence with formal L2 syntactic properties, the same grammars were found to display divergent and even optional competence at the discourse-syntax interface.

Such optionality is manifested in the L2 learners’ persistent target-deviant performance on both the use and interpretation of overt subject pronouns cross-linguistically. Though knowledge of the null vs. overt pronoun paradigm in NSLs is acquired by non-NSL native speakers at a very early stage (Liceras, 1989; Phinney, 1987; Lozano, 2003), the same learners were found to acquire the discursive constraints (namely, the [+Topic-Continuity], [+Topic-Shift] feature specifications) regulating the distribution of pronouns in NSLs rather late (Perez-Leorux et al., 1999; Perez-Leroux & Glass, 1997, 1999; Al-Kasey & Perez-Leroux, 1998; Lozano, 2002a, 2002b, 2003, 2006; Montrul & Rodríguez-Louro, 2006). As Perez-Leroux & Glass (1999) note “morphosyntactic aspects are learned before discourse-pragmatic properties of the distribution of null/overt pronoun subjects, while knowledge of the marking of the topic/focus distinction is subject to temporal constraints and L2-input, in other words, it is acquired over time and experience” (Perez-Leroux & Glass, 1999: 242). The late acquisition of the discourse-related properties regulating the distribution of null and overt subject pronouns in a NSL is usually manifested in the overexpansion of overt pronouns to contexts that would call for the use of null pronouns in production tasks, as well as in the relaxation of PAH constraints with overt pronouns allowing co-reference with both subject- and non-subject antecedents in comprehension.
In the last twenty years there is a longstanding debate as to the exact cause of such optionality in developing grammars. Two hypotheses have been proposed in the existing L2 acquisition literature. The first (known as the Interpretability Hypothesis) argues for critical period constraints restricting L2 intermediate or advanced learners’ ability to represent new uninterpretable features not instantiated in their L1 (Tsimpli 1997, 2003; Hawkins & Chan, 1997; Tsimpli & Dimitrakopoulou, 2007; Hawkins & Hattori, 2006). Nevertheless, the possibility has been proposed that in advanced stages of L2 acquisition L2 learners manage to approximate target performance, thus, eliminating real optionality from their system (Tsimpli & Mastropavlou, 2008). According to the Interpretability Hypothesis, this is the result of some compensatory mechanism of the L2 grammar which accommodates the input using interpretable features which are claimed to be fully accessible to the L2 learner since they are not subject to critical period constraints. The second hypothesis prioritizes L2 learners’ insufficient processing resources and it is called the Interface Hypothesis (Lozano, 2006; Sorace & Filiaci, 2006; Sorace, 2005, 2006; Hopp, 2006). The specific account attributes the ‘optionality’ phenomenon to L2 learners’ difficulty to process features conditioned by the discourse-syntax interface due to the higher processing cost inflicted by the integration of multiple types of information pertaining to different domains. Under this view, and in contrast to the Interpretability Hypothesis, optionality is not directly related to the problematic representation of the uninterpretable formal features in the L2 but to a processing limitation hindering the integration of the cues derived from the core syntax with information stemming from other grammatical modules. Such a deficit is assumed to yield interlanguage grammars that may differ in interface areas from native systems in important ways. For example, while native speakers have one-to-one mappings between null pronouns and the [+Topic-continuity] feature, and between the overt pronoun and the [+Topic-shift] feature, L2-speakers are assumed to have a wider range of interface mappings for pronominal subjects than native speakers: they can also map the overt pronoun to the [+Topic-continuity] feature treating, thus, the overt pronoun as if it was an English unstressed pronoun.
A detailed review of the studies investigating L2 learners’ acquisition of the constraints regulating the distribution of subject pronouns in a NSL is beyond the scope of the present thesis. However, we should stress the fact that the developmental grammars provide supporting evidence in favour of the assumption that the sometimes persistent optionality demonstrated at the interfaces is not coincidental and that any given property that is simultaneously governed by both a formal grammatical and a discursive constraint (like those regulating the distribution of null and overt subject pronouns in NSLs) will most probably exemplify instability in pathological grammars as well. As such, supporting evidence from acquisitional studies (e.g. Papadopoulou et al., 2007) may be useful in the evaluation of the aphasic processing of the relevant configurations. Bearing in mind that pathological grammars resulting from language breakdown have been very frequently aligned with developing grammars on a range of syntactic phenomena (see Jakobson’s ‘Language regression hypothesis’ 1941/1968), it would be interesting to test whether the fundamental processing based nature of the proposals accounting for L2 learners’ disparities in the processing of null and overt subject pronouns could also be extended to explain similar patterns in other populations, like agrammatic aphasics.
4.2. REVIEW OF THE STUDIES ON VERBS OF ALTERNATING TRANSITIVITY AT THE LEXICON-SYNTAX INTERFACE

Anti-causatives have been extensively studied with regard to the difficulties they tend to cause in L1 acquisition (e.g. Snyder, Hyams & Crisma, 1995; Babyonyshev, Ganger, Pesetsky & Wexler, 2001) and L2 learning cross-linguistically (e.g. Tsimpli, 2006; White, 2003; Montrul, 1999; 2005; Balcom, 1997; Oshita, 2000; Sorace & Shomura, 2001; Samioti, (2009)). While this area has also been explored in the field of aphasiology, very few cases of relevant research has been conducted in languages other than English. The following section cites evidence of studies examining the production and interpretation of anti-causative verbs by patients with Broca’s aphasia as well as theories proposed to account for the patients’ deficient performances.

Kegl (1995) was the first to report on the argument structure distribution profile of verbs in agrammatic production. In her data analysis, Kegl focused on the percentage of argument structure types produced by an English-speaking agrammatic subject in each of the following categories: (i) verbs with a base-generated external argument including transitives, ditransitives, and unergative intransitives, and (ii) verbs without an external argument, i.e. copular constructions (e.g. seem) and anti-causative verbs. Kegl found that the aphasic patient’s argument structure distribution profile showed a significant lack of anti-causative verbs. Even after six months of a syntactic mapping therapy-session designed to increase the production of anti-causative structures, the patient’s percentage increased from zero to only 3% of target constructions, most of which were ambiguous between true passives and adjectival passive productions. Such a performance contrasted sharply with that of the language-unimpaired matched control subject that showed an almost equal split between constructions with and without an external argument, as well as an equal division between copular and anti-causative verbs.
These findings were accounted for by Kegl (1995) on the basis of the Syntactically Enriched Verb Entry Hypothesis (SEVEH). The specific hypothesis stresses the role of derivational complexity in syntactically-based aphasic deficits. Its main prediction is that any construction that requires movement of a DP from one argument position in D-structure to another in S-structure, such that the lexically-specified arrangement of arguments would be permuted, will result in production problems in agrammatism. According to Kegl (1995) the processing of displaced arguments requires specific syntactic knowledge (of A-motion) that probably lacked in the agrammatic patient of the particular study\(^2\). Under the same reasoning anti-causative verbs should be as difficult for agrammatic aphasics to process as passives because of the presence of a surface syntactic subject with an Undergoer/Theme interpretation reflecting movement of the verb’s single syntactically active argument from the underlying object position to subject position in [Spec,IP]. On the other hand, Kegl (1995) argues that verbs whose argument structure pattern contains a base-generated external argument are in general more stable and easier to process by agrammatic aphasic subjects because the presence of an external argument precludes the need for movement rules that displace arguments from their lexically-specified positions. Kegl’s assumption was confirmed by evidence provided by the aphasic subject of her study who managed to produce unergative intransitive verbs without difficulty in his narrative samples.

\(^2\) There is a growing body of research that demonstrates that any displacement of arguments from their underlying position that results in a tangible permutation of the arguments relative to the verb and to each other is problematic for the great majority of agrammatic aphasics. Such constructions involving argument displacement from their underlying position (besides verbs of alternating transitivity) are verb movement (e.g. Bastiaanse & van Zonneveld, 1998) and object scrambling (Bastiaanse, Koekkoek, & van Zonneveld, 2003). A very recent study conducted by Bastiaanse, Bouma, & Post (2009) on the basis of corpus frequency data from agrammatic aphasics argues that the patients’ deficient performance at such altered structures can only be accounted for in terms of the configurations’ linguistic complexity rather than in terms of their low frequency in spoken and written corpora.
Kegl’s research (1995) was extended by Kim & Thompson’s (2004) study that has also focused on the argument structure distribution of the verbal predicates produced by Korean agrammatic aphasic patients. Agrammatic data were gathered by having the patients and their matched controls freely narrate three well-known Korean folktales and describe actions or activities of videotaped scenes administered to elicit certain pre-targeted predicates with a designated argument structure (i.e. unergative and transitive verbs, causative verbs with a causative morpheme, passive verbs with a passive morpheme, middles, inchoative anti-causative verbs, and predicate adjectives). Subsequently, the elicited verbal predicates were coded along the [±external argument] variable thus resulting in two classes of verbs: transitives, causatives, and unergatives were coded as predicates with an external argument, whereas passives, middles, anti-causatives, and adjectival predicates were coded as predicates that lack an external argument. The overall pattern of the production performance of the agrammatic subjects showed that the percentage of anti-causative predicates compared to the total number of the codable predicates produced was lower in the patient group than in the control group. However, Kim & Thompson (2004) did not observe the same dramatic absence of anti-causative verbs as the one reported by Kegl (1995) for her single English-speaking agrammatic patient. In fact, the difference found between the two [±external argument] predicate classes elicited by the Korean agrammatic patients did not reach significance, thus, implying that the aphasics did not experience any particular difficulties in the production of constructions that lack an external argument including anti-causatives. Kim & Thompson concluded that the frequency pattern in the production of verbal

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22 In fact, the second picture-description task in Kim & Thompson’s (2004) study demonstrated a narrower gap in the response patterns between the patient and the control group across the [± external argument] division relative to the gap demonstrated by the free narrative production task. According to the two authors, such a difference suggests that when aphasics show a preference for a certain type of construction in narrative production, it may not necessarily indicate that they lack the capacity to produce other types of verbal constructions. Therefore, from a methodological point of view, the picture description task appeared to be a more appropriate method for measuring aphasics’ competence relative to the narrative production task.
predicates did not hinge upon the presence or absence of an external argument in any given predicate’s argument structure representation, unlike in the English case reported in Kegl.

This cross-linguistic difference in aphasic behaviour according to the authors is to be expected if one considers the differences in the grammatical structures of the two languages (English vs. Korean) and, more specifically, the differences in the syntactic process of deriving anti-causative constructions: the movement of a D-structure object to the surface subject position in a verb-final language like Korean (SOV) would not cause a tangible permutation of arguments relative to the verbal predicate between the two different syntactic levels of representation (i.e. S-structure and D-structure). This becomes evident in (48):

(48)  *Anti-causative structures in Korean at D-structure and S-structure:*

D-structure: subject [raindrops] fall

\[\downarrow\]

S-structure: [raindrops]–Nom \ t \ fall

*Anti-causative structures in English at D-structure and S-structure:*

D-structure: subject fall [raindrops]

\[\downarrow\]

S-structure: [raindrops] fall \ \ t

Thompson (2003) and Lee & Thompson (2004) attempted to account for English-speaking Broca’s aphasics’ target-deviant performance on anti-causative verbs by proposing the Argument
Structure Complexity Hypothesis (ASCH) which attributes aphasics’ deficient performance to the argument structure properties of anti-causative verbs. This theory (originating from Shapiro et al.’s Predicate Argument Structure (PAS) theory (1987, 1989, 1990, 1993)) holds that verb complexity either manifest in the high number of arguments associated with the verb, or in the non-canonical mapping between the argument structure entry of the verb and its S-structure representation, may affect verb access even in individuals without language impairment; the more argument structure options a verb is encoded with, the longer it takes for the parser to access it. With regard to patients with Broca’s aphasia, the verb complexity effect was found by Shapiro, Gordon, Hack & Killakey (1993) to affect their performance on anti-causative verbal predicates, thus, suggesting that all possible verb arguments are accessed in the immediate temporal vicinity of the verb during sentence processing and that Broca’s aphasics’ PAS knowledge is presumably spared. Interestingly, Wernicke’s aphasic patients with posterior brain damage did not display a verb complexity effect (in fact, their performance was equally worse across actives, passives, cleft–objects and cleft-subjects), thus, suggesting that posterior brain sites are crucial for processing verb argument structure information.

Lee & Thompson’s (2004) and Thompson (2003)’s studies attempted to check the predictions of Shapiro’s complexity metric with a group of Broca’s aphasics. What they found was that anti-causative verbs with a single syntactically-active argument were more difficult to produce than verbs with two arguments. Moreover, sentences with anti-causative verbs were found to be considerably more difficult to produce than sentences with frequency-matched unergative verbs. Thompson (2003) argued that the observed discrepancy stemmed from the added complexity associated with the

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23 The same patients were found to perform better on comprehension tasks involving anti-causative constructions relative to the production tasks, thus, suggesting that the argument structure representation of anti-causative verbs was unimpaired in the specific patients and normally accessed in comprehension. According to Lee & Thompson (2004), the same finding provides supporting evidence in favour of the assumption that agrammatic aphasia should be primarily characterized in terms of a production (rather than a comprehension) deficit.
movement chain in the anti-causatives that lacks in unergatives. Lee & Thompson (2004) provided further evidence in favour of the ASCH by including alternating anti-causative verbs in their experimental stimuli, i.e. verbs appearing in both transitive and intransitive sentence frames, like ‘break’. The aphasic subjects of the particular study scored better in non-alternating than in alternating anti-causatives. This finding evinces that along with the number and the type of arguments associated with a verb, the number of lexical entries corresponding to each verb is crucial in sentence processing as well.

In a later study, Thompson, Dickey, Cho, Lee, & Griffin (2007) replicated and extended data supporting the ASCH by monitoring Broca’s aphasics’ eye-movements as two and three-argument verb structures were produced during a picture-description task. Verbs with greater argument structure complexity (i.e. three-argument verbs) elicited qualitatively different eye-gazing patterns than those of the normal controls, while two-argument structure verbs elicited similar to controls’ eye-movement patterns, implying that the former engendered greater encoding demands that exceeded the aphasics’ processing capacities. The argument structure complexity effect manifested in the aphasics’ recorded eye-movements was also reflected in their production accuracy rates which were significantly higher in the two-argument rather than the three-argument condition.

Based on Lee & Thompson’s (2004) ASCH whereby the problematic production of anti-causative verbs in agrammatism is due to the lack of direct mapping of verb arguments to sentence slots, Bastiaanse & Van Zonneveld (2005) have tested the specific hypothesis with Dutch-speaking aphasic patients to see if it holds cross-linguistically. Their research was methodologically different from the previous studies since the Dutch-speaking aphasic subjects recruited in their study were asked to use the anti-causative verbs in sentences while the studies of Kim & Thompson’s (2000), and Lee & Thompson’s (2004) focused on the single word level. Bastiaanse & Van Zonneveld argue that the aphasics’ deficit in the production of anti-causative verbs stems from a deficit in thematic role assignment which would be most evidently manifested at the sentence rather than at the word level.
Their study tested this hypothesis with alternating anti-causative verbs in a production test that elicited from the aphasic patients the same verbal stimuli in transitive and anti-causative frames. The results showed that the Broca’s patients were significantly better in producing the sentences in the transitive frame that required no movement. In fact, the performance gap between the two conditions for the Broca’s patients was entirely caused by a single error type: the patients systematically produced a transitive sentence when an anti-causative sentence was targeted by the picture stimuli. The specific finding lead Bastiaansen & Van Zonneveld (2005) to the conclusion that the factor that compromised patients’ performance was the greater amount of syntactic encoding inflicted by anti-causative verbs. Their finding is in accordance to the predictions of the Derived Order Problem Hypothesis (DOP-H) (Bastiaanse & Van Zonneveld, 2005) according to which sentences with derived subjects, such as anti-causatives, are more difficult to produce and parse than sentences in which the thematic roles are at their base-generated position.

Koukoulioti, Stavrakaki & Kambanaros (2007) have recently addressed the issue of unaccusativity in Greek Broca’s and Wernicke’s aphasia. The main assumption triggering their research was that argument structure complexity interacts with morphological marking on the verb. To test their hypothesis they tested Aspect marking on unergative, anti-causative and transitive verbs. Their main prediction was that the aspectual morphological marking of anti-causative verbs would be harder to implement due to the specific verbs’ more complex argument structure relative to the rest of the two verbal categories. A forced choice completion task was administered to three aphasic patients (one non-fluent and two fluent). The results partially confirmed their initial hypothesis with respect to the argument structure complexity effect on the verbs’ aspectual morphological marking. With regard to the non-fluent patient, Aspect was found to be mostly impaired in anti-causatives followed by unergatives and transitives. On the other hand, the two fluent patients performed much better relative to the agrammatic subject.
Froud’s (2006) single-case study also provides evidence in favour of the deficient production of anti-causative verbs by Broca’s aphasics, yet, she accounts for it in terms of a grammatical reduction of some formal features implemented in the morphological component where unaccusativity on verbal predicates is assumingly specified. More specifically, following the spirit of Pesetsky’s (1995) analysis, Froud claims that both alternating and non-alternating anti-causative predicates result from an underlying causative representation which is the same as that for a transitive verb with positions for an internal and an external argument. The anti-causative reading emerges from the suppression of the external theta role of the verb by means of the lexical predicate’s adjunction to some argument-structure-changing functional head labelled UNACC. This adjoining process according to Froud (2006) takes place at an isolable morphological component (akin to the Morphology Interface of Smith & Tsimpli, 1995) whose role is to specify the featurally neutral representations of categories by assigning them a morphological realization before they reach the syntactic component. As such, an anti-causative verb exists as a categorically distinct functional head in the UG lexicon, but its features are not specified until it reaches the level of the morphological component, where unaccusativity is realized on the verb. According to Froud (2006) the pre-syntactic identification and selection of the UNACC functional head by an originally transitive substantive verb implicates that anti-causative verbs should be classified and treated as functional heads.  

Froud (2006) further speculates on the derivation of alternating verbs with an anti-causative and a transitive variant by assuming that the adjunction of the originally causative verb to the UNACC functional head is optional. This would mean that the structure projected can either be a functional one (the intransitive anti-causative form) or an extended projection with a lexical head (the transitive/causative form). According to Froud, the optionality of selecting the UNACC morpheme or not is dependent on the strength or weakness of the semantic trigger for unaccusativity. More specifically, she claims that the obligatoriness of anti-causative realizations of causative verbs could be the reflection of a graded phenomenon: the more the semantic features on the verb’s lexical entry assumed to trigger anti-causative syntax, the more difficult to override the requirement for the verb to be pre-syntactically adjoined to the UNACC head and vice versa. The specific unaccusativity ‘diacritic’ on the verb’s lexical entry is traced back to Borer’s account (2004) according to which unaccusativity gets
In order to confirm her hypothesis Froud (2006) presents data from an English-speaking agrammatic patient. The specific subject demonstrated a specific pattern of performance characterized by a robust dissociation between substantive and functional categories in the single-word reading modality. More specifically, the patient exhibited a profoundly compromised ability to read functional items (e.g. auxiliary verbs, complementizers, conjunctions, determiners, negation, particles, pronouns, quantifiers, and wh-words), while his ability to read lexical items classified as substantives was almost intact. Most interestingly, the production of anti-causative verbs was equally problematic for him and sometimes his erroneous readings included misidentifications of the anti-causative verb with other functional items. Based on the specific data, Froud assumes that the problem with the specific patient stemmed from a selective deficit in the implementation of the functional lexicon in the morphology interface; when adjunction of the causative verb to the UNACC morpheme was carried out, the complex head that was created was identified by the patient's parser as being functional in nature, yet, the morphological component failed to compute or retrieve categorical and structural information related to the verbal predicate's unaccusativity features. According to Froud (2006), the patient's characteristic within-(functional) category substitution errors provides supporting evidence in favour of the functional nature of anti-causative verbs.

Froud's (2006) account of the agrammatic subject's performance on anti-causative verbs is not unproblematic from several respects. First of all, Froud herself notes that there is a chance for her agrammatic patient to be classified as a phonological or a deep dyslexic. If such a diagnosis holds true, the subject's function word deficit manifested in the reading modality could have stemmed from a

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25 When no transitive alternation was available though, the aphasic subject read anti-causative verbs correctly around 70% of the time.
neuropsychological malfunction rather than a linguistically-defined selective breakdown at the morphology interface. Moreover, another limitation of Froud’s account is the stipulation of the functional UNACC head whereby anti-causative verbs are derived from originally transitive predicates in the morphology interface. The specific mechanism appears to be more a theoretical artefact devised to account for the performance of the specific agrammatic patient rather than a mechanism having overall applicability to the derivation of anti-causative verbs in aphasics’ (and language-unimpaired individuals’) grammar.

The effect of verbal structural complexity on the production capacities of aphasics was also investigated by a very recent study conducted by Cho & Thompson (2009) which has measured aphasics’ eye movements during the production of ACT transitive and anti-causative sentences. More specifically, the elicitation of the sentences was achieved through syntactic priming, such that participants listened and viewed a prime sentence (ACT transitive or anti-causative), and then repeated it aloud. Next, a picture appeared and participants were expected to describe it by using the primed sentence structure. The results demonstrated that while the control group performed at near ceiling level in both transitive and anti-causative conditions, the aphasics performed significantly more poorly in the anti-causative condition relative to the transitive condition, thus, providing supporting evidence in favour of the difficulty producing anti-causative sentences in agrammatic aphasia. The most prevalent error type of aphasics' productions in the anti-causative condition consisted of transitive-for-anti-causatives productions.

Moreover, the aphasics’ eye-movements associated with the incorrect responses in the anti-causative condition were qualitatively different from the trials eliciting correct responses. More specifically, the aphasics was found to spend a significantly longer time gazing at the first entity to be produced (i.e. the Causer of the event portrayed by the anti-causative verb) even after producing it as compared to when correct anti-causative sentences were produced. The same pattern was also attested in the correct production of ACT transitive verbs, i.e. they spent considerably longer times
gazing at the agent of the transitive event. On the other hand, the eye data from the normal speakers indicated that the latter gazed at both entities (causer and theme) in the anti-causative verb condition, whereas they only spent time looking at the first entity (i.e. the Agent) for ACT transitive sentences. The qualitatively distinct eye-gazing patterns between the two experimental conditions in the language unimpaired-group suggest according to the authors that the processing of distinct sentence types require different processing mechanisms corresponding to the two structural configurations’ underlying nature. These mechanisms of sentence planning are continuously available to normal speakers and the most appropriate and efficient one can be chosen when needed. However, these choices may not be available for agrammatic aphasic speakers, resulting in the employment of the same processing routines for both transitive and anti-causative sentences.

In a later study, Lee & Thompson (2010) have examined agrammatic aphasics’ and controls’ real-production of unergative and unaccusative verbs in sentences by tracking their eye-movements during a sentence construction task. This time, the speakers were asked to construct a sentence using written words. Both the controls’ and the aphasics’ eye-movements revealed increased processing cost with the unaccusatives reflected by their increased gazes while producing the Theme subject noun phrase in the unaccusative condition as compared to the unergative condition. However, the aphasic speakers showed the difference before speech onset, while controls showed the difference during speech. According to the authors, these findings suggest that the distinction between unergative and unaccusative structures remains preserved in agrammatic sentence production, but their time course of sentence planning may be different from that of normal speakers.

Contrary to the findings of the aforementioned studies, the production of anti-causative verbs did not appear to pose any difficulties to a Hebrew-speaking agrammatic patient in a recent single-case study conducted by Biran and Friedmann (2008). The latter examined whether the predicate argument structure and the sub-categorization requirements of a list of verbs had any effect on the patient’s receptive and expressive capacities. To check their hypothesis two tests were conducted: (i) a
grammaticality judgement test of the patient’s knowledge of P(redicate) A rgument S(tructure), and (ii) a sentence completion task checking the patient’s sensitivity to the sub-categorization requirements of the verbal stimuli which have also included anti-causative verbs. The patient’s scores in both tasks have reached ceiling performance (95% and 100%, respectively). According to the authors, these results suggest that PAS knowledge and access to the verbs’ underlying argument structure in the specific patient were very well preserved.

On the other hand, a considerable number of studies exist that demonstrate that comprehension of anti-causative verbs in aphasics is in general superior to production. These studies indicate that agrammatic aphasics have relatively intact access to the lexically-specified argument structure of anti-causative verbs in comprehension.

Grodzinsky (1995a, 1995b) was one of the first to investigate unaccusativity in agrammatism. In order to account for Broca’s aphasics’ problematic performance on anti-causative constructions he first proposed the well-known TDH. This hypothesis later on underwent some changes and was reformulated into the Trace-Based Account (TBA) in order to incorporate some new empirical data like the R(eferential) Strategy, as well as additional advances in linguistic theory. More analytically, according to the TBA, the traces are thought to be invisible to theta assignment in agrammatism so that the derived subject in anti-causative structures should not be able to receive its theta role. R-Strategy is predicted to apply and assign an instrument (instead of a Theme) role to the moved DP\(^26\). The reason why the DP cannot receive an Agent role is because it is not animate. According to Grodzinsky (1995a, 1995b), this constraint causes a breakdown in aphasics’ processing system which yields chance or below chance performance on the interpretation of anti-causative verbs. However, later studies

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\(^26\) Theta-role assignment is carried out in accordance to Jackendoff’s (1972) Thematic Hierarchy: agent>instrument>experiencer>theme (qtd. in Grodzinsky, 1995b: 16).
empirically refuted TBA's predictions showing that Broca's aphasics' comprehension of anti-causative verbs is normal-like.

Pinango (1999) has examined the comprehension performance of two Broca's patients on anti-causative derivations. There were three experimental conditions involved in her study: unergatives, non-alternating and alternating anti-causative verbs. The experimental results demonstrated that both agrammatics performed like the normal subjects, i.e. they scored above chance in all experimental conditions. Pinango (1999) accounted for the agrammatics' normal-like performance on anti-causative verbs in terms of the Argument Linking Hypothesis (ALH). According to the latter, there are two ways of linking thematic roles to the DPs at the S-structure of a sentence (49i) (49ii):

(49)

(i) Semantic linking which is purely semantically-based and establishes a correspondence between arguments (agent, theme...) and linear positions in the sentence (first DP, second DP, etc...), and

(ii) Syntactic linking which establishes a correspondence between arguments and syntactic functions (subject, direct object) based on syntactic principles.

(from Pinango, 1999: 81)

In the intact brain, the system of correspondence is constrained in such a way that syntactic linking always prevails over semantic linking. This is defined as the linking constraint that crucially prevents semantic linking from interfering with the syntactic linking. According to Pinango (1999), the only way semantic linking emerges as the dominant system of correspondence is whenever syntactic principles of linking fail to be properly implemented or fail to be implemented on time. In a non-fully active grammatical system such as that of agrammatic patients, the linking constraint is impaired with the implication that, although both syntactic representation and argument structure are intact, the
system now has two (instead of one) active linking mechanisms that must compete against each other. The ALH states that whenever the two linking mechanisms agree, absence of the linking constraint is not noticeable. However, whenever the two linking mechanisms yield conflicting correspondences, i.e. whenever semantic roles are reversed in syntactic representations, impaired comprehension reflected in chance level performance will arise. The reason why both patients performed normal-like on anti-causatives according to Pinango (1999) was that both syntactic and semantic linking mechanisms in the relevant constructions coincided, in other words, the aphasics did not misinterpret the argument of the anti-causative verbs as agent simply because the anti-causative derivations include only one syntactically-active argument that originates in the internal argument position. As such, the lack of a thematic role reversal in anti-causative structures prevented a crash between the syntactic and the semantic linking mechanism.

In a later on-line study, Burkhardt, Pinango & Wong (2003) have also shown that aphasics’ knowledge of the underlying structure of anti-causative verbs is spared which would explain the patients’ normal-like performance on the comprehension of the relevant structures in off-line tasks. The impetus for their study was Pelmutter’s (1978) Unaccusativity Hypothesis whereby anti-causative derivations have a post-verbal argument trace left by the DP object moving from the object to the subject [Spec,IP] position. Burkhardt et al. (2003) examined the real-time comprehension of anti-causative constructions by using a cross-modal lexical decision priming paradigm. Normal subjects provided evidence that the antecedent of the argument trace is reactived post-verbally, yet not immediately at the trace position but at a significantly later point in time (650 msecs after the anti-causative verb) (for similar results see Friedmann, Taranto, Shapiro, & Swinney, 2008 with language-unimpaired adults). On the other hand, the aphasic patients also failed to activate the antecedent at the point of the trace, yet, their parser did show priming for the antecedent on average 150 msecs later than the unimpaired subjects. The researchers accounted for such a delay in terms of the Slow Syntax Hypothesis according to which aphasics’ syntactic knowledge and implementation are relatively spared,
so that the establishment of dependency relations during the syntactic derivation of anti-causative structures would be indistinguishable from that of normal subjects. Yet, the basic syntactic processes by which the referential dependency between the derived subject and its trace are instantiated are composed in a protracted/delayed manner attributed to aphasics’ limited processing resources. It is worth noticing that no clear pattern of priming effect for the antecedent was shown by the Broca’s subjects when tested on non-alternating anti-causatives thus implying that the factors underlying the processing of the latter are different from those underlying the processing of alternating anti-causatives.

Stavrakaki, Katsarou, Bostanjopoulou & Alexiadou’s study (2006) has also addressed the issue of anti-causatives in agrammatism by testing two Greek-speaking aphasics’ production and comprehension performance on anti-causative verbs. The most interesting parameter of their study was the manipulation of the [ACT/NACT] morphological marking observed in anti-causative verbs in Greek which allowed researchers to investigate the morphological complexity effect on agrammatic patients’ production of the relevant verbs. The tasks used were an elicited production task and a picture-pointing task, while the experimental materials included 15 transitive and 15 anti-causative verbs of both NACT and ACT voice. Both patients showed a high level of correct performance on the comprehension of both transitive and anti-causative verbs. However, they did not show homogeneous performance on the production of anti-causative verbs; NACT morphological marking on anti-causative verbs facilitated verb naming in one of the two Greek-speaking Broca’s aphasics, while the second patient could not name anti-causative verbs altogether irrespective of their voice morphological marking. According to Stavrakaki et al. the problem with the production of anti-causative verbs of ACT voice morphology is mainly attributable to a grammatical encoding deficit preventing the patient from mapping the thematic roles onto syntax. The reason why the aphasic patient found naming of NACT verbs easier was that “the additional layer of passive morphology in anti-causatives functioned as a marker of intransitivity and, thus, facilitated grammatical encoding”.

Finally, one of the most recent studies of anti-causative verbs in the field of aphasiology is the one conducted by McAllister, Waters, Caplan, & Bachrach (2008) with nine English-speaking agrammatic patients. The specific study tested anti-causatives across both the expressive and the receptive modality in a tightly controlled fashion encompassing a range of various tasks. The first task in their unaccusativity battery was a measure of single-word production of anti-causative and unergative verbs matched for lexical frequency. Following the design described by Thompson (2003), the subjects were instructed to produce a single verb to describe a depicted action. In the second task, the subjects were prompted with a target verb and asked to produce a sentence describing a picture stimulus. For alternating anti-causative verbs such as ‘break’, separate pictures were generated to evoke both intransitive and transitive frames. In the last test of the experimental battery the subject heard one sentence and chose between two possible pictures. Stimuli could be anti-causative or not, and each verb occurred in both movement (passive or non-alternating anti-causative) and non-movement (transitive or alternating anti-causative) conditions. Some sample sentences are cited in (50) and (51) below:

(50)
(a) The girl was poked by the teacher. Non-anti-causative, + Movement
(a) The girl poked the teacher. Non-anti-causative, - Movement

(51)
(a) The boy is choking. Anti-causative, + Movement
(b) The boy is choking the girl. Anti-causative, - Movement

Analyses of the nine patients’ accuracy scores across the three measures revealed that anti-causative derivations were both produced and comprehended with lower accuracy than comparable
constructions without movement. According to the authors, these results point towards a central deficit affecting both production and comprehension of anti-causative constructions. Their finding aligns with Finocchiaro’s (2002) single-case study in Italian reporting better performance on [+agentive] than [-agentive] verbs across a battery of verb production tests (both in isolation and in context) and grammaticality judgement tasks (Finocchiaro, 2002).

What is most interesting in McAllister et al.’s (2008) study is that the performance disparity manifested between unergative and anti-causative verbs was present not only in the performance of the nine aphasic subjects but in the performance of the age-matched controls as well. According to the authors, this finding does not support an aphasia-specific deficit in the representation of movement chains; rather, these results are interpreted as evidence that the disparity between anti-causatives and constructions not derived by A-movement is in fact a reflection of the increased processing load associated with anti-causative syntax. Under this perspective, McAllister et al.’s (2008) study points towards a clear differentiation between representational deficit models in support of a selective impairment in movement constructions, such as Grodzinsky’s TDH (1986a, 1986b, 1990, 1995a, 1995b, 2000), and processing-limitation models that suggest that aphasics have reduced processing capacities which are overwhelmed by the computationally more complex non-canonical sentence frames.
Chapter 5 RESEARCH HYPOTHESES AND PREDICTIONS OF THE PRESENT STUDY

As already mentioned the main objective of the present thesis is to investigate the nature of the potentially predictive relations between interface-based structures and processing difficulty in eight Greek-speaking individuals with Broca’s aphasia. This objective was addressed through the investigation of ambiguous subject pronoun resolution at the discourse-syntax interface, whereby the null/overt pronoun paradigm in the Greek language was manipulated so that the interaction between discourse-level information and grammatical choices could be revealed, as well as through the study of verbs of alternating transitivity whose processing critically relies upon the retrieval of information at the lexicon-syntax interface. What follow is the research questions of the study and their accompanying predictions.

➢ 1st Research question: What does the aphasic performance at the interfaces evince about the notorious competence/performance deficit dilemma in Broca’s aphasia?

The main research question of this study addresses the characterization of Broca’s aphasia as a loss of (part of) the knowledge of grammar or as a processing deficit compromising patients’ possibility of utilizing such knowledge. Such a dilemma will be explored through a better understanding of the Broca’s aphasics’ difficulties with linguistic phenomena lying at the interfaces between narrow syntax and discourse, as well as lexical constraints. If agrammatism is best characterized in terms of a competence deficit, we expect that the aphasics will make use of their relatively intact resources (i.e. discourse and lexical cues) to compensate for their deficient functional categories in the disambiguation of anaphora resolution and unaccusativity, respectively. This means there will be less demand on syntactic capacity because the discourse and the lexical components will supposedly be ‘ready to go’
requiring little or no functional processing. Furthermore, we expect that the aphasic performance in the on-line tasks will be similar to the same patients’ performance off-line. Such an expectation follows from the natural assumption that their linguistic behavior is compromised by lack of knowledge of grammar that has a global effect on the computation of language, and not by reduced procedural capacities that would have mainly affected their performance in real time constraints.

If, on the other hand, agrammatism is best characterized in terms of a performance deficit, we expect that the aphasics will experience difficulties with interface-conditioned phenomena perhaps because the processing of such phenomena goes beyond the narrow syntax and requires access to interface-based constraints. The patients may start parsing the relevant structures with reliable syntactic cues, but the gradual addition of other sources of information requires additional processing resources that are out of reach of their systems. As such, differences in the severity of the deficit is predicted to be easily translated into differences in the availability of processing resources: the more severely impaired systems are predicted to perform more poorly in the interface-conditioned phenomena relative to the less severely impaired systems. If this is the case, on-line tasks are expected to be more demanding than off-line tasks, since the former require that the patients demonstrate rapid, almost automatic integration of multiple sources of information in real time.

Furthermore, we expect the patients’ meaning-encoding capacities in producing anti-causative verbs to be more compromised relative to their decoding capacities in the comprehension modality. Such a disparity is attributable to the fact that decoding auditory signals will probably allow a more robust access to lexical representations, par consequence, to lexical, semantic, and morphological cues during language comprehension. The relevant performance contrast between the two modalities is predicted to be demonstrated only in the tasks testing the production and the interpretation of the verbs at the lexicon-syntax interface, since the tasks at the discourse-syntax interface only focus on the interpretation of subject pronouns in ambiguous contexts.
Overall, our main prediction with respect to the notoriously problematic origin of the non-target-like linguistic behavior of agrammatic patients is that the difference between language-unimpaired individuals and aphasics is attributed to a language performance breakdown rather than to fundamental grammatical knowledge representation differences. We assume that evidence pertaining to task effects and to the (production vs. comprehension) modality distinction in the patients’ performance will be able to reflect the processing nature of the agrammatic deficit by appeal to the increase in the processing cost caused by on-line tasks as well as tasks targeting the patients’ production capacities.

2nd Research question: What are the underlying factors motivating the aphasic performance within each interface domain and why?

With respect to the aphasics’ performance at the discourse-syntax interface, we expect it to drop in the task conditions being more demanding in terms of processing resources. More specifically, we expect the aphasic patients to show strong effects of complexity when resolving pronouns in inter-sentential (vs. intra-sentential) contexts. We address this effect within work on the nature of working memory deficits in aphasia and the way these tap on domain-general, executive processing impairments that affect multiple aspects of cognitive processing, including working memory. Following this line of reasoning, we predict that recoverability of antecedent information for the aphasics will be harder under the ‘deep processing’ conditions imposed by the testing materials of the inter-sentential task.

With respect to the lexicon-syntax interface, we predict that the processing of ACT anti-causative verbs will be harder for the aphasic patients in the on-line cross-modal lexical priming task relative to the off-line sentence-picture matching task. We hypothesize that the cross-modal lexical priming task will yield strong evidence in favor of prolonged garden path effects negatively influencing the anti-causative sub-categorization of ACT/morphologically unmarked verbs. Such performance will be addressed in terms of the aphasics’ limited on-line access to lexicon-filtered information which, in
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turn, may partially stem from a resource allocational deficit assumingly characterizing agrammatic aphasia.

- **3rd Research question:** Does the aphasic performance at the two interfaces evince use of compensatory strategies and heuristics instead of a grammar-driven parser?

We reason that if linguistic information is computed more heuristically in structurally taxing situations, and if such tax-dependent shifts in processing strategy apply to both impaired and language-unimpaired populations, agrammatic performance should evince a relatively increased degree of heuristic strategy application. With respect to the discourse-syntax interface, we predict that subjecthood will have clear effects on the choice of the antecedent due to cognitive saliency reasons, such that the subject antecedent rates will tend to increase under stressful linguistic conditions, like the testing conditions in the on-line self-paced listening antecedent identification inter-sentential experiment. The prolonged spatial memory load along with the non-canonical word-order alternations could create a higher verbal working memory burden, hence, greater misanalysis for the subject pronouns on behalf of the aphasics. Also, the choice of the syntactic subject as the ‘default’ alternative is assumed to prevail in the patients due to their assumingly deficient inhibitory control mechanisms, preventing them from suppressing in time inappropriate (subject antecedent) choices once the syntactic subject preference clashes with interface-filtered constraints.

With respect to the lexicon-syntax interface, we expect a much wider use of heuristics and compensatory strategies mainly associated with the animacy features of the DP subjects and the voice morphological marking of the verbs, respectively. In fact, the two features are expected to considerably influence the performance of both the aphasics and the controls by either allowing limited recourse to on-line processing of the interface or by increasing processing difficulty depending on their set value.
More specifically, a compensation strategy predicted to be employed by the aphasics during the processing of the verbs stems from the NACT suffix and its strong expression of transitivity changes in Greek. Following this transitivity cue, we predict that ACT anti-causative verbs will be harder to process than their NACT voice counterparts due to the lack of morphological voice marking rendering the transitivity change less explicit. On the other hand, we expect the NACT suffix to be decisive in triggering antecedent re-activation post-verbally, thus, further boosting the gap-filling procedure and identifying the intransitive verbs in question as anti-causatives. Moreover, the further natural assumption is that the ACT voice-alternating anti-causative verbs in Greek (i.e. those verbs that have a NACT morphological alternant) will be easier to parse for the patients relative to the ACT non-alternating anti-causatives. With the precondition that the aphasic participants have normal access to the verbs’ conceptual representations and can syntactically attach the medio-passive suffix and maintain the NACT structure along with the ACT one in memory during on-line processing, we expect the gap-filling procedure to be more robust with voice-alternating (vs. non-alternating) ACT anti-causatives.

Finally, we predict that an animacy-based heuristic may be deployed in the verbs' processing at the lexicon-syntax interface. More specifically, we expect that the animate DP subjects in the NACT anti-causative structures will give raise to garden-path effects, possibly as a result of a conflict between a heuristic-based theta-role assignment (i.e. the additional possibility of reflexive readings with animate subjects and NACT verbs) and a syntactically-determined interpretation (i.e. the surface subject in anti-causatives derives from object position). Animacy-based biases in argument processing are also predicted to be activated in the ACT anti-causatives, which (along with other derived structures, like passives and middles) typically co-occur with an inanimate subject due to the latter’s derived status. As such, an animate subject is expected to bring delay in antecedent-reactivation for the relevant verb class in the cross modal lexical priming experiment.
4th Research question: Are the two interfaces equal in terms of processing difficulty or does the aphasic performance differ with respect to each interface tested?

A subsidiary prediction stemming from the assumingly problematic status of the interfaces in Broca’s aphasia refers to the distinction drawn between the two interfaces dealt with in the present paper (i.e. discourse-syntax, lexicon-syntax) in terms of processing difficulty. Structures lying at the discourse-syntactic interface are predicted to be harder relative to the lexicon-syntax interface-conditioned structures, since the processor of ambiguous pronouns has to engage more subtle and multi-facet information under deep processing conditions, including: knowledge about the plausibility of the individual sentence, the output of the syntactic parser referring to the type of the verbal event and to the critical pronoun along with its grammatical features, the type of the pronoun’s antecedents and the word-order of the constituents within the sentence frame. Most importantly, the processor will also have to disengage from the pragmatically salient discourse entity of the syntactic subject by means of successfully applying inhibitory control mechanisms. What we propose is that executive functioning, specifically failures in inhibitory control, may partially account for the patients’ occasional insensitivities to discourse-regulated, other-than-the-syntactic-subject antecedent candidates. Appropriate resolution of ambiguous anaphora is thus a composite judgment influenced by information at various levels, such that we assume that discourse-relevant constraints on antecedent acceptability will be less visible to the agrammatic parser.

The integration of lexical with syntactic information, on the other hand, is expected to be less problematic. We assume that that such a procedure partially relies on information about the subcategorization verb entries which is internal to the grammatical module apart from the long-term frequency effects stemming from extra-linguistic/pragmatic knowledge. We thus hypothesize that the structural analysis of verbs of alternating transitivity (in comprehension at least) is partially lexically-dependent, such that a sub-categorization entry may potentially act as a reliable cue to retrieve the
target structure. Moreover, as will be further discussed, the aphasic comprehenders may also take advantage of the NACT voice morphology, as well as the animacy heuristics which, as will be seen, are strongly predictive of the patients’ (and, occasionally, of the control subjects’) success in tracking morpho-syntactic regularities critical for verb class identification. Especially NACT voice morphology is treated as the strongest predictor of the critical verbs’ underlying argument structure activation which is highly attributable to the high interpretability of the medio-passive suffix and its productive use in Greek as a cue to a transitivity change. Following these assumptions, it is predicted that the processing of verbs of alternating transitivity will be relatively easier, because a structural prediction can be assessed on the basis of the sub-categorization entry of the input verb, as well as animacy and voice-morphology cues, and need not await full access to extra-grammatical, probabilistic constraints formed by linguistic experience.

Last but not least, the performance variations observed in the eight Broca’s aphasics will be weighed along a series of non-linguistic dimensions, and more specifically, the eight patients’ (i) age, (ii) lesion site, and (iii) educational level. Though the aphasic subjects that have participated in the present study were not purposely selected from the beginning on the basis of age, neurological and socio-economic criteria, we believe that the occasional variance observed in their performances across the various tasks may be accounted for in terms of a number of non-linguistic, demographic and neurological factors. More specifically, we predict that:

- Younger patients in the present study will perform better than older ones on the basis of the well-documented, age-related declines in verbal working memory and self-monitoring mediating linguistic behaviour.
- Highly literate aphasic patients will perform better than illiterate patients in the interpretation of anti-causative verbs across both the sentence-picture matching and the cross modal lexical priming tasks of the study. We believe that the quantity and the quality of the language input received in the
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The subjects’ mother language within the framework of the formal educational system cause speakers to prefer certain structures and lexical-structural pairings over others, leading to broad distributional regularities in language. Comprehenders implicitly learn these patterns and apply them as probabilistic constraints to interpreting new input. On this view, the subjects’ interpretational preferences in the tasks investigating the processing of verbs of alternating transitivity may reflect learning over the patterns in the input, which may themselves stem from the subjects’ training within formal education. As such, the patients with a considerably higher number of years in the formal educational system are expected to exhibit greater sensitivity to the unaccusativity features of certain intransitive verbs due to their higher exposure to S-V lexical-structural pairings encoding unaccusativity in the Greek language. The specific prediction mainly pertains to active voice anti-causatives (as well as [+alternating] active voice anti-causatives having a non-active morphological alternant in Greek) lacking an explicit morphological marking that would otherwise serve as a strong cue to a thematic structure change. It becomes evident that the specific expectation assumes that distributional regularities in the linguistic input influence argument activation during sentence processing, but holds that the unaccusativity effect is also contingent on verb-specific information, i.e. unaccusativity/change-of-state features are inherently encoded in the verbal stem cross-linguistically.

- The neuro-anatomical regions affected by the stroke or the haemorrhagic episode in the Broca’s aphasic individuals participating in the present study may partially account for specific linguistic limitations observed throughout the various tasks for each of the patients.

The research hypotheses along with their predictions, as well as the non-linguistic account of the heterogeneity in the aphasic performances are going to be extensively discussed in the final chapter of the thesis.
Part III

THE STUDY
Chapter 6 **SUBJECTS AND METHODOLOGY**

This chapter deals with the experimental part of the present research. Section 6.1 presents the selection of the controls and the biographical-neurological profile of the agrammatic participants as well as the diagnostic tasks upon which the clinical evaluation of the aphasics' speech and language deficits was based. Section 6.2 describes the nature of materials and tasks designed to investigate the processing of subject pronouns and verbs of alternating transitivity by the two experimental groups.

### 6.1 THE SUBJECTS

*Aphasic subjects.* Eight aphasic patients have participated in the experiments of the present study.

Table 6.1 gives a summary of the biographical and neurological profile of each patient.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Age</th>
<th>Occupation</th>
<th>Education (in yrs.)</th>
<th>Aetiology</th>
<th>Site of lesion</th>
<th>Onset</th>
<th>Hemiplegia</th>
<th>Handedness</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCH</td>
<td>M</td>
<td>57</td>
<td>glass trader</td>
<td>12</td>
<td>CVA, ischaemic</td>
<td>Left</td>
<td>2006</td>
<td>No</td>
<td>R</td>
</tr>
<tr>
<td>VSK</td>
<td>M</td>
<td>47</td>
<td>cellar owner</td>
<td>16</td>
<td>CVA, ischaemic</td>
<td>Left</td>
<td>2005</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>SP</td>
<td>M</td>
<td>68</td>
<td>bus-ticket collector</td>
<td>9</td>
<td>CVA, subarachnoid</td>
<td>Left</td>
<td>1989</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>THP</td>
<td>M</td>
<td>87</td>
<td>worker at a mill</td>
<td>4</td>
<td>CVA, ischaemic</td>
<td>Left</td>
<td>2003</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>DENT</td>
<td>M</td>
<td>79</td>
<td>dentist</td>
<td>17</td>
<td>CVA, ischaemic</td>
<td>Left</td>
<td>2003</td>
<td>R</td>
<td>R/L</td>
</tr>
<tr>
<td>THR</td>
<td>M</td>
<td>74</td>
<td>Builder</td>
<td>4</td>
<td>CVA, ischaemic</td>
<td>Left</td>
<td>1st incid. 2006 2nd</td>
<td>R</td>
<td>R</td>
</tr>
</tbody>
</table>
All the patients were assessed using the short form of the Boston Diagnostic Aphasia Examination (BDAE: Goodglass & Kaplan, 1983) test standardized in Greek by Tsapkini, Emmanuel, Passalidou & Nassiopoulou (2007) which looks at various aspects of speech production and comprehension. The aim of the specific diagnostic test is to characterize aphasic patients according to the syndrome classification which was developed by the Boston school of aphasiologists. There are well-documented problems with the syndrome classifications but a discussion of these lies outside the scope of the present work (see Badecker & Caramazza, 1985, 1986; Caplan, 1986, 1987; Marshall, 1986, Shallice, 1988; Goodglass, 1993; Bartlett & Pashek, 1994; Zurif, 1996, Druks & Marshall, 1996).

Nevertheless, a standardized assessment such as the BDAE is quick and easy to administer and provides a starting point for further clinical investigations, as well as a diagnostic category which even when assigned no theoretical significance can be used as a shorthand descriptor of the pattern of performance demonstrated by an aphasic patient.

The BDAE makes use of a considerable range of tasks. First, a sample of the agrammatic patients’ spontaneous speech was elicited by the famous ‘Cookie Theft’ picture. The picture shows a woman washing dishes at an overflowing sink, looking through the window which has a view of the garden. A boy is slipping from a stool which he has used to reach the cookie jar from a high cupboard and a girl is eating one of the stolen cookies. The aphasics’ spoken language output was further tested by the brief version of the Boston Naming Test in which each subject was asked to correctly name...
fifteen pictures depicting objects that carried various degrees of imageability. When needed, each patient was provided with a semantic cue (meaning), a phonemic cue (sounding out the first letter of the target word) or both. Testing on the aphasics’ spoken language output also included elicitation of automatized sequences (days of the week & numbers 1-21), repetition of single words and short, grammatically simple sentences, and elicitation of single-word responses to simple questions, e.g. ‘What can we do with a soap?’ The comprehension subtests of the BDAE included auditorily presented instructions of increasing complexity, answering questions on short narratives, and screening of special categories including letters, numbers and colors. The aphasics' receptive vocabulary was assessed by a picture-matching task which required the subjects to match one of four pictures to an auditorily presented word. The patients’ reading performance was assessed by five BDAE subtests checking reading of: (i) letters, (ii) numbers, (iii) substantives, (iv) sentences of increasing complexity, and (v) short paragraphs. Due to the fact that reading in some of the patients was mildly disturbed after the stroke, with most of their errors being function word substitutions, there were only three patients (namely, VSK, THP and DENT) that performed the specific reading tasks. Finally, the patients’ written output was assessed by the writing subtests of the BDAE that required the written production of each aphasic subject’s name and address, dictated words and short sentences, as well as other well-learnt sequences, such as the alphabet and numbers from 1 to 12. The aphasic subjects’ written output was also assessed by the written description of the ‘Cookie Theft’ picture mentioned above. Because most of the aphasic patients’ writing performance was so severely damaged as to be all but unintelligible, and because it did not seem to yield to theoretical interpretation, it has not been taken into account for the purpose of diagnosing the specific subjects as Broca’s aphasics.

The aphasic patients were also submitted to a range of sentence-picture matching tasks checking the patients’ comprehension of various syntactic structures (Peristeri, 2005), like verbs of mediopassive morphology (passives-24 items & reflexives-6 items), clitic left dislocated (CLLDed) (8 items) and focused (20 items) sentences, subject (S) (6 items) and object (O) (6 items) relative clauses,
as well as to an elicitation task targeting subject-verb (S-V) agreement (20 items). Overall, the test included 90 items. With respect to the SPMTs, for each sentence orally produced by the researcher, three pictures were presented simultaneously. In the triplets of pictures, apart from the target picture, there were also two non-target pictures, one depicting the ‘θ-role reversal’ reading and the other depicting a pragmatically irrelevant event. It was only in reflexives that the dis-preferred reading was represented by a picture encoding a passive reading, i.e. an agent initiating the action portrayed by the verb. What should be stressed is that the term preferred reading is used instead of target for the reflexive verbs because the latter refers to grammaticality. As was made clear in the ‘Linguistic Framework’ of the study, grammar in Greek allows more than one readings of the same NACT verb with an animate subject, such that the misidentification of a reflexive as a passive is not grammatically illicit but it is claimed to be a purely pragmatic property stemming from frequency and real-world knowledge effects. As such, for each of the six reflexive sentences there was a preferred reading whose preference status is accounted for in terms of pragmatic effects, while the grammatical but less preferred (passive) reading will be referred to as dis-preferred. Each subject listened to each sentence and then had to decide which of the array of the pictures most appropriately depicted the action portrayed by the relevant sentence. The position of the target picture was random and the order of presentation of the sentences was the same for all the subjects but randomized with respect to the type of the structure tested. All verbs were presented in the 3rd person singular present tense. The inclusion of these tests aimed at providing a more fine-grained and complete picture of the aphasics’ syntactic comprehension capacities which could not possibly be provided by the BDAE alone, since the latter lacks syntactic comprehension subtests.

Table 6.2 gives a summary of the individual performance of each aphasic patient in the BDAE battery and in the SPMTs checking syntactic comprehension.

There is no distinction between simple and continuous present tense in Greek.
Table 6.2. The aphasic patients’ individual performances in the BDAE & in the syntactic comprehension tests (raw data & %).

<table>
<thead>
<tr>
<th>BDAE subtests</th>
<th>GCH</th>
<th>VSK</th>
<th>SP</th>
<th>THP</th>
</tr>
</thead>
<tbody>
<tr>
<td>severity rating (0/very severe-100/close to normal)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>fluency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>phrase length</td>
<td>90%</td>
<td>90%</td>
<td>20%</td>
<td>90%</td>
</tr>
<tr>
<td>melodic line</td>
<td>100%</td>
<td>30%</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td>grammatical form</td>
<td>70%</td>
<td>60%</td>
<td>20%</td>
<td>80%</td>
</tr>
<tr>
<td>conversation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>simple social responses</td>
<td>80%</td>
<td>80%</td>
<td>20%</td>
<td>90%</td>
</tr>
<tr>
<td>auditory comprehension</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>basic word discrimination (16)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>commands (10)</td>
<td>8 (80%)</td>
<td>7 (70%)</td>
<td>4 (40%)</td>
<td>7 (70%)</td>
</tr>
<tr>
<td>complex ideational material (6)</td>
<td>4 (67%)</td>
<td>3 (50%)</td>
<td>2 (33%)</td>
<td>5 (83%)</td>
</tr>
<tr>
<td>articulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>articular agility</td>
<td>30%</td>
<td>40%</td>
<td>20%</td>
<td>60%</td>
</tr>
<tr>
<td>recitation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>automatized sequences (4)</td>
<td>4 (100%)</td>
<td>2 (50%)</td>
<td>4 (100%)</td>
<td>4 (100%)</td>
</tr>
<tr>
<td>repetition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>words (5)</td>
<td>3 (60%)</td>
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<td>4 (80%)</td>
<td>4 (80%)</td>
</tr>
<tr>
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<tr>
<td>naming</td>
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<tr>
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<td>6 (60%)</td>
<td>6 (60%)</td>
<td>7 (70%)</td>
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<td>Boston Naming Test (15)</td>
<td>3 (20%)</td>
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<td>4 (27%)</td>
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<tr>
<td>special categories (12)</td>
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<td>12 (100%)</td>
<td>10 (83%)</td>
</tr>
<tr>
<td>Mean</td>
<td>62%</td>
<td>64%</td>
<td>61%</td>
<td>76%</td>
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Syntactic subtests (SPMTs)

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<td>4</td>
<td>4</td>
<td>3</td>
<td>5</td>
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### The Subjects of the Study

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<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td></td>
<td>(67%)</td>
<td>(67%)</td>
<td>(50%)</td>
<td>(67%)</td>
<td>(67%)</td>
<td>(67%)</td>
<td>(68%)</td>
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<tr>
<td>O-relative clauses (6)</td>
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<td>4 (67%)</td>
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<td>15 (75%)</td>
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<td>11 (55%)</td>
<td>10 (50%)</td>
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<td>5 (63%)</td>
<td>6 (75%)</td>
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<td>19 (79%)</td>
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<td>6 (100%)</td>
<td>2 (33%)</td>
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<td>S-V Agreement (20)</td>
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<td>19 (95%)</td>
<td>15 (75%)</td>
<td>16 (80%)</td>
<td>15 (75%)</td>
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<td>Mean</td>
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<td><strong>47 (52%)</strong></td>
<td><strong>67 (74%)</strong></td>
<td><strong>47 (52%)</strong></td>
<td><strong>67 (74%)</strong></td>
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### BDAE subtests

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<tr>
<td>phrase length</td>
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<tr>
<td>90%</td>
<td>90%</td>
<td>90%</td>
<td>20%</td>
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</tr>
<tr>
<td>melodic line</td>
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<tr>
<td>40%</td>
<td>80%</td>
<td>60%</td>
<td>20%</td>
<td></td>
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<tr>
<td>grammatical form</td>
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<tr>
<td>50%</td>
<td>20%</td>
<td>50%</td>
<td>20%</td>
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<tr>
<td>conversation</td>
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<tr>
<td>simple social responses</td>
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<td>80%</td>
<td>20%</td>
<td>80%</td>
<td>50%</td>
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<tr>
<td>auditory comprehension</td>
<td></td>
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<tr>
<td>basic word discrimination (16)</td>
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<tr>
<td>11.5 (72%)</td>
<td>10.5 (66%)</td>
<td>14 (88%)</td>
<td>13 (81%)</td>
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<tr>
<td>commands (10)</td>
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<tr>
<td>8 (80%)</td>
<td>5 (50%)</td>
<td>10 (100%)</td>
<td>10 (100%)</td>
<td></td>
</tr>
<tr>
<td>complex ideational material (6)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 (17%)</td>
<td>2 (33%)</td>
<td>4 (67%)</td>
<td>5 (83%)</td>
<td></td>
</tr>
<tr>
<td>articulation</td>
<td></td>
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<tr>
<td>articulatory agility</td>
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<td></td>
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</tr>
<tr>
<td>40%</td>
<td>20%</td>
<td>60%</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>recitation</td>
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</tr>
<tr>
<td>automatized sequences (4)</td>
<td></td>
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<tr>
<td>4 (100%)</td>
<td>4 (100%)</td>
<td>4 (100%)</td>
<td>1 (25%)</td>
<td></td>
</tr>
<tr>
<td>repetition</td>
<td></td>
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<tr>
<td>words (5)</td>
<td></td>
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</tr>
<tr>
<td>5</td>
<td>5 (100%)</td>
<td>5 (100%)</td>
<td>3 (25%)</td>
<td></td>
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</tbody>
</table>
In what follows, we provide detailed descriptions of the manifestations of the aphasic patients’ language disorder in various modalities on the basis of the data provided by the performance of each patient on the diagnostic tasks employed in the present study.

<table>
<thead>
<tr>
<th></th>
<th>Sentence (2)</th>
<th>Naming (10)</th>
<th>Boston Naming Test (15)</th>
<th>Special Categories (12)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(100%)</td>
<td>(100%)</td>
<td>(100%)</td>
<td>(100%)</td>
<td></td>
</tr>
<tr>
<td>Naming</td>
<td>2 (100%)</td>
<td>4 (40%)</td>
<td>5 (33%)</td>
<td>12 (100%)</td>
<td>66%</td>
</tr>
<tr>
<td>Responsive naming</td>
<td>2 (100%)</td>
<td>2 (20%)</td>
<td>9 (60%)</td>
<td>2 (100%)</td>
<td>63%</td>
</tr>
<tr>
<td>Boston Naming Test</td>
<td>2 (100%)</td>
<td>10 (100%)</td>
<td>10 (67%)</td>
<td>12 (100%)</td>
<td>89%</td>
</tr>
<tr>
<td>Special categories</td>
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<td></td>
<td>71%</td>
</tr>
</tbody>
</table>

|                                |              |             |                         |                         |      |
|                                | 5 (83%)      | 6 (100%)    | 15 (75%)                | 4 (50%)                 | 19 (79%)                | 3 (50%)              | 18 (90%)          |      |
|                                | (83%)        | (33%)       | (25%)                   | (75%)                   | (38%)                    | (50%)                | (100%)            |      |
|                                | 5 (83%)      | 2 (33%)     | 5 (25%)                 | 6 (75%)                 | 9 (38%)                  | 3 (50%)              | 6 (100%)          | 70   |
|                                | (83%)        | (33%)       | (75%)                   | (75%)                   | (38%)                    | (50%)                | (100%)            | (78%) |

|                                | (100%)       | (100%)      | (100%)                  | (60%)                   |      |
|                                | 2 (100%)     | 2 (100%)    | 2 (100%)                | 1 (50%)                 |      |
|                                |              |             |                         |                         |      |
|                                | (100%)       | (20%)       | (100%)                  | (90%)                   |      |
|                                | 4 (40%)      | 10 (100%)   | 9 (60%)                 | 9 (90%)                 |      |
|                                |              |             |                         |                         |      |
|                                |              |             |                         |                         |      |
|                                |              |             |                         |                         |      |
|                                | (100%)       | (100%)      | (100%)                  | (60%)                   |      |
|                                | 10 (100%)    | 12 (100%)   | 12 (100%)               | 12 (100%)               |      |
|                                |              |             |                         |                         |      |
GCH is a 57 year old male who was educated to Lyceum level and then spent many years working in his private business as a glass-merchant up to the time of his stroke. In September 2006, he was struck by an ischaemic CVA in the temporal-parietal area of the left hemisphere. Over a period of one week in the hospital, GCH made slow but steady improvement, eventually returning home where he still lives.

This is a characteristic sample of GCH’s description of the ‘Cookie Theft’ picture:

(52)  *Ta pitsirikia pezu, o enas sto trapezi, i mama eido skupizi...pos to len...ta piata...eido halase...to nero...ine vlakia...skurtina...pos to len...ne.*

“The children are playing, the one on the table, mum here is drying...what is it called...the dishes...here it broke down...the water...it is stupid...scurtain (instead of ‘curtain’)...what is it called...yes.”

What follows is another sample of GCH’s spontaneous spoken output produced during an informal dialogue we had with him during our first meeting at his house:

(53)  *(EP: Pia itan i dulia sas?)...Pes to more...pulate tza mia. Dieadi se kathe poli ehi dio tria magazia, parapano den ehi kathe poli...Trikala, Volos, Larisa, ine...pes to...(EP: Eboros).* 
*Bravo.*

*(EP: Pia ine i pliris diefthisi sas?)...Ine...pes to...Agiu...Agiu defteru...pos len tin eklisia?...Ine Agiu Serafim ke...tipota.*

*(EP: Perigrapste mu ligo ti mera ekini pu pathate to egefaliko)...Tipota...kathomun sto horio, kathomun me ton patera mu eki pera, ekatsa deka lepta ke leo ‘tha kathiso!’, piasan ta heria mu, kati ftiaksame...ftiahtname me ton papu ki ekatsa deka lepta...iha omas to...entaksi, den ine tipota, tha*
The Subjects of the Study

“(EP: What was your job?)...What is it called...you sell glass. I mean it has 2-3 stores in every town, each city doesn't have more...Trikala, Volos, Larisa (names of towns), it is...what is it called...(EP: Trader). Well done.

(EP: What is your full address?)...It is...what is it called...Saint's...Saint's second...how is the church called?...It is Saint's Serafim and...nothing

(EP: Give a brief description of the day you have been struck by the stroke)...Nothing...I was staying at the village, I was sitting with my father over there, I stood ten minutes and I am saying 'I will sit!', my hands were frozen, we made something...we were making with the old man and I sat ten minutes...but I had...OK, it is nothing, it will pass...I didn't take it seriously! After ten minutes again...afterwards it ended, it ended, since that moment I stopped, I couldn't...speak...what happened to me there...we are talking it is over...I couldn't remember everything, everything. On the second day, Saturday, Monday, on Tuesday then I started and..."

GCH’s spoken language output was non-fluent (with a fairly slow speech rate, i.e. 40-50 words per minute), with incomplete sentences and a few semantic and phonological paraphasias. In spite of its non-fluency, GCH’s spontaneous speech did contain a range of syntactic structures, and functional morphemes were evidenced like negation, agreement, coordination, pronouns, adverbials, prepositional phrases and determiners. The sample contains no conditionals or passives, though there are two examples of anti-causative verbs (one marked with ACT voice morphology and the other inappropriately marked with ACT voice morphology, i.e. halase-ACT/’broke down’ and piasan-ACT ta heria mul/’my hands got stiff’, respectively), an example of a wh-question (pos len tin eklisia?/’how is the
church called?’) and negation (i.e. *den mporusa na miliso*’I couldn’t speak’). These instances constitute evidence that functional morphology is used by the specific patient. On the other hand, there was a single instance of a subject-verb agreement violation (*pulate tzamia* ‘you sell glass’ instead of *pulao tzamia* ‘I sell glass’). **GCH** also had a moderate word finding difficulty which interfered with his ability to produce lengthy utterances. He relied on his comparatively intact prosody and few well-preserved phrases in conversation: the phrase *pes tol*’say it’ appeared several times and he was apt to use questions like *pos tolti lene*…/‘how is it called?’ to maintain a conversational flow. Moreover, **GCH** had access to a wider range of intonational contours than a typical Broca’s aphasic but his articulation was judged as moderately impaired.

**GCH**’s results at the BDAE reveal severe impairments in single-word and sentence repetition, naming and comprehension of spoken passages, with relatively mild impairment of his written language skills. More specifically, in the Boston Naming Test, whereby pictures had to be matched with spoken words, **GCH**’s scores were well below the norm with the majority of his errors being semantic paraphasias (e.g. he chose ‘sea’ instead of ‘octopus’), thus, implying a lexical semantic deficit. Repetition of longer (compound) and phonemically complex words (e.g. *odontovurtsa*’toothbrush’) and sentences, as well as the auditory comprehension of complex ideational material were classified as severely impaired. On BDAE scale of ‘minimal’, ‘mild’, ‘moderate’, and ‘severe’, the disturbance of his language skills was classified as ‘moderate’, most problems lying in naming and repetition.

On the tests (Peristeri, 2005) designed to assess **GCH**’s syntactic comprehension capacity, he performed above chance on all sentence types apart from those involving verbs of mediopassive morphology, namely passives and reflexives. In fact, **GCH** scored at chance level in both verb classes, making typical thematic role reversals in passives and misidentifying reflexives as passives. Though **GCH**’s poor performance in passives implies a breakdown of comprehension along syntactic lines, the fact that (i) the sentences targeting a reflexive reading were only six (relative to the passive structures which were twenty-four), and (ii) the third non-target picture in the SPMT was a semantic distractor,
prevents us from drawing any safe conclusions with respect to the nature of GCH’s processing of reflexivity.

GCH participated in the present study one month post onset.

VSK is a 47 year old male with high education, who was a student of Medicine but dropped University at the age of 22 and worked full-time as a wine-dealer in his own business. In April 2005, he suffered a CVA in the temporal area of his left hemisphere, which left him with a right-sided hemiparesis. He was instantly discharged to a rehabilitation unit in Athens and then to his family house in the Greek province where he still lives. He moves in a wheelchair due to his persisting right-side hemiplegia and he is extremely dependent on the help provided by his family. VSK’s diagnosis as a Broca’s aphasic was made on the basis of consensus by the neurologist and the speech-therapist of the rehabilitation center who observed him clinically for about one month after the stroke. Administration of the BDAE battery took place five months after. It is highly unlikely that the patient’s pattern of performance changed dramatically during such a short period of speech-therapy sessions. Also, VSK’s clinical observation at the time of testing was that he still showed characteristics of agrammatic aphasia.

This is a characteristic sample of VSK’s spontaneous spoken output produced during an informal dialogue we had with him during our first meeting at his house:

(54) (EP: Poso kero menate stin Athina?)...ehm...Ikosi hronia...ke para...ke parapano.
Ine...imastan ke mes sti nihta ego san kava pu iha...mera nihta, ĉulia ke poto, ĉulia ke poto ke...thelo isihia ne. Etihe to peristatiko tora, entaksi.
The Subjects of the Study...

"(EP: How long have stayed in Athens?)...ehm...Twenty years...and mo...and more. It was...we were living in the night me since I owned a cellar...day and night, work and drinks, work and drinks and...I want peace yes. The incident happened now, ok.

(EP: Do you have any brothers?)...My brother has...it is one Sotiri old...one Dionisi, one Pavlo, one me and...one my sister...we are every two years...Pavlos now that he has the City Hall is necessarily to...once a day we are together...the rest of the brothers at Athens..."
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(EP: Why did you go bankrupt with your cellar?) We did faster, fortunately because otherwise we would go to jail, sort of saying, immediately, instantaneously...the job has been done and...sort of saying, every supermarket gave birth by itself.

(EP: The more one opens out, the more he works)...ehm...It works but there was...were ups and downs...the job decayed sort of saying...the supermarket yes...unfortunately...the job was moving only with beers and Coles. Job passed to the supermarkets. ‘Muses’ themselves closed down...he did, they did fifty stores...chain-stores and he sold them and he closed it down...it. I you...I owned stores at Plaka and Pagrati, at Pagrati and at Filis (names of suburbs)...affiliated chain-stores, affiliated because...a big catch but it was cut off abruptly...anyway...business worked me up.

(EP: You were lucky in your misfortune) He was lucky in...then there was the stroke me...we are fine...I am fine...don’t...

(EP: What did the doctor tell you about the paralysis of your hand?)...This, this is moving, he’s saying, it is only that (hand) that is moving, I mean this is the...the middle finger that is the driving...thumb, it doesn’t work without the thumb...cut them all to have the thumb because, but...this does move...anyway...I believe one...within one semester because I improve...I ‘m doing good...very good...it (will) im-pr-ove..."

VSK doesn’t seem to fall into the classical Broca’s aphasic category mainly because of the first-pass observation that his spontaneous production evinces ample use of functional morphology (e.g. negation, wh-morphemes, the future particle θα/’will’, relativizers, co-ordinations, adverbials, prepositional phrases, auxiliaries, conditionals, and clitics). His speech rate though was halting and fairly slow, with 30-40 words per minute. VSK’s low fluency may be ascribed to his articulatory problems and his word finding difficulty. He seemed to rely on light verbs (e.g. imaste/’we are’ instead of sinantiomaste/’we meet’, egine to egefaliko/’the stroke became’ instead of sinevi to egefaliko/’the stroke happened’) and a few expressive idiomatic phrases (e.g. na pume/’sort of saying’, varese
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*kanoni*"was sold", *megalolavraki"a big catch") to compensate for his non-fluency. There were also a few examples of ACT voice anti-causative verbs (e.g. *halase-ACT*/'broke down', *pesanei*/'they fell', *aftokunai*/'this moves') though one of them was inappropriately integrated into a transitive structure (*me futnosei* /dulia*/'business has worked me up' instead of *funtosa apo ti dulia*/'I got worked up by business'). Moreover, *VSK*’s spontaneous speech was interspersed with some verbs of mediopassive morphology (e.g. passives *kopike*/'it was cut', *thaveltiothi-NACT*/'it will improve') though one reflexive was inappropriately marked with ACT voice morphology instead of NACT (*genuse-ACT* mono *tu*/'gave birth by itself' instead of *geniotan-NACT* mono *tu*/'it was born by itself). Finally, there were very few instances of subject-verb agreement violations riddled with attempts at self-correction which were most of the times successful. In general, *VSK* was able to communicate his conversational intentions fairly well, still his speech was dysprosodic.

*VSK*’s BDAE scores revealed a mild to moderate aphasia. Naming and auditory comprehension were moderately impaired, the greatest difficulties being with uncommon, long (compound) words and complex ideational material, respectively. His repetition of words was significantly above chance level and reached ceiling level when the same words were integrated into sentential contexts, thus suggesting that syntactic frames boosted his repetition capacity and in some cases this was sufficient information for him to produce words he could not utter otherwise. The BDAE has also revealed a persistent difficulty with the production of automatized sequences (both days and consecutive numbers). The patient’s written language abilities were also moderately disturbed, free writing being more impaired than writing to dictation. It is also worth mentioning that *VSK*’s reading involved many characteristic function word substitution errors (e.g. *gia na*/'in order to' instead of *oste na*/'in order to', *pul*/'which’ instead of *to opiol*/'which’).

Finally, *VSK*’s syntactic comprehension was also impaired but only with regard to verbs of mediopassive morphology, namely passives and reflexives. In fact, his score in the interpretation of reflexive structures was significantly below chance level (33%), most of reflexive events receiving an
agentive reading. On a comparative analysis of VSK’s performance across all tests, the highest performance was scored in the S-V agreement elicitation task in which there was only one instance of an S-V violation.

VSK participated in the present study two years post onset.

<SP>

SP is a 68 year old male, who was educated to primary school level and worked as a bus-ticket collector up to the time of his stroke. In June 1989, he suffered a subarachnoid haemorrhage in his left hemisphere while undergoing surgery. This resulted in a right hemiparesis, apraxia of speech and aphasia. He has indicated that his language problems started right after the surgery and that they increased from then on, in severity as well as scope. At first, his problems seemed to be limited to word finding difficulties, then language comprehension began to be disturbed and subsequently the impairment spread to writing and reading. In spite of his severe moving and language problems, SP is extremely independent, maintaining a network of friends and relatives in the Greek province where he still lives.

What follows is SP’s brief description of the ‘Cookie Theft’ picture:

(55)  Ne, afto…ehm…eðo…ehm…pjiato…ehm…skabo, pjiato, kurtina, koritsaki

“Yes, this…ehm…here…ehm…dish…ehm…stool, dish, curtain, little girl.”

What follows is another sample of SP’s spoken output abstracted from his social responses as well as from his description of a picture depicting everyday life in a neighbourhood:
The Subjects of the Study

(56) (EP: Pote sinevi to egefaliko?)...Pente, δεκα, δεκαπέντε hronia, ne

(EP: Poso hronon iste?)...Eksintatria, eksintapente, eksintaeksi, ne.

(EP: Pia ine i pliris διεθνις sas?)...Ikosi tesera

(EP: Hionise katholu perisi?)... dio fores...ehm...δυλευα...ke ligo

(EP: Apo pio dromo erheste gia to eksohiko?)...Εδώ...ehm...ena ki ena...ehm...διο δρομος

“(EP: When did the stroke happen?)...Five, ten, fifteen years, yes

(EP: How old are you?)...Sixty-three. Sixty-five, sixty-six, yes

(EP: What is your full address?)...Twenty four (instead of Thermopilon Street, 24)

(EP: Did it snow last year?)...Twice...ehm...I was working...and little

(EP: Which road to you take to get to the cottage?)...Here...ehm...one plus one...ehm...two roads.”

……………………………………………………………………………………………………………………………

(57) Aftokinito...ehm...peδακια pezun...ehm...parathiro, porta...ehm...ohi
dus...ehm...skilos...ehm...gileko...ehm...peδακι, papus, saka...ehm...ehi
psonia...ehm...portokali, potistiri, gata ke...ehm...psari, to troi, glastr...ehm...ki afto
potistiri...ehm...gata...ehm...agalia...ehi...ehm...διαβαζι...ehm...skilaki...ehm...nosokomio,
pigane ke...ehm...sto nosokomio, milai...ehm...akustiko, eδo pernai...ehm...to treno,
karavaki ine, papia edo...ehm...trohonomos, to poto...ehm...fagane, tha
fane...ehm...paputsia, pagoto, tost...ehm...ohi...ehm...psomi.

“Car...ehm...children are playing...ehm...window, door...ehm...no
shower...ehm...dog...ehm...vest...ehm...little boy, old man, school-bag...ehm...has the
shopping...ehm...orange, watering-can, cat and...ehm...fish, it eats it, pot...ehm...this a watering-can
At first pass, SP’s spontaneous speech looks classically agrammatic, because almost all functional categories are omitted. His spoken output was limited to substantives, and more rarely two-word utterances systematically consisting of a substantive and a verb or a verb and an adverbial. The proportion of closed-class words calculated from the second sample was considerably lower than that of open-class words-in fact, it placed SP within the range for agrammatic aphasics, as did his ratio of determiners to nouns, the ratio of nouns to clitic pronouns and the proportion of well-formed sentences in the sample. The only ‘non-agrammatic’ aspect of SP’s performance was his ability to use the future-particle *tha*/*will* to provide tense information. SP also used specific strategies to express negation, mainly shaking his head and producing the particle ‘no’ followed by a substantive (e.g. *tost...ohi...psomi/toast...no...bread*). Moreover, his responses in the simple social responses output sample shows that SP has only recognized partial categorical information associated with the wh-words initiating the examiner’s questions, since his responses to these items evince that he misidentified them with other function words (e.g. he misidentified *potel/when* with *poso kero/how long* or *apo pio dromo/which road* with *apo posus dromus/how many roads*). Finally, SP’s spoken output was very dysprosodic and speech rate was fairly slow (up to 10 words per minute). His non-fluency was further intensified by his word finding difficulty indicated by filled pauses. His searching behavior in articulation indicated an apraxia of speech. Verbal expression was in general difficult.

SP was tested with the BDAE twelve years post-onset. His scores revealed a severe aphasia most problems lying in sentence repetition, auditory comprehension and understanding of structures whose processing is made critically dependent upon the correct use of syntactic information. More
specifically, SP’s repetition of words (80%) was in direct contrast to his repetition of sentences which was severely impaired (at zero level). More specifically, SP performed extremely poorly with sentences, being unable to repeat any function word, mainly pronouns and determiners. Such pattern of performance could be accounted for in terms of a severe short-term memory deficit which might have interfered with SP’s ability to retain a spoken sentence long enough to repeat it accurately. On the Boston Naming Task, SP correctly named 4 out of 15 (27%) pictures; while the appropriately uttered words were short, easily pronounced lexical items whose elicitation was alleviated by phonological cueing. The aphasic subject also named 6 out of 10 items in the responsive naming subtest and he reached ceiling performance when naming letters, colors and numbers. Such a performance reflects SP’s word finding difficulties but shows that the impairment is not severe.

In the SPMTs checking syntactic comprehension, SP showed difficulties with the majority of the syntactic constructions tested but especially with object-relative clauses (33%), focused constructions (25%) and passives (25%) but had relatively less problems with CLLDed sentences (63%) and S-V agreement (75%). This suggests that he had a preference for canonical word order in spite of the fact that theta roles in Greek are made visible in morphology by the assignment of structural case. Moreover, the fact that the θ-role reversal interpretive effect noted in semantically reversible verbs was also observed for passives and focused constructions having a non-reversible verb (e.g. to dedro kovete apo ton ksilokopo ‘the tree is cut by the lumber’, and to karotsi semi o adras ‘the cart-FOC the man draws’, respectively) suggests that SP didn’t apply extra-linguistic knowledge during interpretation. SP’s comprehension of auditorily presented commands and complex ideational material was functionally poor, with the relevant tasks being performed at below chance levels. There is no evidence that SP had a lexical semantic deficit which could account for such pattern of performance; the difficulties he experienced with auditory comprehension could tentatively be accounted for in terms of the theta role assignment deficit or the deficient short term memory buffer preventing the retention of
verbal stimuli in memory for a prolonged period of time. Finally, written language abilities were also severely impaired.

SP participated in the present study seventeen years post onset.

<THP>

THP is an 87 year old male with a very low educational level (he studied up to the 4th grade of primary school) who was a worker at a mill in the Greek province. In 2003 he was struck by an ischaemic CVA in his left hemisphere. Unfortunately, no CT scan was available. The stroke resulted in a mild right-sided hemiparesis and an aphasia. This is THP’s description of the ‘Cookie Theft’ picture:

(58) Vlepo eðo to peði…anevke epan sti skala ke kremase…ke to koritsi dini to peði, to dini…afth i kiria eðo kratai to ðisko…afth ine ksiristiki mihani…ksiristiko…ta piata to vlepo, ta piata to sfugizi i kopela afthi…to pðdi kremase…to kremase to…gl…glika…ta vale sto dulapi…ke ta perni ta glika ke ta ðini sto koritsi, aploni to heri.

‘I see the child here…he went up the stair and got hang…and the girl gives to the boy, she gives him…the lady here holds the tray…there is a shaving-machine there…shaving…the dishes I see it, the dishes that girl is drying it…the boy hang the…can…candies…she put them back in the cupboard…and he takes the candies and gives them to the girl, she is stretching her hand.’

THP’s spontaneous speech was rather slower than normal (60-70 words per minute), and evidences a mild to moderate word finding difficulty which when combined with the patient’s articulatory deficit resulted in frequently cut-off sentences and disfluency. THP’s spontaneous speech also included a single instance of semantic paraphasia (ksiristiki mihanì’‘shaving machine’ instead of vrisì’‘tap’) which
may be suggestive of a lexical semantic deficit. His speech contains a relatively wide range of functional morphemes and syntactic structures (co-ordinations, adverbials, prepositional phrases, determiners and CLLDs with lack of agreement, yet, observed between the dislocated object and the pre-verbal clitic, e.g. *ta piata to viepol*’the dishes I see it’, *ta piata to sfugizi*’the dishes she is drying it’) that are normally encountered in the speech of a typical Broca’s aphasic, however, certain constructions (passives, wh-questions, negation, conditionals) are totally missing from his spoken output. We should also mention that THP’s sample contained a single instance of a passive verb which was inappropriately marked with ACT voice morphology though (*to pedi kremase-ACT*’the boy hang’ instead of *to pedi kremastike-NACT*’the boy was hung’). In spite of his difficulties in spoken language, THP’s communicative abilities were judged as being high enough to maintain a conversational flow.

Four years post onset, THP was tested with the BDAE test. The severity of his aphasia was rated as ‘mild’. The battery did not reveal any prosodic disorders, while most problems seemed to lie in naming and sentence repetition. More specifically, THP’s repetition of single words was relatively unaffected while his repetition of sentences was rather poor with a clear length effect, though this might have been due to a short-term memory deficit. The patient also showed a mild to moderate word finding problem with color naming being particularly problematic. THP’s performance in the responsive naming (70%) and Boston Naming Task (60%) is not particularly conclusive with respect to this hypothesis, as a 65% hit rate is not sufficiently near chance performance to be persuasive; thus, the existence of a word finding problem is neither confirmed nor completely refuted. Finally, THP’s comprehension of syntactic constructions was functionally good, with sentence-picture matching tasks performed at close to normal levels. However, the patient showed a problem on testing with sentences containing focused objects (55% accuracy rate), as well as with object-relative clauses (67% accuracy rate), thus, suggesting that THP’s comprehension breaks down along syntactic lines. Finally, THP’s written language abilities were mildly disturbed, writing to dictation being more severely impaired than reading aloud.
THP participated in the present study four years post onset.

<DENT>

DENT is a 79 year old male with high-level education, who worked as a dentist up to the time of his stroke. In September 2003 he was struck by a cortical CVA in his left hemisphere. This resulted in a very severe right-sided hemiplegia that kept him in bed for about a semester. Since the beginning of 2004 he made very slow but steady improvement after systematic physiotherapy sessions. Today, he is able to move in a wheelchair. This is DENT's description of the 'Cookie Theft' picture:

(59) To peði me ta glica...ðen ehi kati sto heri...ti ehi afto...ti ðulia kani...piato to kseplini...to nero pu stazi kato...elefadaki.

“The boy with the candies…he doesn’t have something in his hand…what does he hold…what is he doing…she rinses off dish…the water that drips down…little elephant.”

Due to the extreme brevity of DENT's spoken output, a semi-formal assessment of the patient’s spontaneous speech was also carried out in the hopes that this might shed some more light on the range of structures available to him. The analysis was carried out on the basis of the following sample taken from DENT's spoken output during a talk we had with him during one of the breaks:

(60) (EP: Ti imerominia ehume simera?) ðekatesseris Fevruarios...2006...Savato
(EP: Pos iste simera?) kala...orea
(EP: Perigrapste mu ligo ti mera pu pathate to egefaliko) Imun kala...legame pola ke ðiafora...stagones vazo sta matia mu...eki pu evala...piga na valo mesa stin tsada...eki epesa kato...ihame tis esthisis...
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(EP: *Pite mu liga pragmata gia to kedro apokatastasis pu isastan stin Athina*) Afto to iðrima ehi...nosokomio...ehi teseris orofus...sakatiðes...kopsimo to poði alos, to mæheri o alos, ta poðia...oli ihane ena poði...itan i epistimi, to...i...i nevrologia as pume pu ehi to...efto oli sakatiðes...iha vali paravan, paravan ñiko mu gia na mi vlepo...na min ta vlepo...na vlepo katholu...diladi ekana ena mathima as pume ke evlepa...ke evlepa to paravan ke kukulonomuna na mi vlepo...ego ime to pio kalo...ala kratai poli...kratai poli...ego ida Karðitsa (name of a town) to giatro...efto...eftos ñokimase...alagi poli kali, poli kali ñilaði...ke nevrologus ñen ehi giatrus poli kalus...nevrologus.

“(EP: What is the date today?) February 14th...2006...Saturday

(EP: How are you feeling today?) good...nice

(EP: Give me a brief description of the day you have been struck by the stroke) I was feeling good...we were saying many and different things...I put drops in my eyes...as I was putting...as I was putting in my bag...there I fell down...we were still conscious

(EP: Tell me a few things about the Rehabilitation centre you were hospitalized in Athens) This foundation has...hospital...it has four floors...cripples...some had their leg cut...others the knife, the legs...all of them had one leg...science was...the...the...neurology sort of saying that has the...this all of them cripples...I had placed a folding screen, my own screen so that I wouldn’t see...so that I wouldn’t see them...to see nothing...I mean I had a lesson sort of saying and I was watching...and I was watching the screen and I was wrapping myself up so that I wouldn’t see...I am the best...but it lasts too much...I met the doctor in Karditsa (name of town)...it...he tried...very good change, I mean very good...and there aren’t very good neurologists...neurologists.”

**DENT**’s spontaneous speech was non-fluent (approximately 50-90 words per minute), dysprosodic and characterized by articulatory deficiencies and a great number of attempts at self-corrections resulting in dispersed pauses all over his speech. On a closer look, the bulk of the patient’s
self-corrections were observed when he had difficulty with pronoun and determiner selection affecting the intelligibility of his discourse quite extensively. However, most of the times he made a clear effort to produce the appropriate form of a pronoun or a determiner (e.g. to-NEUT...i-FEM...i nevrologia/the...the...the neurology', afto...afti dokimase/it...he tried'). Moreover, his speech sample contained a wider range of syntactic structures relative to those encountered in a typical Broca’s aphasic (e.g. prepositional phrases, negation, wh-questions, anti-causatives (stazi/it drips’), relatives, adverbials and passives). Thanks to the relatively wider repertoire of syntactic structures at his disposal, DENT was able to communicate his conversational intentions fairly well. In fact, the patient used specific well-preserved phrases, like as pume/‘sort of saying’ or some wh-questions, like ti ehi afto...ti dulia kan/’what does he hold...what is he doing’ to facilitate communication in the face of a syntactic problem or a word-finding difficulty.

Based on the BDAE scores, the severity of DENT’s aphasia is rather classified as mild to moderate most problems lying in naming and comprehension of complex ideational material. More specifically, the battery revealed that DENT’s auditory comprehension was good and he was able to retain the gist of a short spoken utterance well enough to answer simple questions on it immediately afterwards. However, his auditory comprehension broke down when the task required the processing and interpretation of complex ideational material; this may be an effect of a poor short-term memory. Naming was moderately impaired; responses on the Boston Naming Task contained semantic paraphasias (e.g. ‘hippopotamus’ instead of ‘rhinoceros’, or ‘colors’ instead of ‘palette’, a.o.) and naming was conspicuously difficult to facilitate even when phonological and semantic cues were provided to the patient, probably indicating a lexical semantic deficit. Testing on the repetition tasks of the BDAE battery showed that repetition was minimally impaired; DENT was able to repeat words of all grammatical classes very well on both sentential and single-word level. Finally, DENT’s performance in the SPMTs testing syntactic comprehension revealed a mild syntactic comprehension deficit (Mean score: 78%) particularly affecting the interpretation of CLLDed sentences (50%) and reflexives (50%)
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most errors being theta-role reversals and agentive readings, respectively. Though DENT's performance in the CLLDed sentences suggests a non-canonical word-order deficit, the patient's poor performance in reflexives may simply be an effect of a methodological misfit (i.e. as already mentioned, the items for the reflexive condition were only six).

DENT participated in the present study five years after the stroke.

<THR>

THR is a 74 year old male with a very low educational level (he studied up to the 4th grade of primary school) who worked as a house-builder up to the time of his first stroke. In April 2006 he suffered a mild CVA in his left hemisphere that has not resulted in any noticeable language problems. In September 2008, he was struck by a CVA in the temporal area of his left hemisphere, which left him with a right-sided hemiparesis and aphasia.

What follows is THR's spontaneous speech elicited by the description of the 'Cookie Theft' picture. We should mention that verbal expression was extremely difficult for the specific patient who ultimately consented to describe the picture given ample time and continuous psychological encouragement.

(61) I mama… pos na to po toa…mesa sto domatio…kuzina…skopizi me pani piao…ta peia tis, epano sto skabo to aori ki ehi to heraki tu apano… pos na to po toa…na pari ta glika na fai…aftos malon krifa…aplose to heri na ti oski ki aiti ena…ston nero…nero…lekani…pos na to po toa…ge…girise o nero hitis ke…vgenun ta nera ekso…ksehili zi ta nera.

“Mother…in the room…kitchen…dries plate with cloth…her children, the boy on the stool and he has his little hand upwards…to take the candies to eat…he rather secretly…she has stretched her hand to
give her herself one…at the water…water…wash-basin…how can I say it now…the kitchen-sink t…turned over and…the water goes out…the water brims.”

THR’s spoken language production was too short to be sufficiently indicative of the patient’s language abilities and impairments. On the basis of the existent data, THR’s spontaneous speech was judged to be fairly slow, with 20-30 words per minute. The fluency of his speech was considerably low and it was frequently interrupted by articulatory misfits of which THR was aware without yet being able to correct them. THR does not seem to fall into the typical Broca’s aphasic category nor can he be classified as normal; his spoken output contained a range of syntactic categories including pronouns, adverbials, PPs, determiners, embedded sentences and one instance of an anti-causative verb *(ksehilizi ta nera/the water brims over*) lacking the appropriate S-V agreement checking relation. Besides the articulatory problems observed, THR also produced many stereotypes and some phonological paraphasias (e.g. *nero-lekani/water-wash basin* instead of *nerohitis/kitchen-sink*, among others) whose frequency was considered to be high in proportion to the total number of words making up THR’s spontaneous speech sample.

THR’s scores in the Greek version of the BDAE reveal moderate impairments in naming, with relatively mild impairment of his auditory comprehension and written language skills. His comprehension deficit was mainly characterized by a length effect responsible for THR’s moderate performance in the complex ideational material subtest; as such, single word comprehension was better than sentence comprehension. On the other hand, all of THR’s errors on the Boston Naming Task were semantic paraphasias; when naming compound words, he was unable to correctly produce them, producing instead a word semantically related to the original lexical item (e.g. *jiatros/doctor* instead of *stithoskopio/stethoscope*, *guruni/pig* instead of *rinokeros/rhinoceros*). THR’s repetition of lexical items was accurate and unaffected by grammatical class or by the psycholinguistic variable of imageability. Furthermore, his repetition of sentences was judged as close to ‘normal’. Finally, THR’s
scores in the SPMTs checking syntactic comprehension revealed that his comprehension broke down along syntactic lines; when presented with SPMTs requiring the processing of reversible verbs and implicating a departure from canonical word order (passives, focused object constructions and object-relative clauses) he had great difficulty and tended to perform below the chance range.

**THR** participated in the study 9 years post onset.

**<THEX>**

**THEX** is a 76 year old male who was educated up to the 1st class of Gymnasium and then dropped school to work as a tinsmith up to the time of his first stroke. In 1992 he suffered a mild CVA in his left hemisphere that hasn’t left him with any language problems. In September 2008, he suffered a stronger CVA in his left hemisphere, which left him with a mild right-sided hemiparesis and aphasia.

What follows is a characteristic sample of **THEX**’s spontaneous speech recorded during an informal discussion we had with him during our first meeting:

(62)  **(EP: Sas aresi eǒo pera?)...Poli...poli...m’ aresi...ehi iremia, de thelo fasaries...etsi...fasaries hortasi...ehm...na filai o Theos...poli**

(EP: To egefaliko to pathate sto horio i stin Karditsa?)...Ohi, ohi stin Karðitsa ime, giati ime...ehm...to pathame k i mana mas...sti mana mas...ke itan ikosi mines eǒo as pume ke i mana mu pethane ke meta epathα to...ikosi tu minos as pume ke ikosi tu minos arostisa (EP: tin iǒia mera?)...Ohi, meta, meta, ne, ne

(EP: Pantos i omilia sas ine kali)...E, ohi, ðen eho provlima katholu αla merikes fores vrahikklono...apo sinithia

(EP: i omilia sas ine poli katanoiî)...E giati, ama ta mperðevo ksero go ine...kolai to...alios ðen eho provlima, ðilaði...ðen boris na fantastis oti eho pro...provlima
(EP: Do you like it here?) …Very much… very much… I like it… it is peaceful, I don’t want noise… so… fed up with noise… God bless us… very much

(EP: The incident happened when you were at the village or in Karditsa (name of town)?) …No, no I am in Karditsa, because I am… ehm… it happened to us and our mother… to our mother… and she has been here for let’s say twenty months and my mother died and then I had the… on the twentieth let’s say and on the twentieth I got sick (EP: On the same day?) … No, later, later, yes, yes

(EP: Your speech is good though) … E, no, I don’t have any problem but sometimes I have a blackout… out of habit

(EP: Your speech is very comprehensible) … E, because when I mix it up, you know, it is… it gets stuck… otherwise I don’t have a problem, I mean… one can not imagine that I have a problem

(EP: What is your opinion of your speech? Does it get better with time?) … The eye understands more than ear… I mean I speak a little and I understand everything, but with the ear it is… I get confused.

(EP: Can you move the leg?) … I move the leg… only hand.”

THEX’s spontaneous speech was fluent (over 90 words per minute), with a mild indication of an articulatory and prosodic disorder. Grammatical form was moderately impaired, most problems lying in the production of auxiliaries carrying aspeccional information (e.g. fasaries hortasi instead of fasaries eho hortasii ‘I am fed up with noise’), determiners (e.g. para afti instead of para to afti ‘instead of the ear’, mono heri instead of mono to heri ‘only the hand’). On the other hand, his spoken output contained a wide range of syntactic constructions and functional morphemes including conditionals, PPs, adverbials, passives, negation, co-ordinations and pronouns. THEX also appeared to have a moderate
word finding difficulty compensated for by the extensive use of light verbs and stereotypical phrases that facilitated his conversational flow.

In July 2008, THEX was tested with the BDAE battery, which yielded the diagnosis of mild aphasia. Repetition and written language skills were minimally impaired. Naming was mildly to moderately impaired, errors being a few semantic paraphasias (e.g. akustika/‘earphones’ instead of stithoskopio/‘stethoscope’) and in case of less common nouns, fairly adequate descriptions (e.g. vgazi fotia/‘fire comes out of it’ instead of ifestio/‘volcano’). THEX performed well on the auditory comprehension subtests of the BDAE, including basic word discrimination and auditorily presented commands. Nevertheless, THEX performed near chance level in the complex ideational material subtest requiring from the subject to listen to auditorily presented short narratives of increasing complexity and to answer to questions related to the narratives’ core meaning. Such a performance may be an effect of a working memory deficit disallowing the retention of lengthy sentences for a prolonged interval of time. Finally, THEX’s scores in the syntactic comprehension tasks revealed a mild comprehension deficit mainly affecting verbs of mediopassive morphology, i.e. passive and reflexive constructions, most errors being thematic role reversals and agentive readings in the two categories, respectively. THEX’s pattern of performance in passives at least implies a language deficit defined in terms of a syntactic impairment.

THEX participated in the present study one month post onset.

<PAPAL>

PAPAL is a 69 year old male who was educated up to primary school level and afterwards dropped school to work as a farmer up to the time of his stroke. In 2007 he suffered a left-hemispheric CVA affecting all Broca’s area as well as part of Wernicke’s area. This resulted in right hypotone hemiparesis and aphasia.
What follows is two samples of PAPAL’s spontaneous speech; the first one was recorded during a semi-formal discussion we had with him during our first meeting at his house, while the second is PAPAL’s spoken description of the ‘Cookie Theft’ picture:

(63) (EP: Pia ine i pliris ðielthinisi sas?)...Me-li-sa
(EP: Eðo genithikate?)...Ohi...ime pera...Kalifoni
(EP: Iste kato apo evðomida?)...Kalo...pira ena
(EP: Pio mina genithikate?)...ðen mporo...ðen mporo...(EP: Martio?) ne...ohi...ton alon, Pebti
(EP: ðulepsate pote?)...Poli, poli, ola

“(EP: What is your full address?) Me-li-sa (name of a village)

(EP: Were you born here?) no..I am over there...Kalifoni (name of village)

(EP: Are you younger than seventy years old?) below...I took one

(EP: What month were you born?) I can’t...I can’t... (EP: In March?) yes...no...the next, Thursday

(EP: Have you ever worked?) very much, very much, everything.”

(64) ðen ksero, pia...to...me semeta...nero...ðio peðia...koritsi, agori...ðen boro...agori apano...klevi mila...kozina...ðolies...vrisi anihte...flintzani...etsi ine...tora ðen boro na po...dapi...dulapi...to parathiri...aspo kurtina...poli...luluðia...kipo...tin poðia...padofles t’ apo mesa...ligo malia

“I don’t know, any more...the...with semeta (non-word)....water....two children...girl, boy...I can’t...boy up...steals apples...kitchen...work...open tap...cup...it’s like that...I can’t say now...cuord...cupboard...the window...white curtain...much...flowers...garden...the apron...slippers the thing within...a little hair.”
PAPAL’s spontaneous speech was halting and his speech rate was fairly slow (approximately 30 words per minute). His spoken output was usually unintelligible, consisting of word-length strings of phonemes which frequently bore no resemblance to the target and which often failed to reflect phonotactic constraints (e.g. semeta instead of petseta/’towel’, or ntapi instead of ntulapil/’cupboard’).

PAPAL was only able to produce fragments of his home address, while the rest of his responses consisted of stereotypical phrases and one semantic paraphasia (Pempti/’Thursday’ instead of Aprilio/’April’). On the other hand, his spoken output elicited by the picture description evinced a rudimentary retention of syntactic awareness, because he produced a few function words (determiners, the negative particle ‘den’ and a few adverbials) interspersed with substantives, mainly nouns and scarcely adjectives and some verbs of rather reduced semanticity (e.g. ime/’I am’, piral/’I took’). Verbal communication was in general difficult and typical of a Broca’s aphasic, with articulatory problems revealing an apraxia of speech, which according to the patient was progressively deteriorating.

In July 2008, PAPAL was tested with the BDAE and was diagnosed as suffering from severe aphasia, most problems lying in repetition and naming. More specifically, his repetition skills were mildly to moderately disturbed, sentence repetition being slightly worse that single word repetition with a clear sentence length effect. Naming and automatized sequences were also highly disturbed. Most errors in the Boston Naming Task consisted of non-word paraphasias with a phonological structure similar to the target words (e.g. htapedi instead of htapodii/’octopus’, htema instead of htena/’comb’, vutsa instead of vurtsa/’brush’) which are probably attributed to the patient’s apraxia of speech. On the other hand, auditory comprehension was minimally impaired, basic word discrimination being slightly worse than sentence comprehension. Finally, PAPAL’s scores in the syntactic comprehension tests indicated an extended deficit mainly affecting structures whose understanding is critically made dependent upon the correct use of syntactic information, namely focused sentences and object-relative clauses which deviate from canonical word order. The patient has also faced difficulty with the processing of verbs.
marked with mediopassive morphology, i.e. passives and reflexives whose interpretation was at chance level. The pattern of language performance reported for PAPAL through the BDAE and the syntactic subtests points towards the patient's classification as a typical Broca's aphasic.

PAPAL participated in the present study one year post onset.

What follows is an overview of the eight patients' syntactic capacities as evinced through their performance in Peristeri's (2005) tests. Due to the fact that (i) the misinterpretations of reflexive structures do not constitute grammatical violations but dis-preferred readings, and (ii) the items in the reflexive condition were only six, the specific experimental condition is omitted. As such, the structures that were taken into account were: S(ubject) relatives, O(bject) relatives, Focus, CLLD, passives, and S(ubject)-V(erb) Agreement.

Figure 6.1. Accuracy rates (%) in Peristeri's (2005) syntactic comprehension tests for the patients GCH, VSK, SP, and THP.
In this chapter, we have provided detailed descriptions of the manifestations of the aphasic patients’ language disorder in various modalities, and demonstrated that a characterization of their deficits in terms of a single definition is not possible. As expected, the eight aphasic subjects’ performances were characterized by considerable heterogeneity thus disallowing their classification into a single syndrome category exhibiting identical traits. This becomes explicitly evident by each patient’s profile on the BDAE test cited below in the form of Figures. The shaded area shows the expected range of performance for a typical Broca’s aphasic. The aphasic subjects’ performance in each test is indicated as a cross. As one can see, none of the patients participating in the present study fell into the limits of a typical Broca’s aphasic performance across all Boston diagnostic categories, since each of them had access to a wider or narrower range of linguistic aspects.
Figure 6.3. GCH's Profile on the Boston Diagnostic Aphasia Examination.

**MELODIC LINE**
Intonational contour

- 1: absent
- 2: limited to short phrases and stereotypes
- 4: runs through entire sentence

**PHRASE LENGTH**
Longest occasional uninterrupted word runs

- 1 word
- 4 words
- 7 words

**ARTICULATORY AGILITY**
Facility at phonemic and syllable level

- Always impaired or impossible
- Normal only in familiar words and phrases
- Never impaired

**GRAMMATICAL FORM**
Variety of grammatical constructions (even if incomplete)

- None available
- Limited to simple declaratives and stereotypes
- Normal range

**PARAPHASIA IN RUNNING SPEECH**
Present in every utterance

- Absent
- Once per minute of conversation
The Subjects of the Study

VOLUME: Hypophonic  Normal  Loud

VOICE: Whisper  Hoarse  Normal

RATE: Slow  Normal  Rapid

REPETITION score in High-Probability subtest

WORD FINDING informational content in relation to fluency

AUDITORY COMPREHENSION mean of percentiles on 3 Auditory Comprehension subtests

fluent without information  information proportional to fluency  speech exclusively content words

1  2  3  4  5  6  7

X

X

X
Figure 6.4. VSK’s Profile on the Boston Diagnostic Aphasia Examination.

- **MELODIC LINE**: Intonational contour
  - Absent
  - Limited to short phrases and stereotypes
  - Runs through entire sentence

- **PHRASE LENGTH**: Longest occasional uninterrupted word
  - 1 word
  - 4 words
  - 7 words

- **ARTICULATORY AGILITY**: Facility at phonemic and syllable level
  - Always impaired or impossible
  - Normal only in familiar words and phrases
  - Never impaired

- **GRAMMATICAL FORM**: Variety of grammatical constructions (even if incomplete)
  - None available
  - Limited to simple declaratives and stereotypes
  - Normal range

- **PARAPHASIA IN RUNNING SPEECH**: Present in every utterance
  - Once per minute of conversation
  - Absent
The Subjects of the Study

VOLUME: Hypophonic Normal Loud

VOICE: Whisper Hoarse Normal

RATE: Slow Normal Rapid

AUDITORY COMPREHENSION mean of percentiles on 3 Auditory Comprehension subtests

WORD FINDING informational content in relation to fluency

REPETITION score in High-Probability subtest
Figure 6.5. SP's Profile on the Boston Diagnostic Aphasia Examination.

- **MELODIC LINE**
  - Intonational contour
  - Absent
  - Limited to short phrases and stereotypes
  - Runs through entire sentence

- **PHRASE LENGTH**
  - Longest occasional uninterrupted word runs
  - 1 word
  - 4 words
  - 7 words

- **ARTICULATORY AGILITY**
  - Facility at phonemic and syllable level
  - Always impaired or impossible
  - Normal only in familiar words and phrases
  - Never impaired

- **GRAMMATICAL FORM**
  - Variety of grammatical constructions (even if incomplete)
  - None available
  - Limited to simple declaratives and stereotypes
  - Normal range

- **PARAPHASIA IN RUNNING SPEECH**
  - Present in every utterance
  - Absent
The Subjects of the Study

REPETITION
score in High-Probability subtest

WORD FINDING
informational content in relation to fluency

AUDITORY COMPREHENSION
mean of percentiles on 3 Auditory Comprehension subtests

VOLUME: Hypophonic Normal **Loud**

VOICE: Whisper **Hoarse** Normal

RATE: **Slow** Normal Rapid
Figure 6.6. THP's Profile on the Boston Diagnostic Aphasia Examination.

**MELODIC LINE**
- Intonational contour
- Absent
- Limited to short phrases and stereotypes
- Runs through entire sentence

**PHRASE LENGTH**
- Longest occasional uninterrupted word runs
- 1 word
- 4 words
- 7 words

**ARTICULATORY AGILITY**
- Facility at phonemic and syllable level
- Always impaired or impossible
- Normal only in familiar words and phrases
- Never impaired

**GRAMMATICAL FORM**
- Variety of grammatical constructions (even if incomplete)
- None available
- Limited to simple declaratives and stereotypes
- Normal range

**PARAPHASIA IN RUNNING SPEECH**
- Present in every utterance
- Once per minute of conversation
- Absent
The Subjects of the Study

VOLUME: Hypophonic Normal Loud

VOICE: Whisper Hoarse Normal

RATE: Slow Normal Rapid
The Subjects of the Study

Figure 6.7. DENT’s Profile on the Boston Diagnostic Aphasia Examination.

<table>
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<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>MELOCIC LINE</td>
<td>absent</td>
<td>limited to short phrases and stereotypes</td>
<td>runs through entire sentence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHRASE LENGTH</td>
<td>1 word</td>
<td>4 words</td>
<td>7 words</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARTICULATORY AGILITY</td>
<td>always impaired or impossible</td>
<td>normal only in familiar words and phrases</td>
<td>never impaired</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRAMMATICAL FORM</td>
<td>none available</td>
<td>limited to simple declaratives and stereotypes</td>
<td>normal range</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PARAPHASIA IN RUNNING SPEECH</td>
<td>present in every utterance</td>
<td>once per minute of conversation</td>
<td>absent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The Subjects of the Study

VOLUME: Hypophonic  Normal  Loud
VOICE: Whisper  Hoarse  Normal
RATE: Slow  Normal  Rapid
Figure 6.8. THR’s Profile on the Boston Diagnostic Aphasia Examination.

- **MELODIC LINE**
  - Intonational contour
  - 1:Absent, 2:Limited to short phrases and stereotypes, 3:Runs through entire sentence

- **PHRASE LENGTH**
  - Longest occasional uninterrupted word runs
  - 1 word, 4 words, 7 words

- **ARTICULATORY AGILITY**
  - Facility at phonemic and syllable level
  - Always impaired or impossible, normal only in familiar words and phrases, never impaired

- **GRAMMATICAL FORM**
  - Variety of grammatical constructions (even if incomplete)
  - None available, limited to simple declaratives and stereotypes, normal range

- **PARAPHASIA IN RUNNING SPEECH**
  - Present in every utterance, once per minute of conversation, absent
The Subjects of the Study

VOLUME: Hypophonic Normal Loud
VOICE: Whisper Hoarse Normal
RATE: Slow Normal Rapid
Figure 6.9. THEX’s Profile on the Boston Diagnostic Aphasia Examination.

**MELODIC LINE**
- Intonational contour
- 1: absent
- 2: limited to short phrases and stereotypes
- 3: runs through entire sentence

**PHRASE LENGTH**
- Longest occasional uninterrupted word runs
- 1 word
- 4 words
- 7 words

**ARTICULATORY AGILITY**
- Facility at phonemic and syllable level
- Always impaired or impossible
- Normal only in familiar words and phrases
- Never impaired

**GRAMMATICAL FORM**
- Variety of grammatical constructions (even if incomplete)
- None available
- Limited to simple declaratives and stereotypes
- Normal range

**PARAPHASIA IN RUNNING SPEECH**
- Present in every utterance
- Once per minute of conversation
- Absent
The Subjects of the Study

**VOLUME:**
- Hypophonic
- Normal
- Loud

**VOICE:**
- Whisper
- Hoarse
- Normal

**RATE:**
- Slow
- Normal
- Rapid

**REPETITION**
Score in High-Probability subtest

**WORD FINDING**
Informational content in relation to fluency
- Fluent without information
- Information proportional to fluency
- Speech exclusively content words

**AUDITORY COMPREHENSION**
Mean of percentiles on 3 Auditory Comprehension subtests

X
Figure 6.10. PAPAL’s Profile on the Boston Diagnostic Aphasia Examination.

MELODIC LINE
Intonational contour

1. absent
2. limited to short phrases and stereotypes
3. runs through entire sentence

PHRASE LENGTH
longest occasional uninterrupted word runs

1 word
2. 4 words
3. 7 words

ARTICULATORY AGILITY
facility at phonemic and syllable level

always impaired or impossible
normal only in familiar words and phrases
never impaired

GRAMMATICAL FORM
variety of grammatical constructions (even if incomplete)

none available
limited to simple declaratives and stereotypes
normal range

PARAPHASIA IN RUNNING SPEECH

present in every utterance
once per minute of conversation
absent
The Subjects of the Study

VOLUME: Hypophonic  Normal  **Loud**

VOICE: Whisper  **Hoarse**  Normal

RATE: Slow  Normal  Rapid

REPETITION score in High-Probability subtest

WORD FINDING informational content in relation to fluency

AUDITORY COMPREHENSION mean of percentiles on 4 Auditory Comprehension subtests

fluent without information  information proportional to fluency  speech exclusively content words
Control subjects. The control group consisted of fifteen adult males (Mean age: 66 yrs., Age range: 45-79 yrs.), all of them native speakers of Greek. Those were selected out of approximately sixty post-office employees working at a post-office in the Greek province. The specific adults were purposely selected so as to match most closely the mean age (Mean: 69 yrs.) and educational level (Mean graduation level: 3rd grade of secondary school) of the aphasic experimental group in order to ensure that any deviation observed between the performance of the controls (used as the baseline) and the eight aphasic patients would not be biased by factors such as age and educational level. Special care was taken so that none of the control subjects that participated in the present study exceeded the aphasic subjects’ mean educational level, i.e. the 3rd grade of secondary school, mainly because of the tasks with verbs of alternating transitivity whose interpretation critically relies upon the lexical preferences of the adult speakers as well as on lexical constraints associated with the semantics of the verbal roots (Tsimpi, 2006: 26). None of the controls had any second language exposure before the age of six, any brain injuries, learning disabilities, or abnormal mental behaviour, and all of them had normal or corrected-to-normal vision and hearing. Finally, we should mention that the specific control subjects took part in all the experiments of the present study but one, namely the self-paced listening sentence-picture matching experiment checking the pragmatic effects on pronoun processing in which we used the data of the language-unimpaired controls taken from Papadopoulou et al.’s (2007) study.
6.2 THE METHODOLOGY

The eight aphasic subjects were submitted to a series of both on-line and off-line experiments aiming at collecting data which could be useful to clarify the problematic nature of the interfaces in Greek agrammatism. More specifically, as has already been noted, the present study focuses on the interpretation of subject pronouns that relies on the discourse-syntax interface, and the interpretation of verbs of alternating transitivity that relies on the syntax-lexicon interface. To this end, two groups of tasks were developed; the first one treated subject pronouns and it consisted of a SPMT, an on-line self-paced listening sentence-picture matching experiment, and an on-line self-paced listening antecedent identification experiment, while the second group treated verbs of alternating transitivity and included a SPMT, a picture-naming and a sentence repetition task, and an on-line cross-modal lexical priming experiment. Finally, the participants of the study have also participated in an on-line working memory task.
6.2.1 Experiments testing the interpretation of subject pronouns at the discourse-syntax interface

6.2.1.1 The sentence-picture matching task

Successful antecedent identification requires (among others) from aphasics to rapidly detect a pronoun’s underlying morphosyntactic features in order to isolate a set of antecedent candidates that would morphosyntactically agree with the co-referring pronoun. In contrast to full NPs, pronouns carry relatively impoverished lexical information, typically only about the gender and the number of a referent. One might thus expect that for the agrammatic patients to be able to participate in ambiguous antecedent-identification tasks like the ones employed in the present thesis, they should first be assessed in a task used to check access to pronouns’ morphosyntactic features.

Studies on morphosyntactic pronominal processing reveal important variation in aphasia depending on the assessment tasks used. The earliest studies on pronominal processing in aphasia used off-line measures to evaluate whether aphasic patients could select the appropriate pronominal referent in referentially unambiguous contexts. These studies generally showed a preserved ability to select the referent according to pronominal gender (Grober & Kellar, 1981; Blumstein, Goodglass, Statlender & Biber, 1983; Friederici, Weissborn & Kail, 1991). All these studies compared different groups of aphasic patients, but the results did not reveal important variations according to the clinical classification.

Linebarger, Schwarz & Saffran (1983) reported the results of a grammaticality judgment task in four French-speaking Broca's aphasic patients. The specific patients were found to be able to judge the well-formedness of various sentential structures, yet, they performed at chance level on comprehension tests involving reversible sentences. Moreover, the patients had trouble judging sentences with a tag
question like (65). This difficulty in detecting pronominal disagreement suggested according to the authors a deficit in processing pronominal co-indexation.

(65) *The blonde woman laughed, didn't it?

Rigalleau, Nespoulous, Gaonach & Guillabert (1997) tested the same patients with a SPMT in which subjects were asked to select the pictorial pronominal referent according to pronominal gender, and a grammaticality judgment task, in which subjects were asked to decide whether a sentence was well-formed or not. They found the same dissociation: French aphasic patients who were able to select the referent of the pronoun among two different gender competitors were not able to reject a sentence where a pronoun did not agree in gender with the unique mentioned referent in the grammaticality-judgement task. Such a deficit was attributed to the greater memory cost inflicted by the grammaticality judgement task since it required from the aphasic patients to maintain the identity, or at least, the gender of the antecedent in memory. On the contrary, the comprehension task was assumed to be less demanding since the aphasic subjects’ memory was supported by the pictorial pronominal referents.

Friederici, Weissenborn & Kail (1991) have also checked aphasics’ ability to access the morphosyntactic features of number and gender encoded on 3rd person pronouns in a large group of both Broca’s and Wernicke’s aphasic patients that came from diverse language backgrounds, namely, German, French and Dutch. The offline measure used was a SPMT in which subjects were asked to choose the picture that correctly depicted the action described in the target sentence. More specifically, three pictures accompanied the target sentence in two of which the possible antecedent and the pronoun were mismatched either in number or in gender. Performance on pronoun comprehension for both types of aphasics was found to be high across the three languages and both conditions, suggesting that the aphasic patients had no problem with retrieving the morphosyntactic information of number and gender encoded on pronouns during the process of assigning reference. The particular
study though does not provide us with sufficient information on whether the agrammatics performed higher on the gender or the number condition.

In a more recent study, Rigalleau & Caplan (2000) have examined the use of morphosyntactic agreement in the co-indexation process through a series of three on-line cross-modal naming tasks with ten Broca’s aphasic patients. Subjects listened to a context sentence that was immediately followed by a visually presented pronoun that the subject had to name. The subject then listened to the words following the pronoun and was required to say if the sentence was well-formed or not. In Experiment 1, the subjects’ ability to make judgments about the appropriateness of sentences with incorrect pronouns was evaluated (66b). The naming latency of incorrect pronouns contrasted against the naming latency of correct pronouns like (66a) was also measured to see if the aphasic patients were immediately sensitive to gender disagreement. In Experiment 2, only correct pronouns were presented but the pronouns could be preceded by two nouns sharing the same gender or different gender (67a) (67b). The naming latency of pronouns was measured; a longer naming latency for pronouns preceded by two different gender nouns in the specific condition would reflect appropriate selection of an antecedent. Finally, in Experiment 3, the materials of the Experiments 1 and 2 were combined, but the questions about pronouns were removed and the speech presentation rate was accelerated to remove the possibility that aphasics adopted a strategic processing in pronominal co-indexation.

(66)
(a)  “Norman and Victor waved in the train; *they* got out at the same station.”
(b)  “Morton and I dug a well in the garden; *they* called for some help.”

(67)
(a)  “Tom questioned Sam because *he* wanted to learn the truth.”
(b)  “Tom questioned Sue because *he* wanted to learn the truth.”
The analysis of the experimental results revealed that the aphasics' access to the pronouns' morphosyntactic features was relatively preserved yet under specific experimental conditions. More specifically, the findings of the first experiment revealed that aphasics were sensitive to gender disagreement errors as reflected in the longer naming latencies recorded in the gender-mismatch condition (66b). With regard to Experiment 2, analyses revealed longer naming latencies in the different-gender antecedent condition (67b) than in the same-gender antecedent condition (67a). This finding according to the authors provides evidence that when two nouns were available as potential antecedents of a pronoun, there was an immediate cost in the aphasic population associated with using gender as a cue to determine which noun was the morphosyntactically appropriate antecedent. The on-line sensitivity to a pronoun's gender disappeared in Experiment 3 whereby the context was purposely designed to reduce strategic processing of the pronouns. The same aphasic patients showed neither a gender-disagreement effect (as in Experiment 1) nor a gender-cue effect in the different-gender antecedent condition (as in Experiment 2). In sum, the aphasic performance across the three experiments according to the authors gives credence to the view that part of the grammatical knowledge concerning morphosyntactic agreement can be preserved in aphasic patients, yet, it cannot be successfully applied under conditions requiring fast and automatic processing like in Experiment 3. This assumption is consistent with the hypothesis of a restriction in computational resources specific to morphosyntactic processes often observed in aphasic populations (Caplan & Hildebrandt, 1988; Caplan & Waters, 1996).

Finally, a very recent single-case study conducted by Biran & Friedmann (2008) provides evidence in favour of a mildly impaired access to grammatical gender encoded in pronouns. The subject of the study was a Hebrew-speaking agrammatic patient diagnosed as a Broca's aphasic. Gender in Hebrew is grammaticalized with pronouns inflecting for gender and agreeing with the critical noun. In a phrase level grammaticality judgement test that assessed the subject's sensitivity to
violations of gender agreement between a pronominal and a noun, the patient scored 70% which was significantly lower than his performance score in tests checking his knowledge of subcategorization frames and argument structure options of various verb classes. These results according to Biran & Friedmann (2008) suggest that different types of lexical-syntactic information, such as grammatical gender and predicate argument structure information, are represented separately and can be damaged selectively.

The present thesis assessed aphasic patients’ access to pronouns’ morphosyntactic features by using a SPMT like the one used in Friederici et al.’s (1991) experimental study.

**Stimuli & Design.** A total of forty-eight SOclV sentences were presented to each participant counterbalanced across two experimental conditions: pronominal gender and number. Each condition contained twenty-four experimental items. All verbs were agentive transitives and had their object in pronominalized form. Unlike English where object pronouns follow the verb, in Greek weak object pronouns, or else clitics, precede it. The experimental items in the first condition had a singular preverbal 3rd person clitic pronoun whose gender was equally balanced across the masculine and the feminine gender. As such, twelve sentences within the gender condition contained a preverbal masculine clitic pronoun and the other twelve sentences contained a preverbal feminine clitic pronoun. The two pictures-distractors didn’t match the target sentence by manipulating the gender of the pronoun’s pictorial antecedent: the depicted antecedent was masculine or neuter if the critical pronoun was feminine and vice versa. On the other hand, the experimental items in the number condition consisted of twelve sentences that had a singular preverbal clitic pronoun and twelve sentences that had a plural preverbal clitic pronoun. The pronoun’s gender in the sentences was equally balanced across the masculine and the feminine gender. The two pictures-distractors in each picture triplet didn’t match the target sentence by manipulating the number of the pronoun’s pictorial antecedent: the depicted antecedent was singular if the critical pronoun was plural and vice versa. The sentences along
with their corresponding picture triplets were randomly ordered and presented across patients in a single session that lasted approximately 20 minutes.

**Procedure.** Each aphasic subject received the test prior to the tasks designed to test disambiguation of referentially ambiguous intra-sentential and inter-sentential contexts. Subjects were tested individually in a quiet room. The participant heard a sentence read by the examiner who was a native speaker of Greek, and saw three pictures on the same page, one next to the other. Figures (6.11.) & (6.12.) demonstrate two examples of typical stimuli taken from the gender and the number condition, respectively. The participant was then asked to point to the picture that correctly described the sentence. Although patients were encouraged to make their choice spontaneously, there was no time pressure for their decision. The subjects’ choices were simultaneously coded in written form by the examiner.

**Data Analysis.** The data of the task consisted of the aphasic patients’ target and non-target choices across both the gender and the number condition.

**Figure 6.11.** A picture triplet used in the SPMT (in the Gender condition) and its corresponding SOcIV sentence that matches the leftmost picture

{o antras ton klotsai / ‘The man kicks’}
Figure 6.12. A picture triplet used in the SPMT (in the Number condition) and its corresponding SOcIV sentence that matches the leftmost picture

*gi neka tis troi/* ‘The woman eats them’
6.2.1.2 The self-paced listening sentence-picture matching experiment

The main goal of the specific online task was to investigate pronoun resolution preferences and resolution timing in ambiguous intra-sentential contexts of forward anaphora. The design of the specific experiment (taken from Tsimpli et al., 2004, and Papadopoulou et al., 2007) is based on prior work on anaphora resolution in various NSLs elaborated upon in the Literature Review chapter (Carminati, 2002; Sorace & Filiaci, 2006 for Italian; Alonso-Ovalle et al., 2002 for Spanish; Diaconescu & Goodluck, 2004 for Romanian; Costa et al., (2004) for European Portuguese, a.o.). All these studies have offered several theoretical accounts of pronoun ambiguity resolution in NSLs, most of them mapping the form of a referring expression to the degree of salience of the referent. More specifically, their basic assumption is that null subject pronouns are preferred for reference to the most salient entity usually identified with the main clause subject and overt pronouns to the less salient referent usually identified with the main clause object. The empirical base for these theoretical accounts comes almost exclusively from behaviour that has been measured offline, i.e. subsequent to the final antecedent assignment in intra-sentential contexts. More specifically, the off-line measures used took the form of sentence-continuation and picture-verification tasks or simple questionnaires. In the present work we investigated the experimental subjects’ behaviour by using an online measure in order to view the pronoun processing system as it is operating in real time.

The self-paced listening sentence-picture matching experiment was based on a cross-modal decision paradigm. More specifically, the participants were shown visual picture-probes on a computer screen and were instructed to make a match or a mismatch decision according to their best judgement while listening to a concurrent sentence. As will be made clearer below, the subjects’ match and mismatch decisions indirectly reflected their preferences regarding the possible linking relations established between the postulated null or overt subject pronoun and the candidate antecedents in each experimental sentence. We believe that the evidence collected via such an experimental design is highly reliable since the specific cross-modal method tapped on the subjects’ implicit linguistic
knowledge relevant to pronominal resolution processes without the subjects being consciously aware of it. In fact, our main methodological concern was to minimize the experiment's interpretive demands by not requiring from the aphasics to give us an explicit interpretive response regarding the referent of each pronoun in the experimental stimuli as would happen if we employed, for instance, an explicit antecedent-identification questionnaire.

**Stimuli.** The experimental stimuli consisted of twenty test items taken from Tsimpli et al.'s (2004) paper. Two definite NPs were introduced in the main clause. One was introduced as the grammatical subject, while the other was introduced as the post-verbal object. Both subject and object were animate entities to prevent animacy effects from influencing the pragmatic salience of the two entities. Each matrix clause was followed by a subordinate clause, in which the form of the referring expression in preverbal subject position was manipulated and was represented as either an overt or a null pronoun. As such, the null pronoun condition contained ten sentences having a null subject pronoun in the subordinate clause and the overt pronoun condition contained ten sentences that had an overt subject pronoun in the subordinate clause. Both arguments of the matrix clause shared the same gender and they were matched with the (overt) pronoun in the subordinate clause on the appropriate morphosyntactic dimensions, i.e. gender and number. As such, the referentially dependent expression in the subordinate sentence could not unambiguously pick out its referent. The conjunction linking the main to the subordinate clause was equally balanced between the connective *otan/when* and the connectives *kathos* or *eno/while*, all of them being temporal. The critical stimuli were intermingled with twenty fillers. The fillers used were semantically diverse and had alternate syntactic structures in order to prevent the participants from developing specific expectations or generating strategies when listening (co-ordinate sentences, relative clauses etc). Finally, a ten-item practice list was also constructed by

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28 Several studies have shown that animate entities are more salient than inanimate entities during sentence processing (Dahl & Fraurud, 1996; Fukumura & Van Gompel, 2009; Kousta, 2005).
sentences with diverse syntactic structures so as to familiarize the participants with the demands of the particular task. All the stimuli were recorded and digitized at a 48 kHz sampling rate by a female native speaker of Greek at a normal speaking rate. The stimuli were afterwards broken into seven blocks consisting of short phrases using Sound-Edit (Dunn 1994) and entered into E-Prime psychological software to create the self-paced listening experiment.

Most importantly, each of the twenty sentences came into three colourful pictorial versions depicting the actions portrayed by the verbal events in the main and the subordinate clause. What distinguished each picture from the rest was the pictorial agent of the subordinate that was manipulated in a manner which was either congruent or incongruent with the referential choice conditioned by the syntax-discourse interface. More specifically, the first picture in the null pronoun condition matched the discourse-syntax interface bias by identifying the subordinate agent with the main clause subject, while the second and the third picture systematically identified the subordinate agent with the main clause object and an extra-sentential referent, respectively. Alternatively, the first picture in the overt pronoun condition matched the discourse-syntax interface bias by identifying the subordinate agent with the main clause object, while the second and third picture identified the subordinate agent with the main clause subject and an extra-sentential referent, respectively. Sentences (68) and (69) demonstrate two examples of typical stimuli in the null and the overt pronoun condition, respectively. Also, Figures (6.13.) and (6.14.) represent the picture triplets corresponding to the two sentences across the single ‘match’ and the two ‘mismatch’ readings. The slashes in the sentential stimuli stand for the frontiers between sound blocks.

(68)  O pateras/ elege/ hronia pola/ sto jio tu/ otan/ pro anige/ tin porta

“The father was telling Happy Birthday to his son when pro opened the door.”
Figure 6.13. A picture triplet in the null pronoun condition used in the self-paced listening sentence-picture matching experiment. The leftmost picture corresponds to the ‘matching’ condition by portraying the subordinate agent as the main clause subject, while the middle and the rightmost picture correspond to the ‘mismatch’ conditions by portraying the subordinate agent as the main clause object and an extra-sentential referent, respectively.

a. ‘Match’ reading 

b. ‘Mismatch’ reading i

c. ‘Mismatch’ reading ii

(69) I mitera/ filise/ tin kori tis/ kathos/ afi/ evoxe/ to palto tis

“The mother kissed her daughter while she was putting her coat on.”

Figure 6.14. A picture triplet in the overt pronoun condition used in the self-paced listening sentence-picture matching experiment. The leftmost picture corresponds to the ‘matching’ condition by portraying the subordinate agent as the main clause object, while the middle and the rightmost picture correspond to the ‘mismatching’ conditions by portraying the subordinate agent as the main clause subject and an extra-sentential referent, respectively.

a. ‘Match’ reading 

b. ‘Mismatch’ reading i

c. ‘Mismatch’ reading ii
Discourse Syntax Interface – Self Paced Listening Sentence Picture Matching Task

**Design.** Two factors were crossed by manipulating the sentential and the pictorial stimuli of the task: the type of the pronoun in subordinate subject position (i.e. null vs. overt) and the type of the referent (i.e. subject, object, or extra-sentential). The experiment was thus given a 2 X 3 design with both factors being completely counterbalanced across individual sentential items. Since there were ten sentences for each type of pronoun condition, the total of trials for the whole experiment was brought to sixty items. In order that no sentence would be heard more than once by the same participant in a single session, three scripts comprising twenty experimental items intermingled with twenty filler sentences were created. Each patient was tested on each one of them on different days, with 7-20 days between sessions. Each script lasted approximately 45 minutes. Standard counterbalancing procedures ensured that each participant saw an equal number of sentences in every possible experimental condition and that, over the entire experiment, each sentence was tested equally often and viewed by the subject only once in each condition. Moreover, the presentation of the trials was arranged in a fixed order such that no adjacent items belonged to the same experimental condition.

**Procedure.** All subjects were tested using an Acer laptop computer which was set up on the table at which the subject and the experimenter were seated. The materials were delivered under computer control using the E-Prime experimental package. At the beginning of each script the following instructions (translated here in English) appeared on screen and they were read aloud by the examiner: ‘In this test you will be viewing one image at a time and you will be listening to sentence fragments at the same time. In order for you to be able to listen to the sentence fragments presented serially, you must press the space bar successively. Try to listen as you would normally do for meaning. At the end of each sentence, the image will disappear and a question mark ‘?’ will appear on the screen. At this point, you must decide as spontaneously as possible whether the sentence you have heard matched the image you have just viewed on the screen or not. If it did, press the ‘1’ button. If it didn’t, press the ‘0’ button. Please, press the space bar to begin the trial. Good luck!’ Participants pressed the space
bar to begin the trial, and the first picture probe of the practice list appeared on the screen all at once. At the same time, the computer played a digitized version of the first sentence fragment over loudspeakers at a comfortable listening level. We should mention that the subjects were encouraged to use their dominant hand for reasons of convenience which was usually the left one since six out of the eight aphasic participants suffered from a right-sided hemiplegia. After passing through the ten-item practice list (six of them being obligatory and the rest of them ran on the subject’s request), the first image of the trial list appeared on screen. The subjects advanced through each recorded sentence by pressing the space bar after they had listened to each part of the sentence. During the temporal unfolding of each sentence, the corresponding picture-probe was continuously displayed individually at the center of the screen, and remained there until the participant has heard the entire sentence. More specifically, the onset of the visual scene coincided with the onset of the first recorded phrase of each experimental sentence, and the removal of the visual scene took place immediately after the offset of the last recorded phrase. As such, display of the visual scene and listening to each experimental sentence took place in a concurrent manner. Each subject could listen to the recorded sentential fragments at his own pace by successively pressing the space bar. Once the last phrase of the recorded sentence was listened to, the picture was succeeded by a grey screen with a question mark ‘?’ on its centre for an infinite interval of time during which the subject had to decide as fast as possible if the sentence he has just listened to matched the visual scene or not. The subject decided by pressing

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29 According to Altmann (2004) the removal of the visual scene right after the offset of the last recorded phrase does not undermine the reliability of the subjects’ match/mismatch decisions. According to him, the response latencies driven by linguistic expressions are not contingent on a visual item being co-present with that expression. On the basis of data from recent studies (Altmann & Kamide, 2004; Altmann, 2004), Altmann claims that subjects’ response latencies are rather based on a mental representation of the visual scene that dynamically changes as a function of the linguistic input. Following Altmann’s line of reasoning, the disappearance or not of the picture after the offset of the last recorded phrase of the sentence until the subject made his match/mismatch decision would not affect his referential choices.
Discourse Syntax Interface – Self Paced Listening Sentence Picture Matching Task

the previously agreed upon button on the computer (‘1’ for match, ‘0’ for mismatch). Feedback on the accuracy of the response was not provided and the subject proceeded to the next picture. The whole trial ended when the subject had answered the last trial question mark. Reaction times (in msecs) for each button press as well as types of responses (match/mismatch) and response times of the subjects’ match/mismatch decisions were collected via E-Prime software and then subjected to statistical analyses.

**Data analysis.** Data analysis was first based on the subjects’ matching decisions across both pronoun-type (null vs. overt) and referent-type (subject, object, or ‘other’) conditions. More specifically, we computed the sum (%) of each subject’s matching decisions in order to see whether significant patterns of co-indexation preferences would have emerged. At a secondary level, we have examined the correlation in performance between the matching rates and the RTs on the (mis)matching decisions and, finally, the relationship between RTs on the subordinate verb in the overt pronoun condition and the time course of pronoun ambiguity resolution.
6.2.1.3 The self-paced listening antecedent identification experiment

The main purpose of designing this task was to check pronoun resolution preferences and resolution timing in inter-sentential contexts. It is assumed that the memory requirements posed to the experimental subjects by the specific task were more demanding due to the increased quantity of the textual material intervening between the two antecedent-candidates and the critical pronoun (Mean: 2.33, and 3.33 lexical items in the SVO and the OVS condition, respectively) in comparison to the self-paced listening picture-matching experiment (6.2.1.2.) in which the intervening lexical material between the antecedents and the pronoun was restricted to a single word, namely, the temporal connector. The measure used in the present task was a word-by-word self-paced listening paradigm. The experimental subjects’ antecedent identification decisions, though, were measured in an off-line manner. Very few self-paced studies have looked at the processing of pronouns in referentially ambiguous inter-sentential contexts (Callahan, Nicol, Love & Swinney, 2007 for Chilean Spanish; Yang, Gordon, Hendrick & Wu, 1999 for Chinese). In only one, namely Callahan et al.’s self-paced reading task, did they find processing difficulty associated with the overt pronoun as reflected by increased reading times in the region following the inflected verb rather than immediately following the overt pronoun.

A secondary but not less important goal of the present task was to disambiguate the roles of grammatical function and word order during ambiguous pronoun resolution in Greek. Unlike English, Greek allows for a fairly wide range of options regarding the placement of the verbal arguments (i.e. subject & object) in sentences. The basic word order in Greek is considered to be the VSO order with the syntactic subject being placed in the [Spec,vP] post-verbal position (Philippaki-Warburton, 1989). As such, SVO order is considered to be a derived one with the lexical subject-DP being moved to a preverbal A’-position (i.e. [Spec, TopP]) (Alexiadou & Anagnostopoulou, 1998; Panagiotidis & Tsiplakou, 2004, among many others). Though the source of the pre-verbal subject in Greek, as well as in other NSLs, has sparked much debate, it is generally interpreted as a topic.
Furthermore, Greek offers the alternative that another argument, namely the object, be placed in topic position while the subject is still present in the sentence. Such constructions have been analyzed as instances of clitic left dislocation (CLLD) whereby the leftmost object constituent is base-generated in [Spec, TopP] and is doubled by a clitic agreeing with the lexicalized object in person, number and gender. According to many studies, the CLLDed object is interpreted as a topic, such as it has been traditionally assumed to occupy a position of prominence in discourse (Tsimpli, 1995; Iatridou, 1991; Alexiadou & Anagnostopoulou, 1998; Martins, l994; Uriagereka, l995; Raposo, l994, 1997; Zubizarreta, l998; Barbosa, 1995, 2000). By manipulating these syntactic options motivated by the need to satisfy information-structural requirements in Greek discourse, we checked whether the surface position of arguments in a sentence would affect the experimental subjects’ pronoun resolution preferences and, more specifically, whether the topic status encoded in CLLDed syntactic objects would behave similarly to that of syntactic subjects in preverbal position. If the pronoun preferences in the SVO word order condition changed in the OclVS condition, this would be taken as an indication that word order affects the salience of entities in Greek. If, on the other hand, both the null and the overt pronouns were preferably interpreted as referring to the grammatical subject of the first clause in both conditions, this would be taken as an indication that it is grammatical function that determines salience in Greek, with subjects ranking higher than objects independently of the word order parameter.

**Stimuli.** A set of twenty four brief two-sentence semantically coherent discourses was constructed. The first sentence was an interrogative and introduced two entities using either SVO or OclVS word order. In order to neutralise any marked referential interpretation that could favour one of the two entities as the pronoun’s most felicitous antecedent and ensure total reversibility, both NPs had proper names as nucleus\(^\text{30}\). Pairs of proper names were controlled for lexical processing, namely word length (each

\(^{30}\) Proper names have been shown to be more effective in establishing discourse entities in comparison to descriptive referring expressions (like *mother* or *policeman*). In fact, it has been claimed that it takes more computational effort on
name never exceeded 8 letters), phonological structure (each name never exceeded 4 syllables), and word stress (always on the penultimate). This procedure allowed us to select equivalent pairs of proper names. Within the SVO word order condition, the first proper name was introduced as the grammatical subject, and the other was introduced as the post-verbal object. On the other hand, in the OclVS word order condition, the object was fronted and the subject appeared post-verbally. In the second sentence the form of the referring expression was manipulated resulting in two alternative versions: one with a null pronoun in the syntactic subject position and the other with an overt pronoun. The overt pronoun in the second sentence could legitimately refer to either of the two proper names in the first sentence which were of the same gender. Furthermore, the verbs included in the first clause were pragmatically neutral so as not to bias the experimental subjects towards the subject or the object of the first clause while resolving the pronoun. Finally, the number of syllables between the two candidate referents in the first clause was also controlled for (Mean number of syllables: 5, and 6 syllables for the SVO and the OclVS condition, respectively) and it was held constant throughout all the experimental items in order to avoid any distance effect between the pronoun and its antecedent. The critical stimuli were intermingled with ninety-six fillers. The fillers used were semantically diverse and were designed to make the critical items less distinctive. The fillers, like the experimental passages, consisted of two-sentence discourses which have also included named referents. They had similar syntactic structures to those of the SVO experimental passages but reference was clearly disambiguated by gender. An

behalf of the human processor to establish a candidate set of referents when the linguistic input consists of referring expressions rather than proper names (Sanford, Moar, & Garrod, 1988).

According to the Immediacy assumption (Clark & Sengul, 1979; Ehrlich, 1980; Garrod & Sanford, 1977) the textual distance between two potential antecedents is a potential confound of pronoun resolution in ambiguous-referent contexts. More specifically, what the particular theory predicts is that it takes longer to recover the referent when the antecedent is further back in the text than when it is not.
initial practice block consisting of ten filler passages was used before each trial block to familiarize participants with the demands of the particular task. The stimuli were recorded and digitized at a 48 kHz sampling rate by a female native speaker of Greek at a normal speaking rate. The stimuli were afterwards broken into blocks consisting of short phrases using SoundEdit (Dunn, 1994) and entered into E-Prime psychological software to create the self-paced listening experiment. Each sentence was shown segmented in either ten or eleven parts depending on whether the subject pronoun was null or overt. In discourses (70a/b) & (71a/b), and (72a/b) & (73a/b) we may see instances of the experimental stimuli across the null and the overt pronoun conditions in the SVO and the OclVS condition, respectively, where the slash ‘/’ stands for the frontier between blocks:

(70)

(a) Giati/ o Nikos/ filai/ to Giani/ toso/ harumena? Null pronoun condition
Why does Nick kiss John so happily?
Giati/ Ø perase/ sto panepistimio/ stin nomiki.
“Because Ø entered the University, the Law School.”

(b) Giati/ o Nikos/ filai/ to Giani/ toso/ harumena? Overt pronoun condition
Why does Nick kiss John so happily?
Giati/ aftos/ perase/ sto panepistimio/ stin nomiki.
“Because HE entered the University, the Law School.”

(71)

(a) Giati/ i Maria/ heretai/ tin Ana/ toso/ lipimena? Null pronoun condition
Why does Mary say waive at Anna so sadly?
Giati/ Ø fevgi/ gia tin ameriki/ simera.
“Because Ø is leaving for America today.”

(b) Giati/ i Maria/ heretai/ tin Ana/ toso/ lipimena? Overt pronoun condition

Why does Mary say waive at Anna so sadly?

Giati/ afti/ fevgi/ gia tin ameriki/ simera.

“Because SHE is leaving for America today.”

(72)

(a) Giati/ to Giani/ ton filai/ o Nikos/ toso/ harumena? Null pronoun condition

Why does Nick kiss John so happily?

Giati/ Ø perase/ sto panepistimio/ stin nomiki.

“Because Ø entered the University, into the Law School.”

(b) Giati/ to Giani/ ton filai/ o Nikos/ toso/ harumena? Overt pronoun condition

Why does Nick kiss John so happily?

Giati/ aftos/ perase/ sto panepistimio/ stin nomiki.

“Because HE entered the University, the Law School”

(73)

(a) Giati/ tin Ana /ti heretai/ i Maria / toso/ lipimena? Null pronoun condition

Why does Mary say waive at Anna so sadly?

Giati/ Ø fevgi/ gia tin ameriki/ simera.

“Because Ø is leaving for America today.”

(b) Giati/ tin Ana /ti heretai/ i Maria / toso/ lipimena? Overt pronoun condition

Why does Mary say waive at Anna so sadly?
Giatí/ aftí/ fevgí/ gia tin ameríki/ simera.

“Because SHE is leaving for America today.”

**Design.** Four counterbalanced sets of materials were constructed by assigning one of the two versions (i.e. the one with the null pronoun and the other with the overt pronoun in subject position) of each SVO and OclVS experimental discourse to each material set. Within each of the four material sets each experimental passage naturally appeared only in one version. Since there were forty-eight sentences for each type of pronoun condition, the total of trials for the whole experiment were brought to ninety-six items. The stimulus materials for each set along with the ninety-six fillers were divided into eight blocks of twenty-four passages each. In each block, there were twelve critical passages intermingled with twelve filler passages. Each patient was tested on each individual session on different days (with 7-20 days between sessions) and each block lasted approximately 20 minutes. Standard counterbalancing procedures ensured that each participant saw an equal number of sentences in every possible experimental condition and that, over the entire experiment, each sentence was tested equally often and viewed by the subject only once in each condition. Moreover, the presentation of the trials in each block was arranged in a fixed order such that no adjacent items belonged to the same experimental condition.

**Procedure.** All subjects were tested using an Acer laptop computer, which was set up on the table at which the subject and the experimenter were seated. The materials were delivered under computer control using the E-Prime experimental package. A computer played a digitized version of the stimuli over loudspeakers at a comfortable listening level. Participants read the instructions on the computer screen and performed the practice block to become familiar with the self-paced listening task. At the start of each trial, the sentence ‘Please, press any key to begin trial’ was presented in the centre of the screen. Participants initiated the trial by pressing the space bar and the first phrase-block (as indicated
by the slashes in the examples above) appeared on the screen all at once. In a self-paced phrase-by-phrase moving window presentation, the participants paced themselves through each sentence one segment at a time by pressing the space-button interfaced with the computer. At the same time they were listening to the stimulus, they could also view it typed on the screen. Subjects were repeatedly instructed to listen to each passage carefully. All materials were presented in black on a white background using an 18-point Ariel Narrow font. At the offset of the last recorded segment of the second clause, the last phrase-probe slide was succeeded by a grey screen with a question mark ‘?’ on its centre for an infinite interval of time, during which each subject was orally asked by the examiner to name the most plausible antecedent of the pronoun (e.g. 70c, 71c). Subjects’ responses were recorded off-line by the examiner. Feedback on the accuracy of the response was not provided. The whole trial ended when the subject had answered the last trial question.

(70)
(c) Pjios apo tus dio perase sto panepistimio, stin nomiki?
“Who of the two entered the University, the Law School?”

(71)
(c) Pjia apo tis dio fevgi gia Ameriki simera?
“Who of the two is leaving for America today?”

Data analysis. The primary data consisted of the experimental subjects’ oral responses identifying the referent of the pronoun weighed by the type of the pronoun (null/overt) in subject position and the word-order of the first interrogative discourse (SVO/OcIVS). The task has also collected and measured the experimental subjects’ RTs in the verb region of the second discourse in the overt pronoun condition only (e.g. perasei’entered’ (70b)/(72b), and fevgii’she is leaving’ (71b)/(73b)). The aim of the specific
analysis was to check for any RT dissociations between the SVO and the OcIVS word order conditions at the region of the verb right after the offset of the overt subject pronominal. RTs were analyzed only for the responses in which the experimental subjects interpreted the overt pronoun as referring to the object of the first clause.
6.2.2 Experiments testing the interpretation of verbs of alternating transitivity at the syntax-lexicon interface

6.2.2.1 The cross modal lexical priming experiment

Antecedent re-activation in anti-causative verbs was investigated in an experiment originally designed by Burkhardt, Pinango, & Wong (2003), and recently adopted by Friedmann, Shapiro, Taranto, & Swinney (2008) to examine the Unaccusativity Hypothesis according to which the surface subjects of anti-causative verbs are underlyingly direct objects. To verify this hypothesis, both studies used the Cross Modal Lexical Priming (CMLP) technique which is based on the idea that the speed of access to a word during sentence processing is affected by semantic priming; an item – or crucially a re-activated item at the position of its trace – primes a semantically related word. Therefore, CMLP is a method for examining the re-activation of an antecedent during sentence processing and can be used to test A-movement involved in anti-causative verbs.

More specifically, Friedmann and al. (2008) have recently tested in English-speaking normal subjects the theoretical claim that SV sentences with anti-causative verbs are derived by movement of the object to subject position while SV sentences in unergatives do not include such a movement. They found as predicted that the processing of sentences with anti-causative verbs includes re-activation of the subject antecedent after the verb, while in sentences with unergative verbs such a re-activation is not observed. Moreover, they found that the re-activation does not occur immediately at the trace position, but rather a short time following it. Finally, a verb-by-verb analysis of the re-activation pattern in anti-causative verbs revealed an interesting dissociation between anti-causatives with and without an alternative causative structure; while the latter showed the expected pattern of antecedent re-activation downstream from the temporal point where it is licensed, the former, i.e. anti-causative verbs with a causative alterant, behaved just like unergatives.
Burkhardt, Pinango, & Wong's (2003) study has also investigated the on-line processing of unergative and anti-causative verbs with two English-speaking agrammatic patients by using the same technique. According to the analyses of the subjects’ response/reaction times in anti-causative verbs, the aphasic patients failed to reactivate the antecedent at the point of the trace, yet, their parser did show priming for the antecedent on average 150 msecs later than the language unimpaired subjects who provided evidence of antecedent re-activation not immediately at the post-verbal trace position but at a significantly later point in time (650 msecs after the anti-causative verb). The researchers have attributed such pattern of performance to the Slow Syntax Hypothesis (SSH) according to which the aphasics’ syntactic knowledge and ability to establish the dependency relation between the antecedent and its trace in anti-causative verbs was spared, yet, delayed automatic syntactic reflexes caused by the anterior lesions to the patients’ left hemisphere prevented them from responding on time. On the other hand, no antecedent re-activation pattern was observed for the unergative verb class in the aphasics.

Two further points worth mentioning from Burkhardt et al.'s study is that (i) no clear pattern of priming effect for the antecedent was shown by the two Broca’s aphasics when tested on anti-causatives lacking a causative counterpart32 in contrast to the control subjects who showed the same re-activation pattern across all anti-causative sentences, and (ii) the neurologically intact control subjects have shown a statistically significant priming effect immediately after the verb in the unergative

32 Burkhardt et al.’s (2003) results with respect to the aphasic performance on anti-causatives without an underlying causative structure are not clear enough. The authors report that the two Broca’s aphasics were initially subjected to a task including anti-causative verbs of both types (i.e. with and without an alternative causative structure), but since preliminary results indicated that Broca’s did not show a clear pattern in anti-causatives without a causative alternant, they decided to do away with these data and concentrate exclusively on anti-causative verbs participating in the causative/inchoative alternation (subnote 8, p.17)
verb class. The specific finding was accounted for by the authors in terms of the VP-Internal Subject Hypothesis (Koopman & Sportiche, 1991, a.o.).

The aforementioned experiments offered converging evidence supporting the distinct processing of the two verb classes, i.e. unergatives and anti-causatives by language-unimpaired populations, while the data from the two patients with Broca’s aphasia in Burkhardt et al.’s study spoke in favour of an overall slowing down of the merge operations through which the dependency relation between the derived NP-subject and the post-verbal trace is instantiated in anti-causative verbs. In the present study, we replicated the CMLP experiment, yet, with some modifications in the experimental population and the experimental stimuli. More specifically, we ran the experiment with the eight Greek-speaking agrammatic patients in the hope of gaining more robust and reliable data on the on-line processing of anti-causative (vs. unergative) verbs by Broca’s aphasics. Furthermore, apart from the morphological marking of certain Greek anti-causative verbs with the NACT suffix, voice alternations (ACT vs. NACT) of certain verbs of the ergative/anti-causative class were also manipulated. Finally, we investigated the effect of the [±animacy] of the syntactic subject variable on the aphasic subjects’ ability to disambiguate the meaning of both ACT and NACT anti-causative verbs during on-line sentence processing.

33 Such verbs are labelled as ‘alternating’ verbs and they are referred to in Greek as verbs ‘ditipias (lit. of two forms, Theofanopoulou-Kontou, 2000). Note, yet, that in both Friedmann and al.’s (2008) and Burkhardt et al.’s (2003) studies the term ‘alternating’ for anti-causative verbs is used instead to denote the verbs participating in the causative/inchoative alternation, such as the verb break (‘John broke the window’/‘The window broke’). On the other hand, the ‘non-alternating’ term is used to refer to anti-causatives whose subject never appears as the direct object, such as the verb vanish (‘John vanished’/*The kidnapper vanished John’). To avoid confusion, we restrict the term ‘alternating’ to the definition offered by Theofanopoulou-Kontou (2000), whereby alternation is understood in terms of optional change of voice morphology (ACT/NACT).
**Materials.** Each participant heard 92 aurally presented sentences consisting of 46 experimental sentences and 46 fillers. The 46 experimental sentences included 16 ACT anti-causative verbs (half [+voice-alternating], and half [-voice-alternating]), 14 anti-causative verbs bearing NACT voice morphology$^{34}$ (half [+voice-alternating], and half [-voice-alternating]) and, finally, 16 ACT unergative verbs. All the antecedents were full DPs and included 15 inanimate and 31 animate nouns. More specifically, all syntactic subjects in unergatives were animate, seven syntactic subjects in the NACT verb condition were [+animate] and seven were [-animate], and, finally, eight syntactic subjects in the ACT anti-causative verb condition were [+animate] and eight were [-animate]. The letter sequences for lexical decision (i.e., the visually presented probes) included 92 words and 46 non-words. The non-word probes conformed to Greek orthographic and phonological rules, and appeared with the filler sentences.

For the word-probes we created 46 pairs of words; in each pair one word was related to the head of the subject DP and the other was unrelated. Related probes were close semantic associates of the subject DP, while each unrelated probe was chosen to be matched in number of syllables with the corresponding related probe. Most importantly, both the related and the unrelated probes in the anti-causative verb trials were always matched with the [±animacy] feature of the syntactic subject. Each head of subject DP and each probe appeared only once per participant during the entire sentence list. All the stimuli were recorded (and digitized at a 48 kHz sampling rate) by a female native speaker of Greek at a normal speaking rate. The stimuli were afterwards broken into 3 blocks using SoundEdit (Dunn, 1994) and entered into E-Prime psychological software to create the CMLP experiment. The experimental and filler sentences were pseudorandomly assigned to positions in a script, such that no more than two of either verb type appeared successively. Finally, a ten-item practice list was also

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$^{34}$ Two NACT anti-causative verbs, namely steogthike/dry-PERF-NACT and zarothike/screw-PERF- NACT, were excluded from the testing materials since they have received very low acceptability rates in the norming study run to measure verb acceptability.
constructed by sentences with diverse syntactic structures so as to familiarize the participants with the demands of the particular task.

As can be seen in examples (74) - (76) below, the visual targets appeared at three probe positions in each sentence. The location of the first two probe positions was determined on the basis of structural criteria: Probe Position 1 was immediately at the offset of the head of the subject and Probe Position 2 immediately at the offset of the verb (i.e. at the point where the trace is licensed). Sentential material was added to the subject DP so that enough time would elapse between the antecedent and the trace to allow for decay in activation from the initial appearance of the subject DP. In light of previous research (e.g. Swinney, 1979; Onifer & Swinney, 1981; Love & Swinney, 1996) claiming that at least three syllables (or reading time equal to 1.5 seconds) are typically required to detect antecedent decay in priming, and in accordance to Friedmann et al.’s (2008) experimental design, the syntactic subject in the experimental stimuli of the present study was always followed by a PP modifying the noun and a modal adverb, together adding up to 5-6 words. The number of intervening words between the subject head and the trace in the present experiment was smaller than the number of the intervening words in Friedmann et al.’s experimental design (Mean N: 8), but the difference was compensated for by the fact that Greek words usually comprise of a considerably greater number of syllables than English words. The words between the antecedent and the gap were semantically unrelated to the head of the subject DP, or to the related and the unrelated word-probes. Probe Position 3 allowed for an at least four word spill-over region after the main verb across all three verb-type conditions. The dieses in the stimuli stand for the positions where probe words appeared as the sentences unfolded.
(74) ACT Unergative Verb Condition

O dolofonos # me to ageliko prosopo ksafrnika drapetefse # otan o astinomikos kimithike stin karekla tu tmimatos # ekso apo to keli

The-NOM murderer-NOM with the-ACC angelical-ACC face-ACC suddenly escape-PERF-ACT-3sg.
when the-NOM policeman-NOM fall-PERF-NACT-3sg. (asleep) on the-ACC chair-ACC of the-ACC police station-ACC out of the-ACC cell-ACC

“The murderer with the angelical face suddenly escaped when the policeman fell asleep on the chair of the police station right out of the cell.”

(75) NACT Anti-causative Verb Condition

(i) [+Animate] Subject – [-Voice-alternating] condition

O arostos # me tis liges meres zois ksafrnika giatreftike # otan episkeftike ena monastiri prin liges meres # ke ekane tama

The-NOM ill man-NOM with the-ACC few-ACC days-ACC life-GEN suddenly heal-PERF-NACT-3sg.
when visit-PERF-NACT-3sg. a-ACC monastery-ACC ago few-ACC days-ACC and make-PERF-ACT-3sg. offering-ACC

“The ill man with the few days of life suddenly healed when he visited a monastery a few days ago and he made an offering.”

(ii) [+Animate] Subject – [+Voice-alternating] condition

I nosokoma # apo tin Kalamata ksafrnika lerothike # otan patise se laspes # se mia lakuva

The-NOM nurse-NOM from the-ACC Kalamata-ACC suddenly spill-PERF-NACT-3sg. when step-
PERF-ACT-3sg. in mud-ACC in a-ACC pit-ACC
“The nurse from Kalamata suddenly spilled when she stepped in mud in a pit.”

(iii) [-Animate] Subject – [-Voice-alternating] condition

Ta luldia # stin akri tu dromu distihos marathikan # otan o k. Giorgos arostise poli varia # ke de dulepse deka mines

The-NOM flowers-NOM at the-ACC corner-ACC the-GEN house-GEN unfortunately wither-PERF-NACT-3pl. when the-NOM Mr.George-NOM fall-PERF-NACT-3sg. (sick) heavily and not work-PERF-ACT-3sg. ten-ACC months-ACC

“The flowers at the corner of the house unfortunately withered when Mr. George fell heavily sick and missed work for ten months.”

(a) [-Animate] Subject – [+Voice-alternating] condition

To harti # me ta politima stihia ksafnika tsalakothike # otan epese kata lathos kato # ke to patisame me ta podia

The-NOM paper-NOM with the-ACC invaluable-ACC data-ACC suddenly crumple-PERF-NACT-3sg. when fall-PERF-ACT-3sg. by mistake down and it-CL-ACC step-PERF-ACT-1pl. with the-ACC feet-ACC

“The paper with the invaluable data suddenly crumpled when it fell down by mistake and we stepped on it.”

(76) ACT Anti-causative Verb Condition

(i) [+Animate] Subject – [-Voice-alternating] condition

O tragudistis # me ta poli perierga ruha ksafnika kriose # otan vgike horis palto # sto dromo pu hionize
The NOM singer-NOM with the ACC very weird-ACC clothes-ACC suddenly catch-PERF-ACT-3sg. (a cold) when go-PERF-ACT-3sg. (out) without coat-ACC at the-ACC street-ACC where snow-IMPERF-ACT-3sg.

"The singer with the very weird clothes suddenly caught a cold when he went out at the street without a coat while it was snowing."

(ii) [+Animate] Subject – [+Voice-alternating] condition

To agori # me ta mavra malia ksafrnika diplose # sto edafos apo aforitus ponus # ke fonaze ti mama tu

The NOM boy-NOM with the ACC black hair-ACC suddenly fold-PERF-ACT-3sg. on the-ACC ground-ACC from unbearable-ACC pains-ACC and scream-IMPERF-ACT-3sg. the-ACC mother-ACC the-CL-GEN

“The boy with the black hair suddenly folded on the ground from unbearable pain and he was screaming for his mother.”

(iii) [-Animate] Subject – [-Voice-alternating] condition

To dentro # sto kentro tis platias ksafrnika anthise # otan o keros egine kaliteros # ke anevike i thermokrasia

The NOM tree-NOM at the-ACC centre-ACC the-GEN square-GEN suddenly blossom-PERF-ACT.3sg when the-NOM weather-NOM become-PERF-ACT.3sg better-NOM and rise-PERF-NACT.3sg the-NOM temperature-NOM

“The tree at the centre of the square suddenly blossomed when the weather became better and the temperature rose.”

(iv) [-Animate] Subject – [+Voice-alternating] condition

To forema # apo to eksoteriko sinehia tsalakoni # logo tis poli kakis piotitas tu # opou ki an kathiso
Design and Procedure. Since there were forty-six verbs and two probe-words (related vs. unrelated) for each probe position (position 1 after the subject DP, and post-verbal positions 2 and 3), the total of trials for the whole experiment was brought to two hundred seventy-six items. In order that no sentence would be heard more than once by the same participant, six scripts comprising the same experimental and filler sentences were created. The three probe positions and the two probe types (related vs. unrelated) for each experimental sentence were then equally distributed across the six scripts. Each participant heard each sentence only once, with one of the combinations of probe position and probe type; more specifically, within a single script participants heard 92 sentences (46 experimental and 46 fillers) containing a verb paired with a probe in each of the three probe positions and, for half of each of these the probe was either related to the antecedent DP or unrelated.

All subjects were tested using an Acer laptop computer which was set up on the table at which the subject and the experimenter were seated. The materials were delivered under computer control using the E-Prime experimental package. A computer played a digitized version of the stimuli over loudspeakers at a comfortable listening level. After an initial practice block consisting of 10 filler sentence constructions, the word ‘READY’ appeared on the screen. Using their dominant hand, the aphasic participants pressed the space bar to indicate that they were ready to begin the trial, and the first experimental item was run. During the temporal unfolding of each sentence, a visually-presented probe appeared centrally on the screen for an infinite period of time. At that point the subjects were required to make a lexical decision on whether the letter string on the screen was a real word or not. They were asked to make the decision as quickly and accurately as possible by pressing one of two keys (‘0’ for a non-word, ‘1’ for a Greek native word). Reaction times for the lexical decisions were
recorded by E-Prime software. Once the lexical decision was made, the subject went through the rest of the aurally presented sentence via the moving time window paradigm. The last part of each sentence was always succeeded by a question mark appearing at the centre of the computer screen. At that point (and in 20% of the trials) the subjects were asked a yes/no comprehension question about the sentence that they had just heard, with the purpose of ensuring that the participants were paying attention to the meaning of the sentences. Each patient was tested on each of the six scripts on different days, with 7-20 days between the sessions. Each script lasted approximately 40 minutes.

**Data analysis.** Priming effects were assessed by comparing the reaction times on the target-probes that were semantically related to the head of the subject DP to the reaction times on the unrelated probes in each probe position and for each verb type condition. The animacy effect in ACT and NACT anti-causative verbs was assessed by comparing the reaction times on the [+related] target-probes that were [+animate] to the reaction times on the [-animate] probes in each probe position. Further analyses were performed on the subjects’ reaction times recorded for the voice-alternating and the non-alternating (ACT and NACT) anti-causative sentences and for each of the two post-verbal positions (probe position 2 and probe position 3) by comparing the reaction times on the target-probes that were semantically related to the head of the subject DP to the reaction times on the semantically unrelated probes. All six scripts were presented to each participant with a one-week interval between two consecutive scripts.
6.2.2.2 The sentence picture matching task

**Stimuli, Design & Procedure.** The SPMT tested the preference for the anti-causative, the reflexive and the ACT transitive reading as compared to the passive. It aimed to examine whether the preference depends on the animacy of the subject, voice morphology and verb class. In all the test sentences targeting an anti-causative and a reflexive reading, the passive reading was *dis-preferred* due to verb class. On the other hand, the passive reading in the sentences targeting an active reading was non-target since the former choice violated grammaticality. Specifically, the verbs were chosen to be either ‘inherently’ reflexive or traditionally assumed to belong to the anti-causative class. Transitive verbs with ACT morphology were included in order to test whether ACT voice morphology would pose processing difficulties to the agrammatic patients, and whether this difficulty would be extended to anti-causative verbs marked with ACT voice morphology as well. The test included twenty-five sentences. For each sentence orally produced by the researcher, three pictures were simultaneously presented. Each subject was asked to choose the picture that fitted the most the sentence meaning. The position of the target picture was random and the order of the presentation of the sentences was the same for all the subjects but randomized with respect to the type of the structure tested. Each sentence consisted of a DP and the verb in the 3rd person singular present or simple past tense. No ‘by-phrase’ was included in any of the sentences.

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35 As will be shown and elaborated upon in the chapters to come (more specifically, in the ‘Results’ and the ‘Discussion and Conclusions’ chapters) we assume that the disambiguation of verbal events (i.e. unaccusativity, reflexivity, reciprocity etc.) is more likely to be determined by probabilistic/frequency effects and lexical factors (e.g. the [+ animacy] of the syntactic subject) rather than being exclusively an inherent property of the verbal stems. Nevertheless, for the time being we will be using the terminology traditionally assumed in the relevant literature (e.g. Alexiadou & Anagnostopoulou, 1998).

36 All the verbs used in the tasks were presented in the 3rd person since first and second person referents are necessarily [+animate].
Table 6.3. Classification of the first 10 test sentences according to +/-reflexivity, voice morphology and subject animacy.

<table>
<thead>
<tr>
<th>Voice morphology, Reflexivity, Animacy</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
<th>S7</th>
<th>S8</th>
<th>S9</th>
<th>S10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voice morphology</td>
<td>ACT</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>NACT</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>+Reflexivity</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>+Animate subject</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
</tr>
</tbody>
</table>

Table 6.4. Classification of the remaining 10 test sentences according to +/-reflexivity, voice morphology and subject animacy.

<table>
<thead>
<tr>
<th>Voice morphology, Reflexivity, Animacy</th>
<th>S11</th>
<th>S12</th>
<th>S13</th>
<th>S14</th>
<th>S15</th>
<th>S16</th>
<th>S17</th>
<th>S18</th>
<th>S19</th>
<th>S20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voice morphology</td>
<td>ACT</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>NACT</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>+Reflexivity</td>
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<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>+Animate subject</td>
<td></td>
<td>+</td>
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<td>+</td>
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<td>+</td>
<td>+</td>
<td>+</td>
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<td>+</td>
</tr>
</tbody>
</table>

Table 6.5. List of verbs by verb type.

<table>
<thead>
<tr>
<th>Reflexives</th>
<th>ACT anti-causatives</th>
<th>NACT anti-causatives</th>
<th>ACT Transitives</th>
</tr>
</thead>
<tbody>
<tr>
<td>plenome/'wash'</td>
<td>vuliazo/'sink'</td>
<td>tripieme/'pierce'</td>
<td>filao/'kiss'</td>
</tr>
<tr>
<td>htenizome/'comb'</td>
<td>mavrizo/'blacken'</td>
<td>lerome/'spill'</td>
<td>vreho/'wet'</td>
</tr>
<tr>
<td>vafome/'make-up'</td>
<td>steegno/'dry'</td>
<td>vithizome/'sink'</td>
<td>deno/'tie'</td>
</tr>
<tr>
<td>dinome/'dress'</td>
<td>plateno/'widen'</td>
<td>krivome/'hide'</td>
<td>agaliazo/'hug'</td>
</tr>
<tr>
<td>fortonezome/'load'</td>
<td>spazo/'break'</td>
<td>zetenome/'heat'</td>
<td>klotsao/'kick'</td>
</tr>
</tbody>
</table>

The target-picture in the anti-causative and the reflexive verb condition was the one depicting the event as anti-causative and reflexive, respectively. Of the other two pictures, one presented the same activity with an additional participant being the agent of the activity. The third picture either showed a different activity (a semantic distractor) or the activity described by the verb but with an ‘active’ reading, i.e. where the subject of the sentence is the agent. The ‘active’ reading was regarded

37 Note though that the anti-causative interpretation of ACT verb forms is significantly more frequent in the presence of an inanimate than an animate subject (Fotiadou, 2010).
to be the “real” non-target one, since it represented an underlying ungrammatical parsing procedure. The choice of either of the two pictures depended on the animacy of the subject and the verb class. More specifically, the sentences with inherent reflexives were presented with two pictures encoding a dis-preferred and a non-target reading, respectively, namely one depicting the activity affecting the subject of the sentence but with another person as agent (i.e. the ‘passive’ reading), and the other where the subject of the sentence is the agent but the activity affects someone else (the ‘active’ reading). The possibility of the active reading was included since it was possible that the verb’s semantics would still be well preserved in the agrammatic aphasics but voice distinctions would be impaired. For example, for S11 (i gineka htenistike ‘The woman combed-NACT’), the target picture is the one where the woman combs herself, the second picture shows the woman being combed by someone else (the ‘passive’ dis-preferred reading) and the third shows the woman combing someone else (the ‘active’ non-target reading).

Sentences with animate subjects, NACT voice morphology and anti-causative verbs were given the following choices: the target picture where only the syntactic subject appears, a picture where someone else is the agent of the action (the ‘passive’ reading) and the third picture which was either a true distractor or where the syntactic subject of the sentence performs the activity on her/himself (the ‘reflexive’ reading). For example, for S8 O adras lerothike ‘The man spilled himself-NACT-3sg.’, the target picture shows a man stepping by mistake on road mud and getting himself dirty, the second picture shows a woman throwing eggs against the man getting his shirt dirty (the ‘passive’ dis-preferred reading), and the third picture shows the man trying to clean his muddy hands by rubbing them on his shirt (the ‘reflexive’ dis-preferred reading).

The sentences with anti-causative verbs in ACT morphology and inanimate subjects included apart from the target picture a picture where someone performs the activity on the syntactic subject according to the verb meaning (the ‘passive’ reading) and a distractor where a different event takes place. This irrelevant distractor was used because the active reading was unavailable for the inanimate
subject. For example, for S19 O tihos mavrise ‘the wall blackened-ACT-3sg.’, the target picture shows a wall with a black spot and black smoke coming out of a fireplace, the second picture depicts a man painting the wall black (the ‘passive’ reading), and the third shows someone pulling the wall down with a hammer (the ‘distractor’).

Finally, the sentences with transitive verbs in ACT morphology and animate subjects and objects included apart from the target picture, a picture where the syntactic object/patient performs the activity on the syntactic subject/agent according to the verb meaning (the ‘passive’ or ‘reversible’ non-target reading) and a third picture where both the agent and the patient perform the action portrayed by the verb on each other (the ‘reciprocal’ reading). For example, for S5 O antras filai ti gineka ‘the man kisses the woman-ACT-3sg.’, the target picture shows a man kissing a woman, the second picture shows a woman kissing a man (the ‘reversible’ reading), and, finally, the third shows a man and a woman kissing each other (the ‘reciprocal’ reading).

Data analysis. The data of the SPMT consisted of the subjects' number of target readings within each verbal class as well as the number and specific type of their non-target/dis-preferred readings. The subjects' non-target/dis-preferred responses were analysed along both the voice morphology and the [+animacy] of the syntactic subject dimensions.
6.2.2.3 The picture naming task

**Stimuli, Design & Procedure.** The main aim of the task was to look for areas of difficulty in the production of voice morphology. The incentive for the particular task was Stavrakaki, Katsarou, Alexiadou, and Bostanjopoulou’s (2006) research which found that NACT morphological marking in Greek anti-causatives facilitated Broca’s aphasics’ retrieval of anti-causative verbs during a picture naming task\(^\text{38}\). In the present task, though, the choice of ACT vs. NACT voice morphology in anti-causative verb naming is not a matter of true optionality since it is constrained by the semantic feature of [±animacy] marked on the DP in the syntactic subject position. According to Tsimpli (2006), the animacy of the syntactic subject forces the predicate to denote a syntactically implicit external cause or argument, hence the NACT voice marking (2006: 24). Alternatively, the choice between ACT and NACT morphology when the syntactic subject is an inanimate entity has to be regulated by the agent vs. cause distinction on an implicit agent. Finally, the choice of morphology is also influenced by whether the anti-causative verb appears in both ACT and NACT form, like the verb keo/’burn’ in Greek which is labeled as a typical verb ‘ditipias’.

The naming task consisted of thirty-four isolated black & white pictures which were presented to each subject one-by-one, followed by a question asked by the researcher, such as ‘What happened to x?’ (for ACT and NACT anti-causatives) or ‘What is x doing?’ (for reflexives and transitives) (Jakubowicz et al., 1996, 1997). The pictures were taken from both the target and the non-target stimuli of the SPM task (6.2.2.2.). More specifically, the pictures aimed at eliciting verbs which belonged to four verbal classes: 9 items in reflexives (NACT morphology), 5 items in anti-causatives with ACT morphology, 10 items in anti-causatives with NACT morphology counterbalanced across the [±animacy] of the syntactic subject dimension, and 10 items in ACT voice transitives. For the elicitation

\(^{38}\) Nevertheless, no information is provided by Stavrakaki et al. (2006) with respect to the type of the anti-causative verbs employed in their picture naming task, and, more specifically, whether their design included voice-alternating anti-causative verbs or not.
of reflexives and ACT transitives the activity always involved an animate subject, while for the elicitation of ACT anti-causatives the activity always involved an inanimate subject.

(77)


(b) ACT Unnaccusatives: *vuliakse* (sank-ACT), *mavrise* (blackened-ACT), *stegnose* (dried-ACT), *platine* (widened-ACT), *espase* (broke-ACT).

(c) NACT Unnaccusatives: *tripithike* (pricked-NACT), *lerothike* (spilled-NACT), *vithistike* (sank-NACT), *kriftike* (hid-NACT), *zestathike* (heated-NACT).


It is common in such naming tests to elicit verbs close in meaning to the target but not the target itself. For example, in case the target verb was *platine* ‘widen’ and the subject produced *fardine* ‘widen’, the response was considered appropriate. Overall, responses were classified as correct when the target or a verb semantically close to the target was produced and the morphology was appropriate (ACT or NACT). Responses in which the verb used was appropriate but voice morphology was not, were classified as inappropriate and coded accordingly. For example, if instead of *vithistike* ‘sank-NACT’ the participant produced *vuliakse* ‘sank-ACT’, the response was inappropriate, and involved overuse of ACT morphology. On the other hand, lexical errors and zero responses were differently coded and were presented as a separate class (namely, ‘other’ responses).
Data analysis. The data of the picture-naming task consisted of the subjects’ number of target namings within each verbal class as well as the number and the type of their non-target namings. The subjects’ non-target responses were also analysed along the [±animacy] of the syntactic subject dimension.
6.2.2.4 The sentence repetition task

Several studies on acquired language disorders, early language acquisition and development are based on spontaneous production observed in naturalistic contexts (Bates, Bretherton & Snyder, 1988; Clark, 2003). This methodology provides researchers and clinicians with important sources of information, allowing the assessment of language use in relation to both context and speaker demands. Despite their many advantages, it is often difficult to obtain a free speech sample that would be sufficiently large from patients with Broca’s aphasia whose speech is highly telegraphic, i.e. it comprises primarily of nouns, modifiers, and to a less extent verbs. For these reasons, we chose to administrate a sentence repetition task which permits the assessment of specific target structures (here, verbs of alternating transitivity) in controlled situations.

Apart from the methodological benefits deriving from such a method, the main motivation for opting for sentence repetition was the assumption that it allows the examiner to gain an indirect look at the aphasic patients’ linguistic competence. We assume that the way each aphasic patient repeated a sentence and in particular the changes he applied to the original model would provide useful clues about the processing of the sentence itself, serving at the same time as a potential marker of the extent to which the aphasic’s language abilities have been impaired. As such, the repetition measure can be used to discriminate specific grammatical profiles in patients with different lesion sites and scores in the BDAE battery. The aphasic patient could for instance reorganize the original anti-causative sentence presented by the experimenter in a way that more closely reflected its underlying structure, e.g. leaving out or adding an extra morpheme to the anti-causative verb or modifying the word-order of the sentence to fit his available processing resources. Nevertheless, data from sentence repetition tasks should be evaluated with great caution since they may underestimate the aphasics’ actual language abilities. The lack of contextual support and the involvement of verbal working memory may impede aphasic subjects’ reproduction abilities, such that severe disparities may occur in the same aphasic subject’s use of anti-causatives in free speech and in the repetition task. Alternatively, there is a chance
that aphasics easily imitate structures that have never previously occurred in their spontaneous speech or that may not be understood, thus, giving a fake overestimated picture of their language abilities. A possible resolution of this contradiction is that all the aphasic patients participating in the present study firmly refused to repeat a sentence that was not comprehensible to them.

**Stimuli & Design.** The Sentence Repetition Task was designed to highlight the aphasic subjects’ capacity to repeat sentences of different morhosyntactic complexity reflected in the voice morphology marking of the verbal predicates. The test consisted of fifty items: 5 reflexive and 5 ACT transitive sentences (also included in the SPMT, see 6.2.2.2.), and forty sentences including 19 ACT anti-causative verbs, 12 NACT anti-causative verbs with an animate subject, and 9 NACT anti-causative verbs with an inanimate subject. Some of the anti-causative verbs were taken from the SPMT (see 6.2.2.2.) and the CMLP (see 6.2.2.1.) stimuli (see Appendix VIII for a full list of the experimental sentences used in the repetition task). As such, some of the anti-causative verbs used in the task were voice-alternating, i.e. they can appear with either ACT or NACT voice morphology. These items were the verbs *tripao* ‘prick-ACT’, *stegnono* ‘drie-ACT’, *keo* ‘burn-ACT’, *zesteno* ‘heat-ACT’, *tsalakono* ‘crinkle-ACT’ and *tentono* ‘stretch-ACT’ for the ACT anti-causative verb class, *tripieme* ‘prick-NACT’, *leronome* ‘spill-NACT’, *zestenome* ‘heat-NACT, *kegome* ‘burn-NACT’, *diplonome* ‘fold-NACT’, *tentonome* ‘stretch-NACT’ and *berdevome* ‘mingle-NACT’ for the NACT anti-causative verb class with an animate subject, and *tripieme* ‘prick-NACT’, *leronome* ‘spill-NACT’, *zestenome* ‘heat-NACT, *kegome* ‘burn-NACT’ and *tsalakonome* ‘crinkle-NACT’ for the NACT anti-causative verb class with an inanimate subject.

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39 The reason why the testing materials of the repetition task were not equally distributed across the four verb classes was the sudden loss of an aphasis patient before we have managed to complete the repetition task, such that we had to limit the rest of the patients’ repetition data to the items practiced by the specific aphasic subject while he was in life.
Each of the sentences included only rudimentary syntactic elements, i.e. the verb in present or perfective tense and its DP-argument(s) (subject or/and object, no by-phrase). Special attention was paid so that only familiar words were used in the construction of the test items, in order to minimize specific effects of variations in vocabulary on sentence repetition.

**Procedure.** Each patient was assessed on his own. Three familiarization items were administered first. The observer sat next to the aphasic and said the first sentence asking from the patient to repeat it as accurately as possible. The observer waited a few seconds depending on the subject’s response. If the aphasic subject did not answer, the verbal input was repeated a second time. The test continued following the same procedure and was carried over in two sessions, each lasting approximately 15-20 minutes. Each aphasic subject’s answers were recorded and transcribed.

**Data analysis.** As in the previous tasks, we have focused on both quantitative and qualitative analyses of the subjects’ repetition data. First, we counted the number of responses in which the verb repeated was appropriate (i.e. either the target form itself or another verb semantically related) but voice morphology was not. For example, if instead of *vithistike* ‘sank-NACT’ the participant repeated *vuliakse* ‘sank-ACT’, the response was inappropriate and implicated overuse of ACT morphology. Such inappropriate repetitions were classified under the ‘non-target response’ category. On the other hand, the responses whereby the verb repeated (i.e. either the target form itself or another verb semantically related) carried the appropriate voice morphology were classified as ‘target’, while verbal substitutions semantically unrelated to the target verbal form and zero responses were differently coded and presented as a separate category named as ‘other’. Finally, the subjects’ non-target responses were also analysed along the [+animacy] of the syntactic subject dimension.
6.2.3 The Working Memory Task

Deficits in working memory (WM) are a critical subset of non-linguistic deficits in aphasia (Murray, Ramage & Hooper, 2001; Wright & Shisler, 2005). Significant differences between WM capacity of individuals with and without aphasia (Tompkins, Bloise, Timko & Baumgaertner 1994; Wright, Newhoff, Downey & Austermann 2003) and significant correlations between WM and general language measures (Caspari, Parkinson, LaPointe & Katz 1998; Wright et al., 2003; Wright, Downey, Gravier, Love & Shapiro 2007) have been demonstrated. Unfortunately, the study of WM in aphasia is fraught with methodological limitations, largely due to the difficulty of controlling for potential confounds in the design of WM tasks and associated performance measures (Ivanova & Hallowell, 2008). Previously used measures of WM capacity in adults with aphasia, for instance, have been heavily influenced by the linguistic nature of the WM tasks, or by covert verbal encoding during “non-linguistic” task performance (Nystrom et al., 2000; Tompkins et al., 1994)

In the current study we report a WM task primarily aimed at evaluating a specific prediction of aphasiological research that verbal WM differences between language-unimpaired and aphasic populations relate to syntactic processing: unreduced controls with intact verbal WM may have more on-line resources available to compute and weigh syntactic constraints in sentence interpretation relative to individuals with Broca’s aphasia. To test this prediction, we directly manipulated the relative difficulty of retrieving from memory object NPs required for the interpretation of object relative clauses (ORCs) which contain a long-distance dependency between the head noun and the embedded verb (Gibson, 1998; Gordon, Hendrick & Johnson, 2001; McElree, Foraker & Dyer, 2003; Lewis, Vasishth & Van Dyke, 2006). More specifically, memory-based accounts characterize processing difficulty in ORCs in terms of WM costs that derive from decay and interference arising during content-based retrieval request of the previously processed object NP to complete the syntactic dependency. The WM task of the present study has explored the participants’ performance in ORCs in relation to (i) short passives,
which are presumably easier to process due to the short distance dependency between the derived subject and the post-verbal trace, (ii) subject relative clauses (SRCs) which consisted of the same number of words as ORCs but were assumingly easier to process due to the fact that retrieving the subject NP is already easy because it is a local dependency, and, finally, (iii) short ACT transitive sentences which consisted of the same number of words as passives and constituted assumingly the easiest to parse sentence-type condition in terms of both length and structural complexity.

Besides exploring the nature of the controls' and the aphasics' processing component by using a SPMT, the present study has also manipulated the interference method (see Grodner, Fedorenko, Hsieh & Glickman, 2009; Ivanova & Hallowell, 2008, for similar experimental paradigms) in an effort to investigate the two groups' storage capacities under the pressure of syntactic processing and vice versa. More specifically, sentences were processed while maintaining in memory a number of nouns thus increasing the extrinsic memory load. More specifically, the interference method was applied to investigate the experimental participants' capacity to retrieve consciously from memory single words in relation to the same individuals' ability to analyze syntactic information simultaneously, i.e. during the time these words were presented individually. In this sense, word retrieval capacity or, more generally speaking, memory is considered to be a by-product of the complexity of the syntactic materials used; retention and retrieval of single words should be more difficult when processing syntactically complex structures, e.g. reversible passives and especially ORCs, relative to structurally simpler sentences, like ACT transitives and SRCs.

The idea that memory and language create an interactive system, both of them drawing from the same pools of processing resources is not novel. King and Just (1991) were among the first to defend the position that language among other cognitive systems utilizes a general, non-specialized WM device for information storage and processing. According to this hypothesis, syntactic processing interferes with WM capacity measured by memory span tests once both tasks take place simultaneously (e.g. Waters & Caplan, 2002; 2004). The present WM task moves one step further by
predicting that the extrinsic memory load/interference effect would be greater for populations with poorer WM capacity (i.e. the Broca’s aphasics) relative to the language-unimpaired controls with a supposedly large WM capacity for language. As such, we expected that there would be more misanalysis difficulty over the parsing of structurally complex structures (i.e. passives and, especially, ORCs) under recall pressure in the Broca’s aphasics relative to the controls.

The advantages of this task also lie in its methodological design aiming first at circumventing confounds associated with existing verbal WM tasks and measures in aphasia, and at a secondary level, at interpreting recall errors/paraphasias in the Broca’s aphasics’ object-retrieval choices. More analytically, the SPM task, used for the processing part of the WM task, is more natural in terms of everyday language use and relies less on intact metalinguistic skills in contrast to true/false judgments. In contrast to random comprehension questions, it also provides a more accurate and detailed index of performance on the processing component of the WM task. Additionally, the WM task was constructed so that the participants could respond either with simple gestures or verbally, to both processing and recall components. On the other hand, the object-distractors used for the recall part of the task were purposely selected such that they were either phonologically/semantically related to the target object or totally unrelated. The purpose of such a design was to explore the eight aphasic patients’ state of lexical processing system and whether it was globally or selectively affected. To this end, we plotted each aphasic patient’s pattern of erroneous object identification choices at the recognition display phase of the WM task and observed whether these included various mixtures of errors (semantic, phonological, irrelevant errors) or only semantic or phonological paraphasias.

**Stimuli, Design & Procedure.** In this task participants were asked to listen to sentences and remember a separate set of words for subsequent recognition at the same time. Length and complexity of the presented sentences were manipulated separately, creating conditions with: (a) short and simple (type of syntactic construction: ACT transitive clause, number of words: 5); (b) short and complex (type
of syntactic construction: passive clause, number of words: 5); (c) long and simple (type of syntactic 
construction: subject relative clause, number of words: 14); and (d) long and complex (type of syntactic 
construction: object relative clause, number of words: 14) sentences. All the sentences in the task were 
semantically and syntactically plausible, and were semantically reversible. The sentences used for 
each condition are presented below:

1st condition: Short and Simple (ACT transitives)

a.  I motosikleta akoluthi to leoforio/ ‘The motorbike follows the bus’
b.  To aftokinito serni to fortigo/ ‘The car draws the truck’
c.  I gata dagoni to skilo/ ‘The cat bites the dog’
d.  To agori ksipnai ti mitera/ ‘The boy wakes the mother’

2nd condition: Short and Complex (Passives)

a.  To leoforio akoluthite apo ti motosikleta/ ‘The bus is followed by the motorbike’
b.  To forigo sernete apo to aftokinito/ ‘The truck is drawn by the car’
c.  O skilos dagonete apo ti gata/ ‘The dog is bitten by the cat’
d.  I mitera ksipniete apo to agori/ ‘The mother is woken by the boy’

3rd condition: Long and Simple (Subject relatives)

a.  Ine I gineka me to makri lastiho pu vrehi ton adra me to kodomaniko/ ‘It is the woman with the 
    long hose that wets the man with the short-sleeved T-shirt’
b.  Ine o adras me ta konta malia pu vrehi ti gineka me to kodomaniko/ ‘It is the man with the 
    short hair that wets the woman with the short-sleeved T-shirt’
c.  Ine to fortigo me tis megales rodes pu travai to aftokinito me ton odigo/ ‘It is the truck with the 
    big wheels that draws the car with the driver’
The materials were delivered under computer control using the E-Prime experimental package. More specifically, each of the sentences was visually presented on the top part of the screen using an 18-point Ariel Narrow font. The computer played a digitized version of the sentence over loudspeakers at a comfortable listening level, such that the participants could listen to and view the sentence typed on the screen simultaneously. Along with the auditory and visual presentation of each sentence, multiple-choice image arrays were presented below the sentence at the bottom of the screen. Each array consisted of three pictures: one target and two foils; the latter consisted of a non-target picture representing a semantically reversible reading, while the other represented a pragmatically irrelevant reading. The participants were asked to point to the image that best matched the sentence. There was no time limit set for the subjects’ responses. Subjects’ responses were recorded off-line by the examiner and each participant was instructed to continue with the task by pressing the space-bar whenever they felt ready. Each sentence-picture triplet was succeeded by a single word that appeared...
on the centre of the screen (for an infinite interval of time) using a 26-point Ariel Narrow font, which each subject was orally asked to memorize so that he could recall it later on in the task. At the end of a set of four sentence-picture triplets and four single words (each one appearing immediately after each one of the picture-triplets) (see Figure 6.15 below) an array of eight pictures including the four targets (representing the four words to be remembered) and four foil images (representing words either phonologically/semantically related or unrelated to the target words) were presented. The recall component of the task relied solely on the recognition of the four target-words. Each participant responded by either naming or pointing to the objects depicted. Feedback on the accuracy of the response was not provided and the subject proceeded to the next trial by pressing the space bar. The task ended when the subject had picked the target-images of the last/fourth sentence-picture trial.

The stimuli consisted of sets of four sentences, with each set being presented within each of the four conditions (i.e. 4 sentences for the short and simple condition, 4 sentences for the short and complex condition, 4 sentences for the long and simple condition, and, finally, 4 sentences for the long and complex condition), such that each participant heard 16 experimental sentences. The presentation of the trial sentences in each of the four sets of the task was arranged in a pseudorandom order such that each sentence belonged to a distinct experimental condition. Furthermore, the words to be recalled were four for each set, while their semantic content or phonological composition were purposely manipulated so that two of the four foil images at each recognition display were either semantically or phonologically-related to two of the four target words. The words used for each trial are presented in the Tables 6.6–6.9. below:

Table 6.6. The recall words in the WM task in the [+semantically-related] condition-Trial 1.

<table>
<thead>
<tr>
<th>Target words</th>
<th>[+Semantically-related] &amp; foil images</th>
</tr>
</thead>
<tbody>
<tr>
<td>radiofono ‘radio’</td>
<td>tileorasi ‘television’ [+semantically-related]</td>
</tr>
</tbody>
</table>

Both the interfering words and the foil images were purposely chosen to be (semantically & phonologically) unrelated to the DP-arguments involved in each sentence in order to avoid similarity-based interference effects.
<table>
<thead>
<tr>
<th>tulipa/ ‘tulip’</th>
<th>potiri/ ‘glass’</th>
</tr>
</thead>
<tbody>
<tr>
<td>psalidi/ ‘scissors’</td>
<td>banana/ ‘banana’</td>
</tr>
<tr>
<td>sapuni/ ‘soap’</td>
<td>petseta/ ‘towel’ [+semantically-related]</td>
</tr>
</tbody>
</table>

Table 6.7. The recall words in the WM task in the [+semantically-related] condition-Trial 2.

<table>
<thead>
<tr>
<th>Target words</th>
<th>[+Semantically-related] &amp; foil images</th>
</tr>
</thead>
<tbody>
<tr>
<td>kialia/ ‘opera glasses’</td>
<td>tileskopio/ ‘telescope’ [+semantically-related]</td>
</tr>
<tr>
<td>zigaria/ ‘scale’</td>
<td>vivio/ ‘book’</td>
</tr>
<tr>
<td>roloi/ ‘clock’</td>
<td>ora/ ‘time’ [+semantically-related]</td>
</tr>
<tr>
<td>prioni/ ‘saw’</td>
<td>kutali/ ‘spoon’</td>
</tr>
</tbody>
</table>

Table 6.8. The recall words in the WM task in the [+phonologically-related] condition-Trial 3.

<table>
<thead>
<tr>
<th>Target words</th>
<th>[+Phonologically-related] &amp; foil images</th>
</tr>
</thead>
<tbody>
<tr>
<td>mila/ ‘apples’</td>
<td>fila/ ‘leaves’ [+phonologically-related]</td>
</tr>
<tr>
<td>giaros/ ‘sea gull’</td>
<td>faros/ ‘lighthouse’ [+phonologically-related]</td>
</tr>
<tr>
<td>stroma/ ‘mattress’</td>
<td>kupa/ ‘cup’</td>
</tr>
<tr>
<td>kiklos/ ‘circle’</td>
<td>stilo/ ‘pen’</td>
</tr>
</tbody>
</table>

Table 6.9. The recall words to be retrieved in the WM task in the [+phonologically-related] condition-Trial 4.

<table>
<thead>
<tr>
<th>Target words</th>
<th>[+Phonologically-related] &amp; foil images</th>
</tr>
</thead>
<tbody>
<tr>
<td>bota/ ‘boot’</td>
<td>kota/ ‘hen’ [+phonologically-related]</td>
</tr>
<tr>
<td>rama/ ‘stitch’</td>
<td>grama/ ‘letter’ [+phonologically-related]</td>
</tr>
<tr>
<td>miti/ ‘nose’</td>
<td>kuklia/ ‘doll’</td>
</tr>
<tr>
<td>gala/ ‘milk’</td>
<td>vurtsa/ ‘brush’</td>
</tr>
</tbody>
</table>
The task was completed in a single session that has lasted approximately 30 minutes for each of the aphasics and 15 minutes for the controls with each subject being tested individually. At the start of the task, participants read the instructions on the computer screen and obligatorily performed a practice block consisting of two sentence-picture triplets and two single words to be remembered so as to become familiar with the demands of the WM task.

Figure (6.15.) below presents an example of a set from the WM task.

**Data analysis.** The following measures (computed for each condition) were used to index performance: (i) processing score expressed as the proportion of items for which the target picture was correctly selected, and (ii) storage score, whereby items were scored as the proportion of correctly recalled/recognized elements per sentence type condition; for the final scores the means of these
proportions were calculated for each of the aphasic participants and the control group. Furthermore, the aphasic participants’ semantic and phonological paraphasias in the recall task were collected and compared.
Part IV

THE RESULTS
Chapter 7 Analyses and Measurements

In this chapter we report the results of the experimental tasks separately for the two interface conditions: the interpretation of subject pronouns at the discourse-syntax interface and the interpretation and production of verbs of alternating transitivity at the lexicon-syntax interface. The subjects’ ratings (and occasionally Reaction Times (RTs)) were inserted into a database using the statistical software SPSS for Windows. All measurements and analyses were performed using this statistical software package. The data of the control participants were merged and mean ratings for each testing condition were calculated for the control group, while each aphasic subject was treated as an individual case in each task (except from the analyses of the task effect for each interface as well as the cross-modal lexical priming task, whereby the eight aphasic individuals’ data have also been merged). Thus, unlike the majority of the studies on Broca’s aphasia wherein only group comparisons are made, the present study examines and quantifies the interface effect(s) on the agrammatic patients’ language performance patterns at an individual level.

Following calculation of the patients’ and the control participants’ performance scores and RTs (when necessary) for each item, for each condition in each of the tasks, these data were submitted to inferential analysis with items (F2) as the random variable. The results are reported for the item analysis collapsing over subjects due to the fact that the number of the language-unimpaired participants (N=15) was nearly double relative to the number of the Broca’s patients (N=8) recruited for the present study. The statistical analyses of the data consisted of overall mixed design ANOVAs followed by a series of separate repeated measures ANOVAs aiming at further searching the source(s) of the significant interaction effects resulting for the various experimental variables in each task. Significant F-tests were occasionally followed up by one-tailed t-tests. Furthermore, the subjects’ performance means were visualized by means of boxplots while resulting significant (p<.05) within and between-subject dissociations were indicated via horizontal and dotted arrows, respectively. Each task
analysis concludes with a summary of the most important results. Finally, section 7.3 of the present chapter analyzes (among others) the task effect for each interface tested, such that the aphasic subjects’ data were also submitted to a merging operation. The two groups’ mean performance rates were fed into an ANOVA with subjects (nested under ‘Group’: aphasics vs. controls) as repeated measures to test the effect of the significance of the group variable (item-based data; collapsing across subjects).
7.1 THE INTERPRETATION OF SUBJECT PRONOUNS AT THE DISCOURSE-SYNTAX INTERFACE

7.1.1 The Sentence picture matching task-Unambiguous pronoun resolution

Two variables, one independent and one dependent, were utilized in this task, i.e. overt pronoun clitics in referentially unambiguous single-sentence contexts and the identification of each pronoun’s antecedent, respectively. The dependent variable was measured through the subjects’ choices of the correct image that depicted the entity referred to by the pronominal. Two experimental conditions were created by manipulating the pronouns’ number and gender features:

- correct gender, wrong number (condition A)
- correct number-wrong gender (condition B)

Normal-like access to the pronouns’ morpho-syntactic features (i.e. gender and number) was anticipated, in order for the aphasic subjects to be able to participate in the experiments checking antecedent preferences in referentially ambiguous contexts. Descriptive values for each condition are presented in Table 7.1.

<table>
<thead>
<tr>
<th>Participants</th>
<th>Mean Rating (%) Gender condition</th>
<th>SD</th>
<th>Mean Rating (%) Number condition</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>100</td>
<td>.0</td>
<td>100</td>
<td>.0</td>
</tr>
<tr>
<td>GCH</td>
<td>95.83</td>
<td>.204</td>
<td>95.83</td>
<td>.204</td>
</tr>
<tr>
<td>VSK</td>
<td>95.83</td>
<td>.204</td>
<td>100</td>
<td>.0</td>
</tr>
<tr>
<td>SP</td>
<td>91.66</td>
<td>.282</td>
<td>91.66</td>
<td>.282</td>
</tr>
</tbody>
</table>
Figure (7.1.) below represents the mean performance rates of the eight patients in the SPMT (6.2.1.1.). As expected, the control subjects performed at ceiling level (i.e. 100% accuracy) across both testing conditions. The repeated measures analysis has revealed a main effect for the subject variable ($F(8, 1094)=5.968, p<.0001$), as well as a significant interaction between the subject and the testing condition variable ($F(8, 1094)=1.993, p<.044$). The subject variable has mainly stemmed from the performance of the patients THP, DENT, and THR who were found to score significantly lower than the controls in the task, as well from the performance of the patient SP who has scored significantly lower than both the controls and the subjects VSK and THEX ($t(1094)=3.289, p<.001$ for the performance dissociation between THP and the controls, as well as between DENT and the controls, $t(1094)=3.256, p<.001$ for the performance dissociation between THR and the controls, $t(1094)=4.386, p<.0001$ for the performance dissociation between SP and the controls, and $t(1094)=2.402, p<.016$ for the performance dissociation between SP and VSK, and between SP and THEX). On the other hand, the significant interaction between the subject and the testing condition variable was attributable to the patient THR who was found to score significantly lower than the controls in the number condition ($t(1094)=4.652, p<.0005$).

<table>
<thead>
<tr>
<th></th>
<th>THP</th>
<th>DENT</th>
<th>THR</th>
<th>THEX</th>
<th>PAPAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>95.83</td>
<td>.204</td>
<td>91.66</td>
<td>.282</td>
<td></td>
</tr>
<tr>
<td></td>
<td>95.83</td>
<td>.204</td>
<td>91.66</td>
<td>.282</td>
<td></td>
</tr>
<tr>
<td></td>
<td>87.50</td>
<td>.337</td>
<td>100</td>
<td>.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>95.83</td>
<td>.204</td>
<td>100</td>
<td>.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>95.83</td>
<td>.204</td>
<td>95.83</td>
<td>.204</td>
<td></td>
</tr>
</tbody>
</table>
Figure 7.1. The aphasic subjects’ performances (%) in unambiguous antecedent identification across the number and the gender condition (SPMT).

7.1.1.1 Summary of the SPMT-Unambiguous pronoun resolution

The results from the present experiment cast some doubts on whether the capacity to retrieve the morpho-syntactic information (i.e. the number and the gender features) encoded on overt pronouns was spared for all the patients of our sample. The possibility that part of some of the patients’ grammatical knowledge was lost would have inevitably distorted their processing of subject pronouns in referentially ambiguous contexts in the tasks to come. Nevertheless, given that the scores of the patients SP, DENT, THP, and THR, who have exhibited a relatively outlying pattern of performance, were considerably above chance level (the lowest score being that of the patient THR, i.e. 87.50% for the number condition), we assume that the identification of the pronouns’ categorical information did not pose considerable difficulty at least to the greatest majority of the aphasic subjects during the process of reference assignment. This assumption is important as it claims that a generalized difficulty in retrieving the morpho-syntactic endowment of a pronoun can be excluded as a potential bias factor in shaping the aphasic subjects’ antecedent preferences in referentially ambiguous sentential contexts.
The self-paced listening sentence picture matching task

As already described in the ‘Subjects and Methodology’ chapter, the self-paced listening SPM experiment included two independent variables: (i) subject pronoun-type (two levels: null and overt), and (ii) antecedent-type (three levels: main clause subject, main clause object, and ‘other’ (meaning a referent not mentioned in the sentence). The dependent variable was the experimental subjects’ antecedent preferences for each type of pronoun measured by the number of their matching decisions for each of the following reference conditions:

- Null pronoun-main clause subject co-indexation
- Null pronoun-main clause object co-indexation
- Null pronoun-other co-indexation
- Overt pronoun-main clause subject co-indexation
- Overt pronoun-main clause object co-indexation
- Overt pronoun-other co-indexation

The primary aim of the task was to analyze the experimental subjects’ matching data in order to throw light on how discourse-level information interacts with grammatical choices in on-line sentence processing. To this end, we examined: (i) matching data across the six testing conditions, (ii) the correlation in performance between the matching rates and the RTs on the matching data and, (iii) the relationship between RTs on the verb following the critical pronoun in the overt pronoun condition and the time course of pronoun ambiguity resolution.

Given the moderate degree of individual variability observed in the aphasic sample’s matching data, we thought that the best way of analyzing the patients’ responses should probably be tailored to an analysis of each aphasic subject’s performance separately, such that each patient was treated as a
single-case study. Following this rationale, no merging of the aphasic data was run. Descriptive values for each condition are presented in Table 7.2.

Table 7.2. Controls’ and aphasics’ mean matching decision ratings (%) for all the conditions in the self-paced listening sentence-picture matching task.

<table>
<thead>
<tr>
<th>Participants</th>
<th>Mean Rating (%) null-subject</th>
<th>Mean Rating (%) null-object</th>
<th>Mean Rating (%) null-other</th>
<th>Mean Rating (%) overt-subject</th>
<th>Mean Rating (%) overt-object</th>
<th>Mean Rating (%) overt-other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>89 .180</td>
<td>57.07 .306</td>
<td>34.19 .199</td>
<td>38.11 .218</td>
<td>79.50 .289</td>
<td>41.34 .250</td>
</tr>
<tr>
<td>GCH</td>
<td>90 .316</td>
<td>30 .483</td>
<td>10 .316</td>
<td>70 .483</td>
<td>70 .483</td>
<td>10 .316</td>
</tr>
<tr>
<td>VSK</td>
<td>100 1</td>
<td>50 .527</td>
<td>10 .316</td>
<td>80 .421</td>
<td>80 .421</td>
<td>10 .316</td>
</tr>
<tr>
<td>SP</td>
<td>60 .516</td>
<td>70 .483</td>
<td>10 .316</td>
<td>30 .483</td>
<td>90 .316</td>
<td>60 .516</td>
</tr>
<tr>
<td>THP</td>
<td>80 .421</td>
<td>40 .516</td>
<td>0 .0</td>
<td>60 .516</td>
<td>90 .316</td>
<td>20 .421</td>
</tr>
<tr>
<td>DENT</td>
<td>90 .316</td>
<td>70 .483</td>
<td>50 .527</td>
<td>50 .527</td>
<td>90 .316</td>
<td>20 .421</td>
</tr>
<tr>
<td>THR</td>
<td>90 .316</td>
<td>20 .421</td>
<td>20 .421</td>
<td>40 .516</td>
<td>90 .316</td>
<td>50 .527</td>
</tr>
<tr>
<td>THEX</td>
<td>90 .316</td>
<td>50 .527</td>
<td>20 .421</td>
<td>40 .516</td>
<td>50 .527</td>
<td>10 .316</td>
</tr>
<tr>
<td>PAPAL</td>
<td>100 0</td>
<td>30 .483</td>
<td>20 .421</td>
<td>60 .516</td>
<td>100 0</td>
<td>60 .516</td>
</tr>
</tbody>
</table>

Detailed analyses of the performances of the controls and each aphasic individual in the present on-line task are presented below.
7.1.2.1. Matching data

<Controls>

Controls’ antecedent preference scores across the six testing conditions are represented in the Figure 7.2. below.

Figure 7.2. The controls’ performance (%) in the self-paced listening sentence-picture matching task.

The variance analysis performed on the controls’ merged responses has revealed a marginally significant pronoun-type (null vs. overt) by antecedent-type (subject, object, other) interaction ($F$(2, 894)=48.024, $p=.069$). The former effect has mainly stemmed from the “null pronoun-subject” reference condition which had significantly higher matching scores than the “null pronoun-other”, the “overt pronoun-subject”, and the “overt pronoun-other” condition ($t$(894)=2.361, $p<.02$ for all three dissociations), as well from the “overt pronoun-object” reference condition which had marginally higher scores relative to the “null pronoun-other”, the “overt pronoun-subject”, and the “overt pronoun-other” condition ($t$(894)=1.889, $p=.064$ for all the three dissociations). Further paired t-tests have revealed that the rate of the controls in the “null pronoun-other” condition was significantly lower relative to the “null pronoun-object” condition ($t$(894)= 2.641, $p<.02$). Finally, the controls were considerably more prone to interpret the critical subject pronoun as referring to the main clause subject when the pronoun was null rather than overt ($t$(894)=6.412, $p<.0001$), while they tended to interpret the pronoun as referring to the main clause object considerably more times when the pronoun was overt rather than null ($t$(894)=2.710,
No significant between pronoun-type dissociations were found for the extra-sentential/’other’ referents.

Figure 7.3. GCH’s performance (%) in the self-paced listening sentence-picture matching task.

The variance analysis performed on GCH’s matching scores revealed a main effect for the antecedent-type variable ($F(2, 54)=14.060, p<.0001$), as well as a significant pronoun by antecedent-type interaction effect ($F(2, 54)=7.120, p<.0001$). More specifically, the antecedent-type effect was attributable to the fact that the subject antecedent was preferred significantly more times than both the object and the ‘other’ referents ($t(54)=2.264, p<.02$ for the subject vs. object dissociation, and $t(54)=5.284, p<.0001$ for the subject vs. ‘other’ dissociation), while the object antecedent was preferred significantly more times than the ‘other’ antecedent ($t(54)=3.019, p<.003$). On the other hand, the reference condition effect has mainly stemmed from significant differences among the matching scores achieved across the six reference conditions.

What is of interest is that these dissociations were mainly reported for the conditions that included an extra-sentential referent across both pronoun types (i.e. null & overt). More specifically, GCH’s score in the “null pronoun-other” reference condition was found to be significantly lower relative to the “null pronoun-subject” ($t(54)=4.381, p<.0001$), the “overt pronoun-subject” ($t(54)=3.286, p<.002$),
and the “overt pronoun-object” reference condition (t(54)=3.286, p<.002). On the other hand, the patient’s score in the “overt pronoun-other” condition was significantly lower relative to the “null pronoun-subject” (t(54)=4.381, p<.0001), the “overt pronoun-subject” (t(54)=3.286, p<.002), and the “overt pronoun-object” condition (t(54)=3.286, p<.002). GCH’s matching score for the “overt pronoun-other” condition was also found to be significantly lower that that of the controls (10% vs. 41.80%, t(953)=2.055, p<.05). Furthermore, GCH’s rate for the “null pronoun-object” reference condition was found to be significantly lower relative to the “null pronoun-subject” (t(54)=3.286, p<.002), the “overt pronoun-subject” (t(54)=2.190, p<.04), and the “overt pronoun-object” reference condition (t(54)=2.190, p<.04). The “null pronoun-object” vs. “overt pronoun-object” dissociation (30% vs. 70%) is of great importance as it suggests that GCH’s ability to identify the distinct distributional properties of the two pronouns was relatively spared.

<VSK>

**Figure 7.4. VSK’s performance (%) in the self-paced listening sentence-picture matching task.**

The repeated measures analysis of VSK’s data has revealed a significant antecedent-type effect (F(2, 54)=23.429, p<.0001), as well as a main interaction effect for the antecedent and the pronoun-type variable (F(2, 54)=10.584, p<.0001). The antecedent-type effect was attributable to the fact that the subject and the object antecedents had a considerably greater influence on VSK’s matching decisions relative to the ‘other’ antecedent which was the least preferred (t(54)=2.090, p<.04 for the subject vs.
object dissociation, \( t(54) = 6.690, p < .0001 \) for the subject vs. other dissociation, and \( t(54) = 4.599, p < .0001 \) for the object vs. other dissociation).

On the other hand, the significant differences registered among VSK’s scores across the various reference conditions were largely due to his poor performance in the conditions establishing a co-referential link between the critical pronoun (null or overt) and an extra-sentential antecedent. More analytically, VSK’s score for the “null pronoun-other” condition was significantly lower than his scores for the “null pronoun-subject” \( (t(54) = 5.400, p < .0001) \), the “null pronoun-object” \( (t(54) = 2.400, p < .02) \), the “overt pronoun-subject” \( (t(54) = 4.200, p < .001) \), and the “overt pronoun-object” condition \( (t(54) = 4.200, p < .0001) \). On the other hand, the patient’s score for the “overt pronoun-other” reference condition was considerably lower than his scores for the “null pronoun-subject” \( (t(54) = 5.400, p < .0001) \), the “null pronoun-object” \( (t(54) = 2.400, p < .02) \), the “overt pronoun-subject” \( (t(54) = 4.200, p < .0001) \), and the “overt pronoun-object” reference condition \( (t(54) = 4.200, p < .0001) \). VSK’s score for the “overt pronoun-other” condition was also found to be significantly lower than that of the controls \( (10\% \text{ vs. } 41.80\%, t(953) = 2.055, p < .05) \). Finally, the patient’s matching score for the “null pronoun-subject” condition was significantly higher relative to the “null pronoun-object” condition \( (t(54) = 3.000 p < .005) \), while his score for the “overt pronoun-subject” condition was found to be significantly higher than that of the controls \( (80\% \text{ vs. } 38.11, t(953) = 2.422, p < .02) \).
The ANOVA analysis of SP’s matching ratings has revealed a significant antecedent-type effect ($F(2, 54)=5.011$, $p<.009$), as well as a main interaction effect for the antecedent and the pronoun-type variable ($F(2, 54)=4.133$, $p<.003$). More specifically, the object antecedent was found to be preferred considerably more times than both the subject and the extra-sentential referent ($t(54)=2.344$, $p<.02$ for the object vs. subject dissociation, and $t(54)=3.014$, $p<.003$ for the object vs. other dissociation).

With respect to the antecedent by pronoun-type interaction effect, this has mainly stemmed from SP’s low performance in the “null pronoun-other” condition. More specifically, the patient’s score for the specific condition was found to be significantly lower relative to the “null pronoun-subject” ($t(54)=2.500$, $p<.02$), the “null pronoun-object” ($t(54)=3.000$, $p<.005$), the “overt pronoun-object” ($t(54)=4.000$, $p<.0001$), and the “overt pronoun-other” reference condition ($t(54)=2.500$, $p<.02$). Especially, the significant “null pronoun-other” vs. “overt pronoun-other” performance dissociation indicates that SP was considerably more prone to accept an extra-discourse referent when the critical subject pronoun was overt rather than null.

Furthermore, SP showed rather unexpected performance in the “null pronoun-main clause subject” condition with his matching score being slightly lower than that for the “null pronoun-main clause object” condition (70% vs. 60%). In spite of the fact that this difference was not found to be
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statistically significant ($p=.343$), such a performance has motivated his classification as an outlier in the specific task. Finally, SP’s performance for the “overt pronoun-subject” condition was found to be significantly lower relative to the “overt pronoun-object” reference condition ($t(54)=3.000, p<.005$).

<THP>

Figure 7.6. THP’s performance (%) in the self-paced listening sentence-picture matching task.

Both the antecedent-type and the antecedent by pronoun-type interaction effects were found to be statistically significant ($F(2, 54)=11.976$, $p<.0001$, and $F(2, 54)=7.382$, $p<.0001$, respectively). According to the effect details analysis, the antecedent-type effect was mainly attributable to THP’s preference towards the subject and the object antecedents as the most plausible candidates for the resolution of the critical pronoun relative to the ‘other’ referent which was preferred the least ($t(54)=4.410$, $p<.0001$ for the subject vs. ‘other’ dissociation, and $t(54)=4.042$, $p<.0002$ for the object vs. other dissociation).

Likewise, the patient’s low scores for the testing conditions that resolved the critical subject pronoun by anchoring it to an extra-discourse referent appeared to contribute the most to the main effect for the antecedent by pronoun-type interaction. More analytically, THP’s score in the “null pronoun-other” reference condition was significantly lower relative to the “null pronoun-subject” ($t(54)=4.406$, $p<.0001$), the “null pronoun-object” ($t(54)=2.203$, $p<.04$, the “overt pronoun-subject”
(t(54)=3.304, p<.002), and the “overt pronoun-object” condition (t(54)=4.957, p<.0001). In fact, THP’s score for the “null pronoun-other” condition was the lowest relative to the rest of the antecedent conditions across both pronoun types. His score in the relevant condition was also found to be significantly lower than that of the controls (35.60% vs. 0%, t(953)=2.654, p<.01). Likewise, THP’s score in the “overt pronoun-other” condition was significantly lower relative to the “null pronoun-subject” (t(54)=3.304, p<.002), the “overt pronoun-subject” (t(54)=2.203, p<.04) and the “overt pronoun-object” condition (t(54)=3.855, p<.0005). Moreover, THP’s matching score in the “overt pronoun-object” condition was found to be significantly higher relative to the “null pronoun-object” reference condition (t(54)=2.753, p<.009).

<Figure 7.7. DENT’s performance (%) in the self-paced listening sentence-picture matching task.>

The antecedent-type and the antecedent by pronoun-type interaction effects were found to be statistically significant (F(2, 54)=5.326, p<.007, and F(2, 54)=3.788, p<.005, respectively). The inspection of the results has shown that the antecedent-type effect has emerged to a great extent from the fact that the subject and the object antecedents had considerably higher proportions of matching decisions than the ‘other’ referents (t(54)=2.417, p<.01 for the subject vs. other dissociation, and t(54)=3.107, p<.002 for the object vs. other dissociation).
With respect to DENT’s performance across the six reference conditions, the specific patient did perform higher in the “null pronoun-main clause subject” condition (90%). Nevertheless, the “null pronoun-subject” vs. “null pronoun-object” dissociation was not found to be significant (90% vs. 70%, p=.16). Surprisingly, although one would expect the extra-sentential referents to be avoided by the aphasic subject relative to the other two potential antecedents, the results did not exactly point towards this direction: DENT performed at chance level in the “null pronoun-other” condition. His score though was significantly lower relative to both the “null pronoun-subject” and the “overt pronoun-object” reference condition (t(54)= 2.028, p<.05, for both dissociations). On the other hand, the patient’s score for the “overt pronoun-other” condition was significantly lower relative to the “null pronoun-subject” (t(54)=3.549, p<.001), the “overt pronoun-object” (t(54)=3.549, p<.001) and the “null pronoun-object” condition (t(54)=2.535, p<.02). Moreover, DENT’s score for the “overt pronoun-subject” condition was found to be significantly lower than his scores for the “null pronoun-subject” and the “overt pronoun-object” condition (t(54)=2.028, p<.05 for both performance dissociations).

<THR>

Figure 7.8. THR’s performance (%) in the self-paced listening sentence-picture matching task.

The patient THR has exhibited high variance across the various reference conditions (F(2, 54)=5.545, p<.0003), which was an anticipated pattern of performance given the pronounced heterogeneity of his performance in the specific task. More analytically, his scores for the “null pronoun-object” and the “null
pronoun-other” conditions were found to be significantly lower relative to the “null pronoun-subject” and the “overt pronoun-object” condition ($t(54)=3.655, p<.0007$ for all dissociations). THR has also been found to reject the object antecedents in the null pronoun trials significantly more times than did the control subjects (20% vs. 57.40%, $t(953)=2.198, p<.04$). Likewise, his mean rating for the “overt pronoun-subject” reference condition was significantly lower relative to the “null pronoun-subject” and the “overt pronoun-object” condition ($t(54)=2.611, p<.02$ for both performance dissociations). Furthermore, THR’s score in the “overt pronoun-other” reference condition was slightly higher than his score in the “overt pronoun-subject” condition, though the difference was not found to be significant (50% vs. 40%, $p=.340$). The patient has also appeared to prefer subject antecedents more than the extra-sentential candidate referents, though the antecedent-type effect was not found to be statistically significant ($p=.087$).

\[<\text{THEX}>\]

**Figure 7.9. THEX's performance (%) in the self-paced listening sentence-picture matching task.**

![Graph showing performance percentages for subjects and THEX](image)

The repeated measures analysis of THEX’s matching scores has yielded a significant effect for the antecedent variable ($F(2, 54)=6.583, p<.003$), as well as a main effect for the antecedent by pronoun-type interaction ($F(2, 54)=3.933, p<.004$). The antecedent-type effect was due to the fact that the subject and the object antecedents were considerably more preferred relative to the extra-sentential
candidate referents ($t(54)=3.431, p<.001$ for the subject vs. other dissociation, and $t(54)=2.402, p<.01$ for the object vs. other dissociation).

With regard to the antecedent x pronoun-type effect, this was mainly due to THEX's score for the "null pronoun-subject" condition which was significantly higher than his scores for the "overt pronoun-other" ($t(54)=4.000, p<.0003$), the "null pronoun-other" ($t(54)=3.500, p<.001$), and the "overt pronoun-subject" condition ($t(54)=2.500, p<.02$). While THEX clearly opted for the subject antecedent in the null pronoun trials (90%), his antecedent preferences appeared to oscillate in the overt pronoun trials, with the overt subject pronouns referring either to the subject or the object antecedents (40% and 50%, respectively). Moreover, THR's mean rate for the 'other' referent was the lowest in the overt pronoun trials ($t(54)=2.445, p<.04$ for the "overt pronoun-object" vs. "overt pronoun-other" dissociation).

Finally, THEX's performance has been found to deviate from that of the controls in statistically significant ways only in the trials having an overt pronoun in subject position. More specifically, his matching scores for the "overt pronoun-other" and the "overt pronoun-object" condition were found to be significantly lower relative to the controls for the same testing conditions (10% vs. 41.80%, $t(953)=2.055, p<.05$ in the "overt pronoun-other" condition, and 50% vs. 41.8%, $t(953)=2.288, p<.03$ in the "overt pronoun-object" condition).

**<PAPAL>**

**Figure 7.10.** PAPAL’s performance (%) in the self-paced listening sentence-picture matching task.
The repeated measures analysis has revealed a marginally significant effect for the pronoun-type variable ($F(1, 54)=3.543$, $p=.064$), as well a significant effect for the antecedent-type, and the pronoun by antecedent-type interaction ($F(2, 54)=3.709$, $p<.03$, and $F(2, 54)=7.221$, $p<.0001$, respectively). The pronoun-type effect was attributable to the fact that PAPAL’s mean rate of matching decisions in the overt pronoun trials was relatively higher relative to the trials having a null pronoun in subject position ($t(54)=1.882$, $p=.064$). The antecedent-type effect was mainly due to the fact that the subject antecedent was much closer to PAPAL’s referential preferences relative to the ‘other’ candidate referent ($t(54)=2.695$, $p<.009$).

Finally, the pronoun by antecedent-type interaction effect stemmed from the fact that PAPAL’s scores in the “null pronoun-other”, the “null pronoun-object”, the “overt pronoun-other”, and the “overt pronoun-subject” conditions were significantly lower relative to the “null pronoun-subject” and the “overt pronoun-object” condition ($t(54)=4.508$, $p<.0001$, $t(54)=3.945$, $p<.0003$, $t(54)=2.255$, $p<.03$, and $t(54)=2.254$, $p<.03$ for the dissociations with both the “null pronoun-subject” and the “overt pronoun-object” condition). Moreover, the patient’s score for the “null pronoun-other” condition was significantly lower relative to the “overt pronoun-other” and the “overt pronoun-subject” condition ($t(54)=2.254$, $p<.03$ for both performance dissociations). As such, PAPAL was the only patient that has showed significant between pronoun-type dissociations for each of the three antecedent types.

### 7.1.2.1.1 Discussion

The heterogeneity registered for the aphasic performance in the specific task ranged from zero to marked depending on the testing condition. Figure 7.11. below illustrates the overall matching scores of the eight patients and the controls across the six co-reference conditions.
The ANOVA analysis with subjects, pronoun and antecedent-type as the repeated measures yielded no difference between the subjects or the way they were influenced by the type of the pronoun in subject position, but yielded a significant subject by antecedent-type interaction effect ($F(16, 1336)=2.347, p<.04$). This effect was largely attributable to the great number of dissociations between the controls and the aphasic individuals reported for the reference conditions with an ‘other’ antecedent across both pronoun-types (i.e. null and overt). More specifically, the controls were found to opt for the ‘other’ antecedent considerably more times than the patients GCH ($t(1336)=2.090, p<.03$), VSK ($t(1336)=2.090, p<.03$), THP ($t(1336)=2.090, p<.03$), and THEX ($t(1336)=1.742, p<.08$).

The ANOVA analysis has not yielded a main effect for the subject by pronoun-type by antecedent-type interaction ($p=.251$). In general, the “null pronoun-subject” and the “overt pronoun-object” co-reference conditions had higher matching scores than the “null pronoun-other”, the “overt pronoun-other”, the “null pronoun-object”, and the “overt pronoun-subject” co-reference conditions across both groups. Nevertheless, the greatest number of significant dissociations among the relevant conditions were registered for the aphasic group ($t(1336)=6.226, p<.0001$ for the “null pronoun-subject” vs. “null pronoun-object” dissociation, $t(1336)=10.255, p<.0000$ for the “null pronoun-subject” vs. “null pronoun-other” dissociation, $t(1336)=4.944, p<.0001$ for the “null pronoun-subject” vs. “overt pronoun-subject” dissociation, $t(1336)=8.423, p<.0001$ for the “null-pronoun subject” vs. “overt pronoun-other”...
dissociation, $t(1336)=5.493, p<.0001$ for the “overt pronoun-object” vs. “null pronoun-object” dissociation, $t(1336)=9.522, p<.0001$ for the “overt pronoun-object” vs. “null pronoun-other” dissociation, $t(1336)=4.211, p<.0001$ for the “overt pronoun-object” vs. “overt pronoun-subject” dissociation, and $t(1336)=7.691, p<.0001$ for the “overt pronoun-object” vs. “overt pronoun-other” dissociation for the aphasics, and $t(1336)=2.361, p<.02$ for the “null pronoun-subject” vs. “null pronoun-other” dissociation, $t(1336)=2.361, p<.02$ for the “null pronoun-subject” vs. “overt pronoun-subject” dissociation, $t(1336)=2.361, p<.02$ for the “null pronoun-subject” vs. “overt pronoun-other” dissociation, $t(1336)=1.889, p<.05$ for the “overt pronoun-object” vs. “null pronoun-other” dissociation, $t(1336)=1.889, p<.05$ for the “overt pronoun-object” vs. “overt pronoun-subject” dissociation, and $t(1336)=1.889, p<.05$ for the “overt pronoun-object” vs. “overt pronoun-other” dissociation for the controls).

What follows next is an overview of the parsing preferences of the aphasics and the language-unimpaired subjects registered for the intra-sentential referentially ambiguous contexts of the self-paced listening sentence-picture matching task. Parsing preferences across the two pronoun-type conditions (null vs. overt) take the form of orderings from strongest to mildest. The ‘>’ symbol was only used in case the difference was statistically significant ($p<.05$). In case it wasn’t, the ‘=’ symbol was used.

Table 7.3. The aphasics’ and the controls’ antecedent preferences across the null vs. overt pronoun condition (Self-paced Listening Sentence Picture Matching Experiment).

<table>
<thead>
<tr>
<th>Experimental Subjects</th>
<th>Null Subject Pronoun Condition</th>
<th>Overt Subject Pronoun Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCH</td>
<td>subject &gt; object = ‘other’</td>
<td>subject = object &gt; ‘other’</td>
</tr>
<tr>
<td>VSK</td>
<td>subject &gt; object &gt; ‘other’</td>
<td>subject = object &gt; ‘other’</td>
</tr>
<tr>
<td>SP</td>
<td>object = subject &gt; ‘other’</td>
<td>object &gt; subject = ‘other’</td>
</tr>
</tbody>
</table>
Overall, the performance of the aphasic patients was not considerably different from that of the controls, at least in the testing conditions involving a null pronoun in subject position. More specifically, all the patients (but SP) preferred to interpret the null subject pronoun as referring to the main clause subject, followed by the main clause object and the ‘other’ referent. In fact, the “null pronoun-main clause subject” co-reference condition was the only wherein both the control and the aphasic performances were positively correlated, since no significant dissociation was reported between the control group and any of the patients. This finding implies that the experimental subjects’ performances for the specific condition were more closely correlated relative to all the rest of the co-reference conditions. On the other hand, the aphasic and the control performance slightly differed in the overt pronoun trials. First, while the controls’ preference for the ‘other’ antecedents occupied the second position in the hierarchical ordering of their parsing preferences, all the aphasics (but patient THR who has exhibited the same performance with that of the controls) proved less prone to assign to the overt subject pronoun an antecedent which was not sententially-anchored. As such, the ‘other’ referent was classified as the least preferred antecedent for the overwhelming majority of the aphasic subjects. Furthermore, in contrast to the controls who have systematically treated the subject referent option as
the most *infelicitous* for the resolution of the overt subject pronoun relative to the rest of the candidate antecedents, the aphasic patients appeared to be less stable with respect to their matching decisions for the overt pronoun trials; half of the patients (i.e. GCH, VSK, DENT, and THEX) have considered the subject and the object antecedents as equally appropriate for the resolution of the overt subject pronoun, while three of the patients (i.e. SP, THP, and PAPAL) were found to prefer the object over the subject antecedent.

### 7.1.2.2 Reaction times on the matching data

The primary aim of the present analysis was to determine whether the parsing preferences established in the matching data would be validated by the experimental subjects’ RTs in the relevant co-reference conditions. More specifically, we expected the co-reference conditions, which were found to be close to the subjects' parsing preferences, to elicit shorter RTs relative to those that they weren’t. Within-subject paired t-tests were performed by taking into account the mean RTs of the subjects’ decisions for each reference condition within each of the two pronoun-type domains (null vs. overt). In addition, the participants’ RTs were tested statistically with a (repeated measures) ANOVA (and post-hoc analyses), so that the effect of the subject, the pronoun and the antecedent-type variable could be checked for significance. RTs were calculated for all trials.

Figures (7.12.-)(7.20.) demonstrate the RT dissociations registered among the testing conditions for each aphasic individual and the control group.

<Controls>

Figure (7.12.) below represents the controls’ (merged) mean RTs performed on their (mis)matching decisions for each reference condition.
The reference condition factor was found to have no significant effect on the control group’s RTs ($p=.407$). As expected, no main effect was found for either of the two variables (i.e. pronoun and antecedent-type). Most importantly, though, the controls’ RT pattern fitted their decisions made in the matching task. More specifically, the subject co-reference condition in the null pronoun trials was assumingly the easiest to parse, eliciting significantly shorter RTs than both the ‘object’ and the ‘other’ reference condition ($t(1914)=8.166$, $p<.001$ for the object vs. subject RT performance dissociation, and $t(1914)=7.225$, $p<.001$ for the other vs. subject RT performance dissociation). What should be mentioned, though, is that the mean RT difference between the ‘object’ and the ‘other’ reference condition was found to be marginally significant ($t(1914)=6.333$, $p=.065$), with the former eliciting longer RTs than the latter. With regard to the trials including overt pronoun subjects, the analysis revealed that the ‘object’ co-reference condition tended to elicit shorter RTs relative to both the ‘subject’ and the ‘other’ condition, yet, only the ‘subject’ vs. ‘object’ dissociation has reached significance ($t(1914)=7.054$, $p<.001$). The mean RT of the controls’ responses for the ‘subject’ co-reference condition was considerably slower relative to the ‘other’ reference condition. The specific dissociation, yet, was found to be marginally significant ($t(1914)=6.530$, $p=.060$).
The repeated measures analysis has revealed a significant effect for the pronoun-type ($F(1, 54)=12.680, p<.0008$) and the antecedent-type variable ($F(2, 54)=3.136, p<.05$), as well as a marginally significant interaction between the two variables ($F(2, 54)=2.580, p=.075$). The pronoun-type effect was due to the fact that the null pronoun trials have triggered significantly slower RTs than the overt pronoun trials (32.210 msecs vs. 14.308 msecs, $t(54)=3.561, p<.0008$), while the antecedent-type effect was attributed to the fact that the ‘subject’ antecedent tended to trigger considerably faster RTs than both the ‘object’ and the ‘other’ antecedent ($t(54)=2.071, p<.04$ for the subject vs. object RT dissociation, and $t(54)=2.255, p<.02$ for the subject vs. other RT dissociation). With respect to the marginally significant pronoun by antecedent-type interaction, this was attributed to the fact that the “null pronoun-object” condition tended to elicit significantly slower RTs than the “overt pronoun-object”, the “overt pronoun-subject” and the “null pronoun-subject” condition ($t(54)=3.692, p<.0005, t(54)=3.551, p<.0008$, and $t(54)=3.070, p<.003$, respectively).

Further paired t-tests have shown that GCH’s RT pattern corresponded to that expected by his matching rates. More specifically, GCH’s mean RTs for the “null pronoun-subject” co-reference condition were significantly shorter relative to the ‘other’ co-reference condition ($t(54)=3.065, p<.02$). On the other hand, the ‘other’ referent condition in the overt pronoun trials was found to elicit significantly higher RTs than the rest of the antecedent conditions ($t(54)=3.594, p<.006$ for the other vs. subject RT
dissociation, and \( t(54)=3.547, p<.007 \) for the other vs. object RT dissociation), while the time difference between the ‘subject’ and the ‘object’ reference condition was not found to be significant.

<VSK>

**Figure 7.14. VSK’s RTs (in msecs) in each testing condition in the self-paced listening sentence-picture matching task.**

The analysis of VSK’s RTs in the task has not revealed any significant effect across the testing conditions. As one can see from Figure (7.14.) above, the most evident characteristic of his RT pattern of performance was that his speed of reaction tended to slow down in the ‘other’ co-reference condition across both pronoun-types, and especially in the trials having a null pronoun in subject position.

VSK’s RT pattern validated his matching data mainly with respect to the null pronoun trials. More specifically, the specific patient has found the ‘subject’ reference condition as an easy to parse structure, such that his RTs for the specific condition were the shortest. Nevertheless, only the mean RT difference between the ‘subject’ and the ‘other’ condition has reached significance \( (t(54)=2.380, p<.05) \). On the other hand, his RT performance slightly deviated from his matching decisions in the overt pronoun trials, since he has found the ‘subject’ referent condition harder to decide than the ‘object’ referent condition. The reader is reminded that VSK has interpreted the overt pronouns as referring to either the subject or the object of the main clause; as such, both conditions were expected to elicit similar RTs. Finally, the ‘other’ referent condition in the trials having an overt pronoun subject has elicited the longest RTs in accordance to VSK’s matching data (10% mean score for the “overt
pronoun-other” reference condition). None of the aforementioned dissociations though has reached significance.

<SP>

Figure 7.15. SP's RTs (in msecs) in each testing condition in the self-paced listening sentence-picture matching task.

The repeated measures analysis performed on SP’s RT data revealed no main effect for the two variables (i.e. pronoun and antecedent-type). Nevertheless, what should be noted is that SP’s mean RTs performed on the null pronoun trials were higher relative to those elicited in the overt pronoun trials. Moreover, SP’s slightly stronger preference for the object (70%) over the subject (60%) antecedent in the null pronoun trials was confirmed by his RTs in the ‘object’ referent condition which were lower than the RTs in the ‘subject’ referent condition. Another interesting finding was that even the “null pronoun-other” co-reference condition has elicited shorter RTs than the “null pronoun-subject” condition. Nevertheless, none of the above dissociations was found to be statistically significant. Finally, SP’s RT performance in the overt pronoun trials completely contrasted his matching decisions; the ‘subject’ referent condition was the easiest to parse, followed by the ‘object’ (t(54)=2.270, p<.05), and the ‘other’ referent condition which was supposedly the hardest since it has yielded the slowest RTs (t(54)=2.960, p<.02).
Neither the antecedent nor the pronoun-type effect was found to be significant. Nevertheless, THP’s pattern of RT performance appeared to fit his matching data for both pronoun types. Pair-wise comparisons revealed the following orderings of RTs, from fastest to slowest in the null and the overt pronoun trials, respectively: subject<other<object, and object<subject<other. The only statistically significant differences though were the ones registered between the ‘subject’ and the rest of the antecedent conditions in the null pronoun trials ($t(54)=2.873, p<.02$ for the object vs. subject dissociation, and $t(54)=2.293, p<.05$ for the other vs. subject dissociation).

Figure 7.17. DENT’s RTs (in msecs) in each testing condition in the self-paced listening sentence-picture matching task.
The repeated measures analysis has not revealed a main effect for the two variables. In fact, DENT’s RT pattern was the opposite of what might have been expected from his matching decisions, mainly with regard to the RTs performed on the overt pronoun trials. First, while the ‘other’ referent condition in the null pronoun trials has elicited the highest RTs as predicted, the ‘subject’ co-reference condition was slower to respond relative to the ‘object’ condition. On the other hand, the paired t-tests performed on DENT’s RT data elicited from the three co-reference conditions in the overt pronoun trials revealed that the specific patient tended to respond significantly slower to the ‘object’ condition relative to the ‘subject’ co-reference condition ($t(54)=3.210, p<.02$). Moreover, DENT’s mean RTs performed on the ‘other’ referent condition were found to be significantly slower relative to the ‘subject’ referent condition ($t(54)=3.210, p<.02$). The latter RT pattern is consistent with DENT’s matching performance for the relevant co-reference conditions, since his mean matching score for the “overt pronoun-other” condition was significantly lower relative to the “overt pronoun-subject” condition (20% vs. 50%).

<THR>

Figure 7.18. THR’s RTs (in msecs) in each testing condition in the self-paced listening sentence-picture matching task.

The repeated measures analysis performed on THR’s RT data has revealed a marginally significant pronoun by antecedent-type interaction ($F(2, 54)=2.631, p=.071$). This effect was largely due to the fact that the “null pronoun-object” condition tended to elicit slower RTs than the “null pronoun-other” co-reference condition ($t(54)=2.271, p<.02$). Further paired t-tests have shown that THR’s RT ordering in
the null pronoun trials deviated from his matching decisions only with respect to the ‘other’ co-reference condition which was responded to faster than the ‘subject’ condition ($t(54)=2.411, p<.04$). With respect to the overt pronoun trials, the ‘object’ condition was found to elicit the shortest RTs, while the ‘other’ referent condition elicited slower RTs than the ‘subject’ condition. None of these differences though was found to be statistically significant.

The repeated measures analysis performed on THEX’s RT data revealed no main effect for the two testing variables. As exhibited by Figure (7.19.) above, THEX’s RT pattern was the opposite of what might have been expected from his matching decision rates across both pronoun types. More specifically, his RT orderings for the null and the overt pronoun trials, respectively, were the following (from faster to slower): other<object<subject, and other<subject<object. None of these dissociations was found to be statistically significant except from the one between the ‘subject’ and the ‘other’ referent condition in the overt pronoun trials ($t(54)=2.638, p<.03$).
As one can see from Figure (7.20.) above, PAPAL’s mean RTs were positively correlated across all the testing conditions. As expected, no main effect was found for the pronoun or the antecedent-type variable. PAPAL’s shortest and longest RTs were elicited from the ‘object’ and the ‘other’ co-reference condition, respectively, across both pronoun types. As such, his RT pattern didn’t seem to fit his matching data, especially with respect to his matching decisions in the null pronoun trials. Nevertheless, none of these dissociations was found to be statistically significant.

7.1.2.2.1 Discussion

The highly variable RT performances of the eight aphasic subjects in the present task required that the statistical analyses would treat the patients as separate single-case studies rather than a group on the basis of the patients’ merged RT data. Such a heterogeneity in the patients’ RTs was anticipated mainly due to the highly idiosyncratic factors affecting the aphasic RT performances, such as each patient’s aphasia-severity level, age or educational level influencing his speed of processing information (see ‘Discussion and Conclusions’ for a relevant analysis of the extra-linguistic factors assumed to mediate the aphasic performance in the tasks of the present study).

The repeated measures analysis has revealed significant effects for all the three individual variables and almost all the possible interactions between them. More specifically, there was a
significant effect for the subject variable ($F(8, 2346)=34.554, p<.0001$), for the pronoun-type and the antecedent-type variable ($F(1, 2346)=17.484, p<.0001$, and $F(2, 2346)=5.039, p<.006$, respectively), a significant subject by pronoun-type interaction ($F(8, 2346)=4.717, p<.0001$), a significant subject by antecedent-type interaction ($F(16, 2346)=1.674, p<.04$, and $F(2, 2346)=5.039, p<.006$, respectively), a significant subject by pronoun-type by antecedent-type interaction ($F(40, 2346)=1.710, p<.04$).

More analytically, the patients GCH, THP, THR, PAPAL, and DENT were found to react significantly slower than the controls across all the six reference conditions ($t(2346)=13.489, p<.000$, $t(2346)=10.876, p<.000$, $t(2346)=7.172, p<.0001$, $t(2346)=5.257, p<.0001$, and $t(2346)=3.233, p<.001$, respectively). Most importantly, the trials having a null subject were responded to significantly slower relative to the trials having an overt pronoun in subject position ($t(2346)=4.181, p<.0001$). In fact, the patients GCH, THP, THR, and PAPAL were found to respond significantly slower than the controls in the null pronoun trials relative to the overt pronoun trials ($t(2346)=13.468, p<.000$, $t(2346)=8.900, p<.000$, $t(2346)=5.423, p<.0001$, and $t(2346)=3.822, p<.0001$, respectively). The antecedent-type effect has mainly stemmed from the fact that the ‘subject’ antecedent has systematically triggered faster RTs relative to both the ‘object’ and the ‘other’ antecedent ($t(2346)=2.234, p<.02$ for the subject vs. object RT dissociation, and $t(2346)=3.070, p<.002$ for the subject vs. other RT dissociation). The antecedent by subject interaction was mainly attributable to the fact that the ‘subject’, the ‘object’ and the ‘other’ antecedent tended to elicit significantly slower RTs for the patients GCH, THP, and THR relative to the RTs of the control subjects for the three antecedent types ($t(2346)=4.592, p<.0001$ (subject), $t(2346)=4.955, p<.0001$ (object), and $t(2346)=9.607, p<.000$ (other) for GCH, $t(2346)=4.844, p<.0001$ (subject), $t(2346)=6.982, p<.0001$ (object), and $t(2346)=7.011, p<.0001$ (other) for THP, and $t(2346)=3.875, p<.0001$ (subject), $t(2346)=4.753, p<.0001$ (object), and $t(2346)=3.794, p<.0002$ (other) for THR). With respect to the antecedent by pronoun interaction, this was largely due to the fact that the “null pronoun-object” and the “null pronoun-other” reference condition have elicited significantly slower RTs than both the “overt pronoun-subject” and the “overt pronoun-object” condition ($t(2346)=4.014,$
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$p < .001$ for the null-object vs. overt-subject RT dissociation, $t(2346)=3.871$, $p < .001$ for the null-object vs. overt-object RT dissociation, $t(2346)=3.856$, $p < .0001$ for the null-other vs. overt-subject RT dissociation, and $t(2346)=3.713$, $p < .0002$ for the null-other vs. overt-object RT dissociation). Finally, the significant subject by pronoun by antecedent interaction effect was largely attributed to the fact that GCH’s RTs for the “null pronoun-subject”, the “null pronoun-other”, and the “overt pronoun-other” condition were significantly slower relative to the controls ($t(2346)=10.592$, $p < .000$, $t(2346)=9.008$, $p < .000$, and $t(2346)=4.579$, $p < .0001$, respectively). THP’s RTs for the “null pronoun-object” and the “null pronoun-other” condition were significantly slower than the controls ($t(2346)=6.170$, $p < .0001$, and $t(2346)=6.022$, $p < .0001$, respectively), and, finally, THR’s RTs for the “null pronoun-object” condition were significantly slower relative to the control group ($t(2346)=4.377$, $p < .0001$). Overall, what these findings appear to imply is that the conditions having a null pronoun in subject position taxed the aphasic parser considerably more relative to the language-unimpaired subjects of the study.

What follows next is an overview of the RT orderings (from fastest to slowest) for the aphasic patients and the controls across the various conditions. The ‘<’ symbol was only used in case the difference registered was statistically significant ($p < .05$). In case it wasn’t, the ‘=’ symbol was used.

**Table 7.4. The aphasics’ and the controls’ RT orderings across the null vs. overt pronoun condition (Self-paced Listening Sentence Picture Matching Experiment).**

<table>
<thead>
<tr>
<th>Experimental Subjects</th>
<th>Null Subject Pronoun Condition</th>
<th>Overt Subject Pronoun Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCH</td>
<td>subject &lt; object = 'other'</td>
<td>object = subject &lt; 'other'</td>
</tr>
<tr>
<td>VSK</td>
<td>subject &lt; object &lt; 'other'</td>
<td>object &lt; subject &lt; 'other'</td>
</tr>
<tr>
<td>SP</td>
<td>subject = object = 'other'</td>
<td>subject &lt; object &lt; 'other'</td>
</tr>
<tr>
<td>THP</td>
<td>subject &lt; object = 'other'</td>
<td>subject = object = 'other'</td>
</tr>
<tr>
<td>DENT</td>
<td>object = subject = 'other'</td>
<td>subject &lt; object = 'other'</td>
</tr>
</tbody>
</table>
Overall, besides the significant quantitative differences between the controls and the eight aphasic patients, the latter have demonstrated important qualitative differences from the control group with respect to the ordering of their RTs weighed by the pronoun and the antecedent-type variable, with the greatest disparity being reported for the null pronoun co-reference conditions. More specifically, as one can see from Table 7.4., the ordering of RTs (from fastest to slowest) for the controls in the null and the overt pronoun trials was subject < other < object, and object = other < subject, respectively. On the other hand, the “null pronoun-subject” and the “null pronoun-object” co-reference conditions have elicited the shortest and the longest RTs, respectively, only in three of the patients. Likewise, the “null pronoun-other” condition tended to elicit the second shortest RTs in three aphasic patients. Generally speaking, the aphasic subjects’ (mis)matching decisions in the null pronoun trials appeared to be underspecified with respect to the RTs they have triggered, such that no clear tendency emerged with respect to the way the antecedent variable has slowed down or accelerated the aphasics’ matching decisions. It appears that the individuals with aphasia did not exert more or less effort as the compatibility of the null pronoun trials with their parsing preferences decreased or increased. If we assume that the trials having a null pronoun in subject position were the most demanding for the aphasics (as reflected by the fact that they have yielded significantly higher RTs relative to the trials with the overt pronoun), their unsystematic RT performance registered for the relevant conditions could be accounted for in terms of a resource-allocational difficulty. Many studies of experimental literature demonstrate that individuals with aphasia have difficulty monitoring their own performance in

<table>
<thead>
<tr>
<th>THR</th>
<th>'other' &lt; subject = object</th>
<th>object = subject = 'other'</th>
</tr>
</thead>
<tbody>
<tr>
<td>THEX</td>
<td>'other' = object = subject</td>
<td>'other' = subject &lt; object</td>
</tr>
<tr>
<td>PAPAL</td>
<td>object = subject = 'other'</td>
<td>object = subject = 'other'</td>
</tr>
<tr>
<td>Control Group</td>
<td>subject &lt; 'other' &lt; object</td>
<td>object = 'other' &lt; subject</td>
</tr>
</tbody>
</table>
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demanding tasks, appropriately evaluating the tasks’ demands, and, thus, allocating a sufficient amount of resources to the task requirements (Murray, Holland & Beeson, 1997; Tseng, McNeil & Milenkovic, 1993).

With regard to the overt pronoun trials, the aphasics’ RTs displayed a more clear-cut effect for the antecedent-type variable during their (mis)matching decisions, with the “overt pronoun-other” condition eliciting the longest RTs in six of the patients, the “overt pronoun-object” condition yielding the shortest RTs in five of the patients, and the “overt pronoun-subject” condition eliciting the second fastest RTs in six of the patients. As such, the ‘object’ and (at a secondary level) the ‘subject’ antecedent candidate appeared to be most close to the parsing preferences of the overwhelming majority of the aphasic patients. The crucial point, thus, that differentiated the two groups’ RT performances in the overt pronoun trials was the ‘other’/extra-sentential antecedent-type which was almost always responded to slower by the aphasics (relative to the controls), thus, implying that the patients faced excessive difficulty when processing referential structures wherein the overt subject pronoun was co-indexed with an entity that did not belong to the mental model of the sentence. In sum, the RTs of the aphasic individuals’ (mis)matching decisions for the overt pronoun trials suggest that the patients had less difficulty monitoring their performance, evaluating the demands of each reference condition having an overt pronoun in subject position, and, thus, allocating an amount of resources analogous to their parsing preferences.

7.1.2.3 Reaction times on the subordinate verb in the overt pronoun trials

The aim of the specific analysis was to look for any evidence of early preferences during the resolution of the overt subject pronoun. Our prediction was that if the [+Topic-Shift] feature grammatically encoded in the overt subject pronoun got activated as early as right after the offset of the overt pronoun at the area of the subordinate verb, this would be reflected in significantly shorter RTs in the trials wherein the
pronoun was antecedced by the main clause object relative to the trials wherein the pronoun was resolved by the main clause subject or an extra-sentential entity. Early emergence of grammatical constraints in the time course of pronoun ambiguity resolution would be in favour of the assumption that the aphasics’ access to interface-conditioned constraints is spared and that they still have access to the discourse-related features marking the overt subject pronoun.

<Controls>

Figure (7.21.) below presents controls’ mean (merged) RTs performed on the subordinate verb in the overt pronoun trials for each of the three antecedent types (i.e. subject, object, other).

Figure 7.21. The controls’ mean RTs (in msecs) on the subordinate verb in the overt pronoun trials of the self-paced listening sentence-picture matching task.

The repeated measures analysis showed no main effect for the antecedent-type variable ($p=.735$), in other words, there was no evidence for early preferences in the control group.
Figures (7.22.) & (7.23.) below display the mean RTs of each of the eight aphasic subjects and the aphasic group, respectively, at the region of the subordinate verb across the three distinct co-reference conditions in the overt pronoun trials.

Figure 7.22. The aphasic patients’ mean RTs (in msecs) on the subordinate verb in the overt pronoun trials of the self-paced listening sentence-picture matching task.

No main effect for the antecedent-type variable was found for any of the aphasic patients or the aphasic group (on the basis of the eight aphasics’ merged RTs). Nevertheless, paired t-tests performed on the aphasics’ merged RT data has found the effect to be marginally significant ($p=.077$). As one can see from Figure (7.23.) below, the RTs of the aphasic group in the subordinate verb region for the “overt pronoun-object” co-reference condition were shorter than the RTs for the “overt pronoun-subject” condition in the same region.
7.1.2.3.1 Discussion

According to the RT data analysis, the control group showed no evidence for early preferences during the processing of overt subject pronouns in the referentially ambiguous intra-sentential contexts. On the contrary, the merged RTs of the aphasic patients provided marginally significant evidence in favour of early preferences based on grammatical constraints. While this finding provides support in favour of the assumption that the aphasic subjects had the grammar of null and overt pronouns (i.e. overt pronouns are pragmatically marked in NSLs), the lack of relevant evidence from each patient’s RTs individually prevents us from drawing any safe conclusions with respect to the significance of this interaction between timing and grammatical principles.

7.1.2.4 Summary of results of the self-paced listening sentence picture matching experiment

All the aphasic subjects (except from the patient SP) and the control group showed aspects of the performance pattern predicted by the universally default parsing hypothesis (Cardinaletti & Starke, 2001) whereby the preferred antecedent in referentially unspecified contexts (i.e. when the subject pronoun is null) is the one in subject position. In fact, four patients, namely DENT, THR, THEX, and
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PAPAL (along with the controls) tended to opt for the subject antecedent considerably more times when the subject pronoun was null rather than overt. Moreover, four aphasic patients, namely SP, THP, THR, and PAPAL, appeared to be sensitive to the marked pragmatic status of the overt subject pronouns by interpreting them as referring to the main clause object significantly more times than did when the subject pronoun was null. As such, the specific aphasics’ performance in reference resolution was similar to the controls’ parsing choices, meaning that it was determined by the markedness and the interface features specified in the grammar of NSLs. However, five of the aphasics (namely, the patients GCH, VSK, THP, DENT, and THEX) differed from the control subjects in their preference rates for the ‘other’ referent provided by the overt pronoun paradigm, since they tended to prefer it much less than the controls. This pattern of performance in the aphasics may be attributable to the higher processing cost inflicted by enlarging the mental model construed. Even in the cases in which the pronoun was anteceded by an extra-sentential referent, the pronominal was most of the times overt rather than null (see the performance of the patients SP and PAPAL).

With respect to the RTs of the patients’ (mis)matching decisions across the six reference conditions, the overwhelming majority of the aphasics were found to respond significantly slower than the controls in the null pronoun trials, with the gap becoming even more pronounced in the “null pronoun-object” reference condition. Indeed, the aphasics showed a relatively inconsistent pattern of performance in the null pronoun trials, with their RTs exhibiting no main effect for the antecedent variable. On the other hand, their RTs registered for the overt pronoun trials appeared to agree with their (mis)matching decisions, with the object antecedent eliciting the fastest RTs followed by the subject antecedent. Furthermore, six of the patients (namely, GCH, VSK, SP, THP, THR, and PAPAL) appeared to have greater difficulty with the reference condition having an extra-sentential referent which was reflected in their slower RTs in the relevant condition. Finally, there was no evidence of early emergence of grammatical constraints during the processing of the overt subject pronoun, at least at the individual aphasic level.
7.1.3 The Self-Paced Listening Antecedent Identification Experiment

The aim of the specific experiment was to investigate both pronoun and word-order effects on pronoun ambiguity resolution in referentially ambiguous inter-sentential contexts. More specifically, pronoun antecedent preferences weighed by structural factors were tested by manipulating the position of the subject constituent, i.e. by placing it either pre-verbally or post-verbally. Evidence from free word-order languages (e.g. Bouma & Hopp, 2007 for German; Miltsakaki, 2002 for Greek, a.o.) refutes word-order based proposals and supports instead the effect of the grammatical role of subjecthood in ambiguous pronoun interpretation.

The present task aimed at exploring the influence of the word-order variable on ambiguous pronoun interpretation in both the fifteen language-unimpaired controls and the eight aphasic subjects whose implementation of syntactic operations over long-distance dependencies is assumingly impaired. In addition, the pronoun-type variable (null vs. overt subject pronouns) was manipulated in the experimental stimuli in order to address the interface-conditioned aspects of pronominal processing. As such, the specific methodological design allowed us to explore both the effect of grammatical constraints on parsing referentially ambiguous sentences, as well as its possible interaction with syntactic operations reflected in subjecthood. To this end, we analyzed both data derived from the experimental participants’ antecedent choices as well as their RTs on the verb after the critical pronoun in the overt pronoun trials in order to check whether the non-canonical OcIVS word order taxed the experimental participants’ processing resources more than the the canonical SVO word order.
7.1.3.1 Antecedent choices

The self-paced listening antecedent identification experiment included two independent variables: (i) subject pronoun (two levels: null & overt), and (ii) word-order (two levels: SVO & OcI/VS). The dependent variable was the participants' preference for the subject antecedent located in the first clause of the two-discourse set of each trial measured by the number of times the participants picked the syntactic subject in each of the following testing conditions:

- Pre-verbal subject, null pronoun subject
- Pre-verbal subject, overt pronoun subject
- Post-verbal subject, null pronoun subject
- Post-verbal subject, overt pronoun subject

Following this rationale, no merging of the aphasic data was run. Descriptive values for each condition are presented in Table 7.5.

Table 7.5. Controls' and aphasics' mean subject antecedent ratings (%) of all the conditions in the self-paced listening antecedent identification task.

<table>
<thead>
<tr>
<th>Participants</th>
<th>Mean Rating (%)</th>
<th>Mean Rating (%)</th>
<th>Mean Rating (%)</th>
<th>Mean Rating (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SVO-null pronoun</td>
<td>OclVS-null pronoun</td>
<td>SVO-overt pronoun</td>
<td>OclVS-overt pronoun</td>
</tr>
<tr>
<td>Controls</td>
<td>58.33 .417</td>
<td>25 .477</td>
<td>29.16 .500</td>
<td>20.83 .499</td>
</tr>
<tr>
<td>GCH</td>
<td>87.50 .337</td>
<td>79.16 .414</td>
<td>50 .510</td>
<td>29.16 .464</td>
</tr>
<tr>
<td>VSK</td>
<td>83.33 .380</td>
<td>62.50 .494</td>
<td>54.16 .508</td>
<td>79.16 .414</td>
</tr>
<tr>
<td>SP</td>
<td>54.16 .508</td>
<td>41.66 .503</td>
<td>37.50 .494</td>
<td>58.33 .503</td>
</tr>
<tr>
<td>THP</td>
<td>83.33 .380</td>
<td>75 .442</td>
<td>58.33 .503</td>
<td>62.50 .494</td>
</tr>
<tr>
<td>DENT</td>
<td>75 .442</td>
<td>62.50 .494</td>
<td>45.83 .508</td>
<td>37.50 .494</td>
</tr>
<tr>
<td>THR</td>
<td>87.50 .337</td>
<td>62.50 .494</td>
<td>62.50 .494</td>
<td>58.33 .503</td>
</tr>
<tr>
<td>THEX</td>
<td>58.33 .503</td>
<td>50 .510</td>
<td>37.50 .494</td>
<td>50 .510</td>
</tr>
<tr>
<td>PAPAL</td>
<td>91.66 .282</td>
<td>87.50 .337</td>
<td>54.16 .508</td>
<td>50 .510</td>
</tr>
</tbody>
</table>
Detailed analyses of the performances of the controls and each aphasic individual in the present on-line task are presented below.

<Controls>

The control group’s (merged) mean preference scores (%) across the four testing conditions are represented in Figure (7.24.) below. The reader is reminded that the dependant variable in the task was the participants’ preference for the subject antecedent measured by the number of times the participants chose the subject antecedent as the pronoun’s most felicitous referent.

**Figure 7.24. The control group’s performance (%) in the self-paced listening antecedent identification task.**

As one can see from Figure (7.24.), the controls tended to opt for the object antecedent in all testing conditions except from the one having a null pronoun and the subject in pre-verbal position. The repeated measures analysis performed on the control subjects’ merged scores has revealed a significant effect for the pronoun-type variable ($F(1, 1531)=27.776, p<.02$), as well as a marginally significant effect for the word-order variable ($F(1, 1531)=13.186, p=.077$). The two effects stemmed from the control subjects’ marked tendency to opt for the subject antecedent considerably more times when the pronoun was null rather than overt ($t(1531)=2.231, p<.02$), as well as when the subject was placed pre-verbally rather than post-verbally ($t(1531)=1.784, p=.077$). As expected, paired t-tests revealed that the control subjects preferred to interpret the null pronoun as referring to the subject...
considerably more times in the SVO than in the OclVS word-order condition ($t(1531)= 8.077, p<.005$).

No word-order effect bias was found for the overt pronoun trials, whereby the controls tended to interpret the pronoun as referring to the object irrespective of whether the subject was pre-verbal or post-verbal ($p=.327$). Moreover, the controls’ performance has exhibited a significant between pronoun-type dissociation within the SVO word-order condition, such that the pronoun guided reference towards the subject significantly more times when the pronoun was null rather than overt ($t(1531)= 8.391, p<.003$). No pronoun-type dissociation was found for the OclVS condition, since both the null and the overt pronoun subjects tended to refer to the CLLDed object.

<GCH>

Figure 7.25. GCH’s performance (%) in the self-paced listening antecedent identification task relative to the controls.

GCH’s tendency to opt for the subject antecedent was clearly associated with the syntactic position of the grammatical subject. More specifically, the variance analysis performed on GCH’s antecedent identification decisions has revealed a main effect for the word-order variable ($F(1, 92)=4.474, p<.03$), as well as a significant pronoun by word-order interaction ($F(3, 92)=6.443, p<.01$). The word-order variable was due to the fact that GCH tended to opt for the subject antecedent significantly more times when the subject was placed pre-verbally rather than post-verbally ($t(92)=2.115, p<.03$). Indeed, GCH’s scores in the SVO-null pronoun and SVO-overt pronoun condition were found to be significantly higher
relative to the OclVS-null pronoun and the OclVS-overt pronoun condition, respectively ($t(92)=3.714, p<.001$, and $t(92)=4.795, p<.0001$, respectively). In fact, GCH’s subject antecedent rates for the conditions having the subject in pre-verbal position were found to be significantly higher relative to the controls ($t(1623)=2.356, p<.02$ for the performance dissociation between the controls and GCH in the SVO-null pronoun condition, and $t(1623)=4.375, p<.0001$ for the performance dissociation between the controls and GCH in the SVO-overt pronoun condition). The significant pronoun by word-order interaction effect stemmed from the fact that the subject antecedent rates in the SVO-overt pronoun condition were considerably higher relative to the OclVS-overt pronoun condition ($t(92)=3.290, p<.001$).

Finally, paired t-tests run on GCH’s scores in the OclVS-null pronoun and OclVS-overt pronoun condition have revealed that the pronominal subject was interpreted as referring to the subject considerably less times when the pronoun was overt rather than null ($t(92)=2.460, p<.02$).

<VSK>

**Figure 7.26.** VSK’s performance (%) in the self-paced listening antecedent identification task relative to the controls.

VSK’s tendency to opt for the subject antecedent was most pronounced in the SVO-null pronoun and the OclVS-overt pronoun condition. More analytically, the repeated measures analysis has revealed a significant effect for the pronoun-type variable ($F(1, 92)=95.640, p<.0001$) which was due to the fact that the subject antecedent was opted by the patient considerably more times when the pronoun was
overt rather than null ($t(92)=9.779$, $p<.0001$). Further paired t-tests, though, have shown that the pronoun-type effect was modulated by the word-order factor; overt pronouns were found to be anteceded by the subject considerably more times relative to the null pronouns only in the OclVS condition ($t(92)=2.768$, $p<0.01$), wherein null pronouns appeared to be neutral (54.16%) with respect to their preferred antecedent. On the contrary, null pronouns in the SVO trials were resolved by the syntactic subject considerably more times relative to the overt pronoun ($t(92)=2.460$, $p<.02$). GCH’s rates for the overt pronoun across both the SVO and the OclVS word-order condition were significantly higher relative to the control subjects ($t(1623)=2.768$, $p<.008$ for the performance dissociation between the controls and VSK in the SVO-overt pronoun condition, and $t(1623)=4.870$, $p<.0001$ for the performance dissociation between the controls and VSK in the OclVS-overt pronoun condition). Further pair-wise analyses have shown significant between word-order type dissociations, whereby null pronouns tended to be anteceded by the subject considerably more times when the subject was pre-verbal rather than post-verbal ($t(92)=3.077$, $p<.005$), and overt pronouns tended to be resolved by the subject considerably less times when the latter was pre-verbal rather than post-verbal ($t(92)=2.144$, $p<.05$).

<SP>

**Figure 7.27.** SP’s performance (%) in the self-paced listening antecedent identification task relative to the controls.
As one can see from Figure (7.27.), the critical pronoun across both word-order conditions appeared to be underspecified with respect to its preferred antecedent, except maybe from the null pronouns in the OclVS word-order condition which have demonstrated a more robust tendency to refer back to the object antecedent. More analytically, there was no main effect found for the two variables (i.e. word-order and pronoun-type). Nevertheless, paired t-tests performed on the specific aphasic's antecedent identification decisions have shown that the overt pronoun was interpreted as referring to the subject more times when the latter was situated post-verbally rather than pre-verbally ($t(92) = 2.144$, $p < .04$). In fact, SP was found to score higher than the controls in the overt pronoun-OclVS condition ($t(1623) = 2.815$, $p < .007$). No significant between-pronoun type dissociation was found for the SVO trials, wherein the subject and the object antecedent were relatively randomly assigned to the pronoun regardless of the latter's form. The overt pronoun in the OclVS trials, yet, was more often interpreted as referring to the post-verbal subject than did the null pronoun which tended to refer to the object ($t(92) = 2.460$, $p < .02$).

<THP>

Figure 7.28. THP's performance (%) in the self-paced listening antecedent identification task relative to the controls.

As one can see from Figure (7.28.), the critical pronoun tended to be anteceded by the subject at an above chance level across all the four testing conditions. More specifically, the repeated measures
analysis has revealed no main effect for the two variables. Nevertheless, according to the results of the paired t-tests run on THP’s rates, the dissociation between the SVO-null pronoun and the OclVS-null pronoun condition was found to be significant ($t(92)=2.768$, $p<.01$). More specifically, null pronouns tended to be anteceded by the grammatical subject considerably more times when the latter was pre-verbal rather than post-verbal. On the other hand, the subject pronoun in the overt pronoun conditions was found to be interpreted as referring to the subject more times in the SVO rather than in the OclVS condition (the dissociation, yet, was marginally significant, $t(92)=1.812$, $p=.073$). No pronoun-type effect was found for the two word-order conditions, since the pronominal was co-indexed more times to the subject irrespective of the form of the subject pronoun in the SVO items, while the object antecedent was preferred slightly more than the subject in the OclVS trials across both the null and the overt pronoun condition. THP was also found to score higher than the controls across all testing conditions except from the one having null pronouns and the subject in pre-verbal position ($t(1623)=3.915$, $p<.0003$ for the performance between the controls and THP in the SVO-overt pronoun condition, $t(1623)=2.085$, $p<.04$ for the performance between the controls and THP in the OclVS-null pronoun condition, and $t(1623)=3.162$, $p<.002$ for the performance between the controls and THP in the OclVS-overt pronoun condition).

<Figure 7.29. DENT’s performance (%) in the self-paced listening antecedent identification task relative to the controls.>

![Graph showing DENT's performance compared to controls for different word-order and pronoun conditions.](image-url)
As one can see from Figure (7.29.), both null and overt pronouns tended to refer more to the subject in the SVO condition and slightly more to the object in the OclVS condition. The repeated measures analysis has revealed a significant word-order effect \((F(1, 92)=4.197, p<.04)\), such that the pronoun tended to be resolved by the subject antecedent significantly more times in the SVO condition irrespective of the type of the pronoun \((t(92)= 3.077, p<.005\) for the SVO vs. OclVS dissociation in the null pronoun trials, and \((t(92)= 2.768, p<.01\) for the SVO vs. OclVS dissociation in the overt pronoun trials). Further paired t-tests have shown that DENT’s preference for the subject antecedent in the SVO-null pronoun condition was significantly higher relative to the OclVS-null pronoun and the OclVS-overt pronoun condition \((t(92)=2.070, p<.05,\) and \((t(92)=2.672, p<.009,\) respectively). Finally, patient DENT was found to score higher than the controls only in the SVO-overt pronoun condition \((t(1623)=2.768, p<.008)\).

Figure 7.30. THR’s performance (%) in the self-paced listening antecedent identification task relative to the controls.

The ANOVA analysis performed on THR’s data has yielded no main effect for the two variables. His preference rates for the subject antecedent were above chance level \((\geq 58.33\%)\) across all four testing conditions. Nevertheless, paired t-tests revealed that pronouns tended to be anteceded by the subject considerably more times in the SVO condition, yet, only when the critical pronoun was null \((t(92)=\)
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2.768, p<.01). A between-pronoun type dissociation has also been found for the SVO trials, with the null pronoun being interpreted as referring to the subject more times than the overt pronoun (t(92)=2.768, p<.01). On the other hand, the rates for the two pronoun types in the OclVS trials were almost equal, both of them referring to the subject more times than the object. As such, the pronoun-type effect was not statistically significant for the OclVS discourses (p=.327). Finally, THR was found to score significantly higher than the controls across all four testing conditions (t(1623)=2.356, p<.02 for the performance dissociation between the controls and THR in the SVO-null pronoun condition, t(1623)=2.768, p<.008 for the performance dissociation between the controls and THR in the SVO-overt pronoun condition, t(1623)=2.407, p<.02 for the performance dissociation between the controls and THR in the OclVS-null pronoun condition, and t(1623)=2.815, p<.007 for the performance dissociation between the controls and THR in the OclVS-overt pronoun condition).

As one can see from Figure (7.31.), THEX appeared to perform at/near chance level across all testing conditions except from the one having null pronouns and the grammatical subject in pre-verbal position, whereby the pronoun was antecedced by the subject slightly more times relative to the object antecedent.
THEX was not found to be significantly affected by the variations in the task’s testing conditions. Nevertheless, paired t-tests have shown that the null pronoun tended to guide preference towards the subject considerably more times when the latter was situated pre-verbally rather than post-verbally ($t(92)= 2.460, p<.02$). On the other hand, THEX’s pattern of performance across both the SVO and the OclVS trials having an overt pronoun in subject position was the same: the subject and the object antecedents competed equally for the overt pronominal. Paired t-tests which were performed to check for any between-pronoun type dissociations within each of the two word-order conditions have not revealed any significant difference. Finally, THEX was found to score significantly higher than the controls only in the OclVS-overt pronoun condition ($t(1623)=2.171, p<.03$).

As one can see from Figure (7.32.), PAPAL’s preference for the subject antecedent was clearly associated with the pre-verbal position of the grammatical subject. No between-pronoun type dissociations emerged for any of the two word-order conditions; both the null and the overt pronoun tended to refer to the subject in the SVO discourses, while the subject-antecedent identification rates for both the null and the overt pronoun in the OclVS trials were at chance level, meaning that reference
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in the OclVS discourses was rather randomly assigned. More specifically, the ANOVA analysis has revealed a main effect for the pronoun variable \( (F(1, 92)=28.839, p<.0001) \) which has mainly stemmed from the patient’s tendency to opt for the subject antecedent when the pronoun was null rather than overt \( (t(92)=5.370, p<.0001) \). The pronoun-type effect though was also strongly modulated by the word-order factor \( (F(1, 92)=15.253, p<.0002) \), such that PAPAL’s subject antecedent identification rates for the SVO-null pronoun trials were significantly higher relative to the SVO-overt pronoun, the OclVS-null pronoun, and the OclVS-overt pronoun trials \( (t(92)=6.559, p<.0001, t(92)=3.452, p<.0008, \) and \( t(92)=4.487, p<.0001, \) respectively). Finally, PAPAL was found to score considerably higher than the controls in all the conditions except from the one having null pronouns and the subject in post-verbal position \( (t(1623)=2.828, p<.007 \) for the performance dissociation between PAPAL and the controls in the SVO-null pronoun condition, \( (t(1623)=5.501, p<.0001 \) for the performance dissociation between PAPAL and the controls in the SVO-overt pronoun condition, and \( t(1623)=2.171, p<.03 \) for the performance dissociation between PAPAL and the controls in the OclVS-overt pronoun condition).

7.1.3.1.1 Discussion

Figure (7.33.) below illustrates the subject-antecedent scores of the eight patients and the controls across the four testing conditions.

Figure 7.33. The performances/subject antecedent rates (%) of the eight aphasic patients and the control group in the self-paced listening antecedent identification task.
With respect to the non-merging analysis technique adopted for the aphasic subjects in the present task, it follows from the rationale whereby it would be inappropriate to merge the data of the eight patients due to the high variability observed across their performances. Instead, we maintained a case-study approach to the patients (as we did in the self-paced listening sentence-picture matching task, see 7.1.2.) so that findings from one patient could be compared to those of another patient, as well as to the control subjects.

The repeated measures analysis has revealed a main effect for the subject variable (\(F(8, 2267)=2.883, p<.002\)), as well a significant subject by pronoun-type interaction (\(F(8, 2267)=9.546, p<.0001\)), and a significant subject by word-order interaction (\(F(8, 2267)=2.337, p<.01\)). The subject effect stemmed from the fact that all the patients (but SP) tended to opt for the subject antecedent significantly more times than the controls across all four testing conditions (\(t(2267)=2.459, p<.01\) for the performance dissociation between GCH and the controls, \(t(2267)=2.459, p<.01\) for the performance dissociation between VSK and the controls, \(t(2267)=3.228, p<.001\) for the performance dissociation between THP and the controls, \(t(2267)=2.776, p<.005\) for the performance dissociation between DENT and the controls, \(t(2267)=4.765, p<.0001\) for the performance dissociation between THR and the controls, \(t(2267)=2.305, p<.02\) for the performance dissociation between THEX and the controls, \(t(2267)=2.152, p<.03\) for the performance dissociation between PAPAL and the controls).

The significant subject by pronoun-type interaction was largely attributable to the fact that all the aphasic individuals (but PAPAL) have opted for the subject antecedent significantly more times in the overt pronoun trials relative to the controls who tended to opt for the object antecedent (\(t(2267)=3.043, p<.002\) for the performance dissociation between GCH and the controls, \(t(2267)=6.521, p<.0001\) for the performance dissociation between VSK and the controls, \(t(2267)=2.730, p<.006\) for the performance dissociation between SP and the controls, \(t(2267)=3.043, p<.002\) for the performance dissociation between THP and the controls, \(t(2267)=2.826, p<.004\) for the performance dissociation between DENT and the controls, \(t(2267)=3.913, p<.0001\) for the performance dissociation between
THR and the controls, and \( t(2267)=2.826, p<.004 \) for the performance dissociation between THEX and the controls).

Finally, the significant subject by word-order interaction was largely due to the fact that six of the patients (namely, VSK, SP, THP, THR, THEX, and PAPAL) opted for the subject antecedent significantly more times in the OclVS word-order condition relative to the controls \( (t(2267)=1.956, p<.05 \) for the performance dissociation between VSK and the controls, \( t(2267)=2.206, p<.02 \) for the performance dissociation between SP and the controls, \( t(2267)=3.695, p<.0002 \) for the performance dissociation between THP and the controls, \( t(2267)=3.695, p<.05 \) for the performance dissociation between THR and the controls, \( t(2267)=1.956, p<.05 \) for the performance dissociation between THEX and the controls, and \( t(2267)=1.956, p<.05 \) for the performance dissociation between PAPAL and the controls). Moreover, three of the patients (namely, GCH, DENT, and THR) were found to opt for the subject antecedent significantly more times than the controls in the SVO word-order condition \( (t(2267)=1.956, p<.05 \) for the performance dissociation between GCH and the controls, \( t(2267)=2.173, p<.03 \) for the performance dissociation between DENT and the controls, and \( t(2267)=3.043, p<.002 \) for the performance dissociation between THR and the controls).

As such, the highest degree of homogeneity for the aphasic group was reported for the SVO-null pronoun condition, whereby the overwhelming majority of the patients have exhibited a tendency to opt for the subject antecedent (75%≥91.66%), while only two patients (namely, subjects SP and THEX) performed near chance level (54.16%, and 58.33%, respectively). With respect to the SVO-overt pronoun condition, five patients (namely, VSK, SP, DENT, THR, and THEX) performed near chance level (41.66%≥62.50%), while the subject antecedent was regarded as being the most felicitous antecedent for three of the patients (namely, GCH, THP, and PAPAL (75%≥87.50%). The overwhelming majority of the patients performed near chance level (45.83%≥62.50%) in the OclVS-null pronoun condition, while two of the patients (namely, SP and THEX) tended to choose the object antecedent (37.50% for both patients). Finally, the highest degree of variability in the aphasic group
was reported for the OclVS-overt pronoun condition wherein two of the patients (namely, THEX and PAPAL) performed exactly at chance level (50%), two of the patients (namely, GCH and DENT) tended to opt for the object antecedent (29.16%≥37.50%), and four of the patients (namely, subjects VSK, SP, THP, and THR) preferred to interpret the overt pronoun as referring to the subject antecedent (58.33%≥79.16%).

On the other hand, the control performance in the relevant conditions was distinct from that of the aphasic patients, such that the language-unimpaired subjects tended to opt for the subject antecedent considerably less times than the aphasics across all the testing conditions except from the one having null pronouns and pre-verbal subjects. More specifically, the controls’ preference rates for the subject antecedent were slightly above chance level (58.33%) in the SVO-null pronoun condition, with the subject antecedent rates considerably dropping in the discourses having overt subject pronouns or/and a CLLDed object. As such, the greatest performance gap between the controls and the aphasic subjects was reported for the experimental conditions having an overt pronoun in subject position, namely the SVO-overt pronoun and the OclVS-overt pronoun conditions, whereby controls tended to prefer a subject antecedent considerably less times than six of the patients (namely, the patients GCH, VSK, THP, DENT, THR, and PAPAL for the SVO-overt pronoun condition, and the patients VSK, SP, THP, THR, THEX, and PAPAL for the OclVS-overt pronoun condition). Performance dissociations between the controls and the aphasics were also reported for the OclVS-null pronoun subject condition whereby half of the patients (namely, the subjects VSK, THP, THR, and PAPAL) preferred to interpret the pronoun as referring to the subject considerably more times than the control group. Finally, the smallest dissociation between the controls and the aphasics was reported for the SVO-null pronoun condition whereby only three of the patients (namely, the subjects GCH, THR, and PAPAL) were found to opt for the subject antecedent significantly more times relative to the controls. On the basis of the aforementioned results, we could roughly claim that the patients that were most close to the controls’ pattern of performance were the patients SP and THEX.
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Overall, the aphasics and the control group have demonstrated some interesting differences with respect to their parsing preferences in the inter-sentential contexts. The first notable difference pertains to the fact that the aphasics tended to interpret the critical pronoun as referring to the subject significantly more times than the controls. In fact, such a pattern was reported for all but the SVO-null pronoun condition, whereby both the controls’ and the aphasics’ rates were relatively positively correlated. The fact, yet, remains that the null subject pronouns in the SVO-null pronoun trials appeared to be underspecified with respect to their preferred antecedent for the controls, such that their preference rate for the subject antecedent was slightly above chance level (58.33%). In contrast, the aphasics’ parsing preferences for the same condition were more robust, with null pronouns being systematically antecedced by the pre-verbal subject. Furthermore, the fact that the controls tended to interpret the overt pronouns as referring to the object considerably more times than the aphasics in the SVO-overt pronoun condition implies that the former were more sensitive to the discourse-marked status of the overt subject pronouns, at least when the subject was in pre-verbal position. (The reader is reminded that only two of the patients, namely VSK and THR, have exhibited a between-pronoun type dissociation in the SVO trials). On the other hand, the aphasics’ and the controls’ pattern of performance in the trials having the object in pre-verbal position suggests that both groups were affected by the change of the structural position of the subject, still, the syntactic position of the object appeared to be more relevant to pronoun resolution for the control subjects relative to the aphasis patients; controls tended to interpret the pronoun as referring to the CLLDed object considerably more times than the aphasics, who appeared to resolve both null and overt pronouns at random. This pattern suggests that the OclVS word-order was probably harder for the aphasics to process. Overall, subject prominence appeared to be defined in structural terms rather than in terms of grammatical function signalled by nominative case for the controls. On the other hand, the aphasics seemed to be less sensitive to the discourse-related features (i.e. topic-shift) associated with the overt subject pronouns,
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while the deviations from the canonical SVO word-order tended to decrease antecedent preference bias stemming from structural or discourse-derived factors.

7.1.3.2 Reaction times on the verb after the critical pronoun in the overt pronoun condition

The aim of the specific analysis was to check for any RT dissociations between the SVO and the OclVS word-order condition at the region of the verb right after the offset of the overt subject pronominal. Our hypothesis was that if the OclVS word-order posed greater processing load on the parser, this would be reflected in slower RTs relative to the RTs in the SVO condition. RTs were analyzed only for the responses wherein the experimental subjects interpreted the overt pronoun as referring to the object of the first clause.

Figure (7.34.) below gives an overall picture of the agrammatic’s and the control subjects’ RTs at the region of the verb after the critical pronoun across the SVO and the OclVS word-order condition for the overt pronoun trials.

Figure 7.34. The aphasics’ and the controls’ mean RTs (in msecs) on the verb of the second discourse in the overt pronoun trials of the self-paced listening antecedent identification task.
The within-subject item (F2) analyses have revealed a main effect for the word-order variable only for the patient GCH \((F2(1, 16)=6.363, p<.02)\), whose mean RTs for the SVO-overt pronoun condition were significantly slower relative to his mean RTs for the OclVS-overt pronoun condition \((981.67\text{ msecs vs. } 1530.25\text{ msecs}, t(16)= 6.363, p<.02)\). For the rest of the aphasic patients and the control group no significant RT dissociation has emerged between the two testing conditions. There was no effect found for the word-order variable in the aphasic group either \((p=.866)\) (see Figure 7.35, whereby the RTs of the aphasic patients have been merged).

**Figure 7.35. The aphasics’ and the controls’ (merged) mean RTs (in msecs) on the verb of the second discourse in the overt pronoun trials of the self-paced listening antecedent identification task.**

![Graph showing mean RTs for aphasics and controls](image)

7.1.3.3 Summary of the self-paced listening antecedent identification task

Summing up, the results of the aphasic and the control subjects in the self-paced listening antecedent identification task evince that the word-order (SVO vs. OclVS) and the pronoun-type (null vs. overt) variables were weighed differently by the two groups. More specifically, the control performance appeared to be constrained by both variables, i.e. positional factors and the pragmatically-marked status of the overt subject pronoun. As such, the highest preference for the subject antecedent was reported for the SVO-null pronoun condition (58.33%), while the rate dropped when the pronoun was overt or/and the object was topicalized through CLLD. In fact, the controls’ strongest preference for the
object antecedent (79.17%) was reported for the OclVS-overt pronoun condition, wherein both grammatical and structural variables were set to their [+marked] value, i.e. the subject pronoun was overt and the object was moved to pre-verbal position. In contrast, the aphasic parsing preferences appeared to be guided mainly by the structural position of the grammatical subject, with the pre-verbal position being a stabilizing factor of reference resolution in a maximally transparent interface between position and reference. As such, the highest rates for the subject antecedent were reported for the SVO testing conditions irrespective of the pronoun-type variable (79.16% for the SVO-null pronoun, and 66.66% for the SVO-overt pronoun condition). On the other hand, the aphasic performance rates dropped to chance levels when the patients were required to process referentially ambiguous OclVS inter-sentential contexts, suggesting that these structures were harder for them to process (Mean subject antecedent preference rates for the aphasic group: 50% for the OclVS-null pronoun, and 54.16% for the OclVS-overt pronoun condition). As such, the process of resolving ambiguous pronouns in inter-sentential contexts by means of relying on both structurally (i.e. CLLD of the object) and grammatically (i.e. marked status of the overt pronoun) determined operations was probably too demanding for the patients' non-fully active grammatical system. We assume that specific conditions of the task—more specifically, the ones involving a non-canonical OclVS word order—posed considerable difficulty to the aphasic parser, such that the patients either tended to assign subject and object antecedents to the critical pronoun at random (as registered for the OclVS-null pronoun trials) or preferred the 'default' choice, i.e. the syntactic subject (in the OclVS-overt pronoun trials). Finally, the analysis of the controls' and the aphasics' RTs at the region of the verb of the second discourse across the SVO-overt pronoun and the OclVS-overt pronoun condition has not provided strong evidence in favour of our initial hypothesis that the OclVS-overt pronoun condition would induce a greater processing cost on the human parser due to its non-canonical word-order.
7.2 THE INTERPRETATION AND PRODUCTION OF VERBS OF ALTERNATING TRANSITIVITY AT THE LEXICON-SYNTAX INTERFACE

7.2.1 The cross-modal lexical priming (CMLP) experiment

The general aim of the specific task was to offer psycholinguistic insights into the agrammatic processing of phonetically unrealized elements that are crucial for the interpretation of anti-causative verbs. The reader is reminded that the surface subjects of anti-causative verbs are underlyingly direct objects. As such, the thematic link between the verb and its argument is mediated by a post-verbal NP-trace. The co-reference between the antecedent and the trace triggers reactivation of the antecedent which has been found to take place 750 msecs after the trace position in language-unimpaired adults (Friedmann, Taranto, Shapiro & Swinney, 2008), and a short time following that position (more specifically, 150 msecs afterwards) for Broca’s aphasics (Burkhardt, Pinango & Wong, 2003).

The aforementioned experiments have offered converging evidence in favour of the distinct processing of the two verb classes, i.e. unergatives and anti-causatives by language-unimpaired and agrammatic populations, in the sense that antecedent re-activation has taken place in the latter but not in the former verb category. Furthermore, the data from the two patients with Broca’s aphasia in Burkhardt et al.’s study speaks in favour of an overall slowing down of the merge operations through which the dependency relation between the derived DP-subject and the post-verbal trace is instantiated in anti-causative verbs. In the present CMLP task we have replicated the same theoretical predictions, yet, we have made some modifications in the experimental stimuli. More specifically, apart from the morphological marking of certain Greek anti-causative verbs with the NACT suffix, voice alternations (ACT vs. NACT) of certain verbs of the ergative/ anti-causative class were also manipulated. Moreover, we have investigated the effect of the [±animacy] of the syntactic subject variable on the aphasics’
ability to disambiguate the meaning of both ACT and NACT anti-causative verbs during on-line sentence processing.

As with the previous tasks, the RT data from the real-time processing of unergative and anti-causative verbs was collected by the same participants, i.e. the eight Greek-speaking agrammatic patients and the fifteen language-unimpaired adults.

7.2.1.1 Norming of the data

Prior to the CMLP experiment, the experimental sentences with the ACT and the NACT anti-causative verbs were tested for acceptability through a paper and pencil questionnaire. The acceptability test was distributed to twenty native speakers of Greek (age 42–63, mean age: 51.1, S.D.: 3.2) who did not participate in any of the main tasks of this thesis. In total, the test included thirty-two experimental sentences (16 for the ACT anti-causative verb condition and 16 for the NACT anti-causative verb condition). The participants were asked to read each sentence carefully and to render scalar (1-5) acceptability judgements following the Likert-type scale below:

1. absolutely acceptable
2. acceptable on most occasions
3. occasionally acceptable
4. acceptable, yet, in rare contexts
5. not at all acceptable; I would never use it

The comparisons among the acceptability ratings for the anti-causative sentences revealed that the experimental stimuli were positively correlated, except from the two items stegnothike/‘dried-NACT’ and zarothike/‘crinkled-NACT’, both marked with NACT voice morphology. These two verbs have
received very low acceptability ratings (i.e. 75% and 60% ‘not at all acceptable’ ratings, respectively, see Figure 7.36.), which have approached significance (χ²(31)=32.90, p<.0001, and χ²(31)=28.53, p<.0001, respectively). As such, the two sentences including the specific verbs were excluded from the experimental stimuli of the CMLP task. With respect to the rest of the sentences, no further dissociations in the acceptability ratings were found, such that any differences in the RTs yielded from the ACT and the NACT anti-causative verbs were unlikely to stem from a plausibility difference.

Figure 7.36. Acceptability judgement ratings (%) for the ACT and the NACT anti-causative verbs in the norming study of the CMLP task.

7.2.1.2 Results of the CMLP task

Prior to statistical analyses, it was observed that performance was virtually flawless for all the subjects on those trials (20%) that required indicating understanding of a sentence. Thus, the participants were indeed listening to the sentences for meaning. Likewise, all CMLP probes were responded to correctly by all the participants (i.e. they always pressed ‘1’ for the real words and ‘0’ for the non-words), such that no responses were removed from further consideration. Finally, bad data were identified as those correct RTs in the CMLP task that exceeded a cut-off of three standard deviations (SDs) above or below the mean for each verb-type (i.e Unergatives, ACT unaccusatives, NACT unaccusatives) and probe position (Position 1, Position 2, Position 3); these data were treated as outliers and were
replaced by the grand mean for the appropriate condition and for each participant as a conservative measure. This data comb encompassed only 1.63% of the data for the aphasic group and 4.8% of the RT data for the controls.

We begin by reporting the results of the CMLP experiment for the two experimental groups on the basis of the subjects' merged re-activation times, as well as for each of the eight aphasic participants separately. The overall mean priming effects for each verb-type and probe position calculated on the basis of the aphasics’ and the controls' merged Lexical Decision Time data are presented in Table 7.6. (The statistically significant effects are indicated by an asterisk on the top left of each related probe vs. unrelated probe pair).

Table 7.6. LDTs to related and unrelated probes by group, verb-type and probe position (in msecs).

<table>
<thead>
<tr>
<th>Unergatives</th>
<th>Probe position 1</th>
<th>Probe position 2</th>
<th>Probe position 3</th>
</tr>
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<tbody>
<tr>
<td>Controls</td>
<td>1292.7-1433.8*</td>
<td>1280.9-1322.5</td>
<td>1414-1443</td>
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<td></td>
<td>$F(1, 30)= 11.060$, $p&lt;.002$</td>
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<td></td>
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<tr>
<td>Aphasics</td>
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<td>3317.1-3265.8</td>
<td>3298-3416.3</td>
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<td></td>
<td>$F(1, 30)= 3.900$, $p&lt;.01$</td>
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</tr>
</tbody>
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<table>
<thead>
<tr>
<th>ACT Anti-causatives</th>
<th>Probe position 1</th>
<th>Probe position 2</th>
<th>Probe position 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>1337.2-1707.1*</td>
<td>1452.7-1585.7*</td>
<td>1509.7-1623.7*</td>
</tr>
<tr>
<td></td>
<td>$F(1, 30)= 6.988$, $p&lt;.01$</td>
<td>$F(1, 30)= 4.044$, $p&lt;.05$</td>
<td>$F(1, 30)= 8.748$, $p&lt;.01$</td>
</tr>
<tr>
<td>Aphasics</td>
<td>3006.1-4126.9*</td>
<td>3170-4069.3*</td>
<td>3307.8-3967.7*</td>
</tr>
<tr>
<td></td>
<td>$F(1, 30)= 3.967$, $p&lt;.01$</td>
<td>$F(1, 30)= 3.747$, $p&lt;.01$</td>
<td>$F(1, 30)= 2.831$, $p&lt;.05$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NACT Anti-causatives</th>
<th>Probe position 1</th>
<th>Probe position 2</th>
<th>Probe position 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>1318.3-1548.9*</td>
<td>1352.4-1478*</td>
<td>1469.6-1515.3</td>
</tr>
</tbody>
</table>
The within-subject analysis has yielded a significant main effect of probe-type for both groups \( F(1, 26)= 38.881, p<.0001 \) for the aphasics’ group, and \( F(1, 274)= 28.505, p<.0001 \) for the controls’ group; related probes yielded significantly faster re-activation times than the unrelated probes. A comparison between the two verb types (i.e. unergatives vs. anti- causatives) at each probe position, which was done by ANOVA analyses for each probe position with verb- and probe-type as the repeated measures, yielded no difference between the verb classes for probe position 1, but yielded a significant verb-type by probe-type interaction for probe position 3 for the aphasics’ group, and for probe positions 2 and 3 for both groups (for position 2: \( F(1, 88)= 10.085, p<.001 \) for the aphasics’ group, \( F(1, 88)= 27.807, p<.0001 \) for the controls’ group, and for position 3: \( F(1, 88)= 19.926, p<.0001 \) for the aphasics’ group), with significant differences between the related and the unrelated probes being reported only for the anti-causative verbs (for position 2: \( t(88)=5.154, p<.0001 \) for the aphasics’ group, and \( t(88)=3.429, p<.001 \) for the controls’ group, and for position 3: \( t(88)=6.071, p<.0001 \) for the aphasics’ group). In fact, the RT dissociation between the related and the unrelated probes for the anti-causative verb class was registered for both ACT and NACT anti-causatives.\(^{41}\) As anticipated, the priming effect for probe

\(^{41}\) No significant priming effect was reported for probe positions 2 and 3 for the unergative verbs across both the aphasics’ and the controls’ merged RTs. Nevertheless, the response times obtained for three of the control subjects in the unergative verb condition registered a statistically significant priming effect immediately after the verb, i.e. at probe position 2. This finding is consistent with Burkhardt et al.’s (2003) study wherein the unergatives registered a statistically significant priming effect 100 msecs after the verb for nine of the neurologically intact control subjects participating in their experiment. Burkhardt et al. have accounted for such effect in terms of the VP-Internal Subject Hypothesis (Koopman & Sportiche, 1991).
position 1 was significant for both groups across all three verb classes, i.e. unergatives, ACT and NACT anti-causatives.

The RT data has also lent itself to an additional type of analysis, and more specifically, an analysis of the two groups' response times in the trials with the word-probe variable set to its [-related] value. An ANOVA analysis for each probe position with verb-type as the repeated measures yielded a significant difference between unergatives and anti-causatives for probe positions 2 and 3 for both groups (for position 2: $F(1, 44)=11.734$, $p<.001$ for the aphasics, and $F(1, 44)=17.435$, $p<.0001$ for the controls, and for position 3: $F(1, 44)=39.704$, $p<.0001$ for the aphasics, and $F(1, 44)=15.640$, $p<.0003$ for the controls). Such an effect was mainly attributable to a significant increase in the mean RTs elicited by the unrelated probes in the anti-causative verbs relative to the unergative verbs. Most interestingly, the highest mean RTs (in msecs) for the aphasic group were elicited by the unrelated probes in the NACT anti-causative verb condition, while the highest mean RTs for the control subjects were elicited by the unrelated probes in the ACT anti-causative verb condition (for position 2: 4518.4 msecs (NACT Anticaus..)– 4069.3 msecs (ACT Anticaus.) – 3265.8 msecs (Unerg.) for the aphasics, and 1478 msecs (NACT Anticaus.) – 1585.7 msecs (ACT Anticaus.) – 1322.5 msecs (Unerg.) for the controls, and for position 3: 4503.2 msecs (NACT Anticaus.) – 3967.7 msecs (ACT Anticaus.) – 3416.3 msecs (Unerg.) for the aphasics, and 1515.3 msecs (NACT Anticaus.) – 1623.7 msecs (ACT Anticaus.) - 1443 msecs (Unerg.) for the controls). These findings could be interpreted as a clear indication of the increased processing load caused by the processing of the anti-causatives (at a post-verbal position) which resulted from gap filling, while no such process took place for the trials with the unergative verbs. Moreover, the processing load inflicted by the process of gap-filling for the controls was found to carry over to the processing level in a more striking manner for the ACT (relative to the NACT) anti-causatives.

The repeated measures analysis has also revealed that the animacy of the subject was crucial in partially modulating the parsing preferences of both the aphasics and the controls. More specifically,
the particular analysis relates only to the anti-causative verbs, since all the syntactic subjects of the unergative verbs in the task were animate entities. A comparison between the priming effect (RTs for unrelated probes minus RTs for related probes) yielded by the animate and the inanimate trials separately, which was done by one-way ANOVAs for each probe position with [±animacy] of the subject as the repeated measure yielded a significant animacy effect at probe position 2 for ACT anti-causatives for the aphasics ($F(1, 14)=3.602, p<.05$, and a significant animacy effect for NACT anti-causatives across both aphasics and controls at probe position 2 and 3, respectively ($F(1, 12)=3.847, p<.05$, and $F(1, 12)=8.711, p<.01$, respectively). Such effects have mainly stemmed from the fact that a significant priming effect (i.e. significantly faster lexical decision times for the related relative to the unrelated probes) was only reported for the inanimate subject condition across both ACT and NACT anti-causatives for the aphasics, but only for NACT anti-causatives for the controls.

Also, the voice-alternation effect was found to be highly significant only for the control group at both positions 2 and 3 ($F(1, 58)=3.471, p<.05$ for probe position 2, and $F(1, 58)=11.898, p<.001$ for probe position 3). Most interestingly, such an effect for position 2 has mainly stemmed from the fact that a significant RT dissociation between the related and the unrelated probes for the anti-causatives was only registered for the voice-alternating verbs, while the voice-alternation effect for position 3 was attributed to the control subjects’ tendency to react considerably faster to the related (vs. unrelated) probes only in the [-alternating] verb condition. More specifically, a priming effect (i.e. faster RTs for the related probes relative to the unrelated probes) at position 2 was registered for both ACT and NACT voice-alternating anti-causative verbs ($t(28)=28.865, p<.0001$, and $t(24)=19.849, p<.0001$, respectively), while a priming effect at position 3 was reported for both ACT and NACT non-alternating anti-causatives ($t(28)=20.304, p<.000$, and $t(24)=29.872, p<.000$, respectively).

Finally, the ANOVA analysis has revealed a voice effect (at the [+related] probe word condition) only for the control group at positions 2 and 3 ($F(1, 44)=4.648, p<.03$, and $F(1, 44)=3.978, p<.05$, respectively). More specifically, both ACT voice predicates (i.e. ACT unergatives and ACT anti-
causatives) tended to elicit significantly faster RTs than the NACT anti-causatives at both probe positions. In fact, further analyses with verb class as the repeated measures have revealed that the ACT unergatives tended to elicit significantly faster RTs than both ACT and NACT anti-causatives (for position 2: \( t(43)=4.058, p<.0005 \) for the unergative vs. ACT anti-causative dissociation and \( t(43)=2.931, p<.05 \) for the unergative vs. NACT anti-causative dissociation, and for position 3: \( t(43)=4.273, p<.0001 \) for the unergative vs. ACT anti-causative dissociation and \( t(43)=4.125, p<.0005 \) for the unergative vs. NACT anti-causative dissociation), while the ACT anti-causatives tended to elicit significantly slower RTs than the NACT anti-causatives \( t(43)=2.412, p<.01 \) for position 2, and \( t(43)=2.288, p<.02 \) for position 3).

With regard to the aphasic group the voice effect was found to be non-significant across both positions (\( p=.737, \) for position 2, and \( p=.175 \) for position 3), yet, the ACT voice predicates (i.e. ACT unergatives and anti-causatives) tended to elicit faster RTs than the NACT anti-causatives at probe position 3 at least (3302.9 msecs<3607.7 msecs). In fact, the NACT anti-causatives at the same probe position tended to elicit slower RTs than both ACT anti-causatives and unergatives, while ACT anti-causatives were found to elicit similar RTs to those elicited by the unergative verbs (3607.7 msecs for NACT anti-causatives > 3307.8 msecs for ACT anti-causatives ± 3298 msecs for Unergatives). Though the aforementioned dissociations were not found to be statistically significant, they can be (carefully) interpreted as implying higher processing load impinged by the processing of NACT anti-causative verbs at later temporal point relative to the control group, i.e. at probe position 3.

Further analyses performed on each aphasic patient’s RT data shed more light into the parsing of the relevant verbal structures, and the way this was constrained by the influence of the [±NACT] voice morphological marking, the [±animacy] of the subject, and the [±voice-alternation] variable. Figures (7.37.) to (7.45) below depict the mean RTs of each aphasic individual and the controls for the related and the unrelated probes for each probe position (i.e. probe position 1, probe position 2, probe position 3) and verb class (i.e. Unergatives, ACT anti-causatives, NACT anti-causatives). The red
circles indicate the statistically significant priming effects, (i.e. the cases wherein the related probes have yielded considerably shorter RTs than the unrelated probes or vice versa).

Figure 7.37. The aphasics’ and the controls’ mean reaction times (in msecs) across the related and the unrelated probes for the Unergative verb class at position 1.

Figure 7.38. The aphasics’ and the controls’ mean reaction times (in msecs) across the related and the unrelated probes for the ACT anti-causative verb class at position 1.
Figure 7.39. The aphasics’ and the controls’ mean reaction times (in msecs) across the related and the unrelated probes for the NACT anti-causative verb class at position 1.

Figure 7.40. The aphasics’ and the controls’ mean reaction times (in msecs) across the related and the unrelated probes for the Unergative verb class at position 2.
Figure 7.41. The aphasics’ and the controls’ mean reaction times (in msecs) across the related and the unrelated probes for the ACT anti-causative verb class at position 2.

Figure 7.42. The aphasics’ and the controls’ mean reaction times (in msecs) across the related and the unrelated probes for the NACT anti-causative verb class at position 2.
Figure 7.43. The aphasics’ and the controls’ mean reaction times (in msecs) across the related and the unrelated probes for the Unergative verb class at position 3.

Figure 7.44. The aphasics’ and the controls’ mean reaction times (in msecs) across the related and the unrelated probes for the ACT anti-causative verb class at position 3.
A within-subject item analysis of the RT data yielded a significant main effect of probe-type for all the aphasic individuals except from the patient GCH for whom we have found a non significant probe-type effect ($F(1, 274)= .728, p=.394$ for GCH, $F(1, 274)=17.147, p<.0001$ for VSK, $F(1, 274)=18.505, p<.0001$ for SP, $F(1, 274)=18.442, p<.0001$ for THP, $F(1, 274)=18.142, p<.0001$ for DENT, $F(1, 274)=18.881, p<.0001$ for THR, $F(1, 274)=18.367, p<.0001$ for THEX, and $F(1, 274)=18.740, p<.0001$ for PAPAL). The specific results mean that the related probes yielded significantly faster RTs than the unrelated probes for the overwhelming majority of the aphasic individuals. More specifically, the priming effect for probe position 1 was found to be significant for the overwhelming majority of the aphasic individuals across all the three verb classes, except from the patient GCH for unergatives and ACT anti-causatives, VSK and THP for NACT anti-causatives, and THR for ACT anti-causatives. What should be mentioned though is that the related probes for the patients VSK, THP, and THR have always yielded faster RTs than the unrelated probes; though these
differences were not statistically significant, they show a clear direction, and this can be interpreted as a relatively spared sensitivity of the patients VSK, THP, and THR to the lexical semantics of the word-probes used in the CMLP task. A comparison between the verb-types at each probe position, which was done by two-way ANOVA analyses for each probe position with verb-type (i.e. unergatives vs. anti-causatives) and probe-type as the repeated measures, yielded no difference between the verb types for probe position 1, but a significant verb-type by probe-type interaction for probe position 2 for seven of the patients ($F(1, 88)=9.039, p<.005$ for VSK, $F(1, 88)=14.746, p<.0005$ for SP, $F(1, 88)=11.850, p<.001$ for THP, $F(1, 88)=13.371, p<.0005$ for DENT, $F(1, 88)=11.850, p<.001$ for THR, $F(1, 88)=2.814, p<.05$ for THEX and $F(1, 88)=11.850, p<.001$ for PAPAL) and for probe position 3 for two of the patients ($F(1, 88)=11.889, p<.001$ for VSK, and $F(1, 88)=23.185, p<.0001$ for SP). The interaction effect for position 2 largely stemmed from significant differences between unergatives and anti-causatives for the patients VSK, SP, THP, DENT, THR, and PAPAL, such that the specific aphasic subjects tended to respond significantly faster to the related (relative to the unrelated) probes only in anti-causatives, while the RTs for the unergatives were not significantly differentiated along the [+relatedness] of the probe-word dimension $t(88)=2.937, p<.005$ for the RT (related vs. unrelated) dissociation in the anti-causatives for the patient VSK, $t(88)=3.324, p<.001$ for SP, $t(88)=2.937, p<.005$ for THP, $t(88)=3.059, p<.005$ for

42 In order to make sure that a lexical-semantic deficit has not negatively biased the specific patients’ RT performance in the CMLP experiment for the rest of the probe positions (i.e. positions 2 and 3) we ran a follow-up priming study that has examined priming of related de-contextualized words. Eighty pairs of words were presented which were either semantically related or unrelated in meaning. The paired t-test analysis has revealed a significant priming effect for the patients VSK, THP, and THR, meaning that their RTs on the related probes were significantly faster than the unrelated probes ($F(2, 77)=72.078, p<.0001$ for VSK, $F(2, 77)=11.868, p<.0001$ for THP, and $F(2, 77)=8.129, p<.0006$ for THR). A marginally significant priming effect was found for the patient GCH ($F(2, 77)=2.876, p=.06$), which probably implies a lexical access deficit for the specific patient.
DENT, $t(88)=4.541, p<.0001$ for THR, and $t(88)=3.111, p<.001$ for PAPAL, for position 2). The verb-type by probe-type effect for the anti-causatives was found to be significantly modulated by the voice factor, with a significant priming effect being registered only for the NACT (and not ACT) anti-causatives at probe position 2 for the patients DENT, THR and PAPAL. On the other hand, the significant RT differences between the related and the unrelated probes for the patients VSK, SP, and THP were reported for both classes of anti-causatives irrespective of their voice morphological marking (for the ACT anti-causatives: at both probe positions 2 and 3 for the patients VSK and SP, and for probe position 2 for THP, and for the NACT anti-causatives: at both probe positions 2 and 3 for the patients SP and VSK, and at probe position 2 for THP). GCH’s RT data has revealed an antecedent re-activation effect for the ACT anti-causatives only at probe position 3, while THEX was the only patient that has yielded a significant verb-type by probe-type interaction effect for the unergative verbs ($F(1, 88)=3.713, p<.05$), such that the related probes at position 2 tended to elicit significantly faster RTs relative to the unrelated probes in the unergative verb class only.

Table 7.7. below presents the mean RTs and the statistically significant priming effects (calculated via one-tailed t-tests [item-based data, collapsing across subjects] and indicated for each related vs. unrelated probe pair by means of an asterisk) caused by the [+relatedness] of the probe-words for each verb-type (i.e. unergatives, ACT anti-causatives, and NACT anti-causatives) and each probe position (i.e. probe position 1, probe position 2, and probe position 3) for each of the eight aphasic patients.

<table>
<thead>
<tr>
<th>Table 7.7. Mean LDTs (in msecs) to the related and the unrelated probes by aphasic subject, verb-type and probe position.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unergatives</strong></td>
</tr>
<tr>
<td>Probe position 1</td>
</tr>
<tr>
<td>GCH</td>
</tr>
<tr>
<td>VSK</td>
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<td></td>
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<td>-----</td>
</tr>
<tr>
<td><strong>SP</strong></td>
</tr>
<tr>
<td><strong>THP</strong></td>
</tr>
<tr>
<td><strong>DENT</strong></td>
</tr>
<tr>
<td><strong>THR</strong></td>
</tr>
<tr>
<td><strong>THEX</strong></td>
</tr>
<tr>
<td><strong>PAPAL</strong></td>
</tr>
</tbody>
</table>

**ACT Anti-causatives**

<table>
<thead>
<tr>
<th>Probe position 1</th>
<th>Probe position 2</th>
<th>Probe position 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GCH</strong></td>
<td>1544.5-1540.4</td>
<td>1767.6-1778.1</td>
</tr>
<tr>
<td><strong>VSK</strong></td>
<td>2254-4956.6*</td>
<td>(30)=4.349, p&lt;.0001</td>
</tr>
<tr>
<td><strong>SP</strong></td>
<td>2822-4726.1*</td>
<td>(30)=4.943, p&lt;.0002</td>
</tr>
<tr>
<td><strong>THP</strong></td>
<td>3033-4088.3*</td>
<td>(30)=2.139, p&lt;.01</td>
</tr>
<tr>
<td><strong>DENT</strong></td>
<td>3109-4569.7*</td>
<td>(30)=3.163, p&lt;.002</td>
</tr>
<tr>
<td><strong>THR</strong></td>
<td>7325-7428.8</td>
<td>5808.1-7991</td>
</tr>
<tr>
<td><strong>THEX</strong></td>
<td>2517-3538.8*</td>
<td>(30)=6.511, p&lt;.0001</td>
</tr>
<tr>
<td><strong>PAPAL</strong></td>
<td>1442-2166.7*</td>
<td>(30)=2.441, p&lt;.01</td>
</tr>
</tbody>
</table>

**NACT Anti-causatives**

<table>
<thead>
<tr>
<th>Probe position 1</th>
<th>Probe position 2</th>
<th>Probe position 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GCH</strong></td>
<td>1528-1889*</td>
<td>(26)=4.180, p&lt;.0001</td>
</tr>
<tr>
<td><strong>VSK</strong></td>
<td>4021-6906.3</td>
<td>2327.7-3635.2*</td>
</tr>
<tr>
<td><strong>SP</strong></td>
<td>2780-4286.5*</td>
<td>(26)=4.051, p&lt;.0004</td>
</tr>
<tr>
<td><strong>THP</strong></td>
<td>4577-14587.3</td>
<td>2870-4398.4*</td>
</tr>
</tbody>
</table>
A comparison between the verb types at each probe position, which was done by one-way ANOVA analyses for each probe position with the probe words set to their [-related] value and the verb-type as the repeated measures, yielded no difference between the verb-types for probe position 1, but yielded a significant difference between the unergatives and the anti-causatives for position 2 for seven of the patients \((F(1, 44)=29.270, p<.001\) for GCH, \(F(1, 44)=7.771, p<.007\) for VSK, \(F(1, 44)=19.917, p<.001\) for SP, \(F(1, 44)=6.316, p<.01\) for THP, \(F(1, 44)=8.722, p<.005\) for DENT, \(F(1, 44)=7.949, p<.007\) for THR, and \(F(1, 44)=9.554, p<.003\) for PAPAL), and for position 3 for six of the patients \((F(1, 44)=12.319, p<.001\) for GCH, \(F(1, 44)=8.368, p<.005\) for VSK, \(F(1, 44)=8.373, p<.005\) for SP, \(F(1, 44)=4.555, p<.03\) for THP, \(F(1, 44)=6.238, p<.01\) for DENT, and \(F(1, 44)=4.129, p<.04\) for THR). More specifically, these effects were attributed to the fact that the RTs elicited by the unrelated probes at probe positions 2 and 3 were significantly higher for the anti-causative verbs relative to the unergative verbs. In fact, the highest RTs were triggered by the processing of the NACT anti-causative verb set, whereby the RT dissociation between NACT anti-causatives and ACT anti-causatives, as well as between NACT anti-causatives and Unergatives in the [-related] probe condition was considerable for almost all of the patients (see Table 7.7.: for position 2: 2224.1 msecs (NACT Anticaus.) - 1778.1 msecs (ACT Anticaus.) - 1243.8 msecs (Unerg.) for GCH, 3635.2 msecs (NACT Anticaus.) - 2695.3 msecs (ACT Anticaus.) - 2460.9 msecs (Unerg.) for VSK, 6701.6 msecs (NACT Anticaus.) – 6051.7 msecs (ACT Anticaus.) - 4460.3 msecs (Unerg.) for SP, 4398.4 msecs (NACT Anticaus.) - 4357.8 msecs (ACT Anticaus.) - 3628.2 msecs (Unerg.) for THP, 3572.6 msecs (NACT Anticaus.) - 3175 msecs (ACT Anticaus.) - 2632.2 msecs (Unerg.) for DENT, 7787.7 msecs (NACT Anticaus.) - 7991 msecs (ACT Anticaus.) - 2632.2 msecs (Unerg.) for DENT, 7787.7 msecs (NACT Anticaus.) - 7991
The ANOVA analysis has also yielded a significant effect for the animacy of the subject variable for half of the aphasic patients. A comparison between the RTs registered for the animate and the inanimate subject trials at each probe position, which was done by two-way ANOVA analyses for each probe position with animacy and probe-type (related vs. unrelated) as the repeated measures has revealed a significant animacy by probe-type interaction effect at probe position 2 for the subjects VSK, SP, THR, and PAPAL ($F(1, 56)=3.687, p<.05, F(1, 56)=14.444, p<.0004, F(1, 56)=10.278, p<.05,$ and $F(1, 56)=9.085, p<.003,$ respectively). Such an effect has mainly stemmed from the fact that significant RT differences between the related and the unrelated probes in the anti-causative verbs were computed only for the inanimate subject condition. In fact, further analyses with voice as the repeated measures have shown that the specific pattern of performance was registered for both types of anti-causatives, such that post-verbal antecedent re-activation was registered only for the inanimate subject trials across both ACT and NACT anti-causatives ($t(28)=1.832, p<.07$ for ACT anti-causatives and $t(24)=1.901, p<.06$ for NACT anti-causatives for VSK, $t(28)=3.401, p<.002$ for ACT anti-causatives and $t(24)=3.587, p<.002$ for NACT anti-causatives for SP, $t(28)=2.349, p<.02$ for ACT anti-causatives and $t(24)=2.598, p<.01$ for NACT anti-causatives for THR, and $t(24)=3.022, p<.005$ for NACT anti-causatives for PAPAL).
Furthermore, a comparison between the RTs triggered by voice-alternating and non-alternating anti-causative verbs at each probe position, which was done by two-way ANOVA analyses for each probe position with voice-alternation (voice-alternating vs. non-alternating anti-causatives) and probe-type as the repeated measures, has yielded a significant voice-alternation by probe-type interaction effect only at position 3 for four of the aphasic patients, namely, for the subjects SP, THP, DENT, and PAPAL (F(1, 56)=3.890, p<.05, F(1, 56)=3.969, p<.05, F(1, 56)=4.189, p<.04, and F(1, 56)=7.316, p<.009, respectively). More specifically, significant RT differences between the related and the unrelated probes were reported only for the voice-alternating anti-causative verbs, such that the patients tended to react faster to the related probes only when the critical verb had a morphological alternant. Further ANOVAs with voice as the repeated measures have revealed that the specific effect was only registered for the ACT voice-alternating anti-causative verbs (t(28)=2.411, p<.02 for SP, t(28)=3.005, p<.005 for THP, t(28)=4.173, p<.0003 for DENT, and t(28)=2.533, p<.01 for PAPAL).

Finally, a comparison between ACT and NACT verbs (i.e. ACT unergatives & anti-causatives, and NACT anti-causatives) with the probe words set to the [+related] value has revealed a main voice effect only for two patients, namely, GCH and DENT, mainly at probe position 3 (for position 3: F(2, 43)=26.982, p<.0001 for GCH, and F(2, 43)=2.438, p<.08 for DENT, and for position 2: F(2, 43)=9.230, p<.004 for GCH). More specifically, the ACT predicates for both patients were found to elicit significantly shorter RTs relative to the NACT predicates (for position 3: 2446.7 msecs for NACT predicates > 1471.1 msecs for ACT predicates for GCH, and 3422 msecs for NACT predicates > 2690.6 msecs for ACT predicates for DENT, and for position 2: 2268.1 msecs for NACT predicates > 1630.2 msecs for ACT predicates for GCH). In fact, further one-way ANOVA analyses with verb class as the repeated measure have revealed that the NACT anti-causatives tended to elicit significantly slower RTs than both ACT anti-causatives and unergatives, while the ACT anti-causatives tended to elicit slower RTs than the unergative verbs for the patients GCH and PAPAL (for position 3: F(2, 43)=21.327, p<.0001, t(43)=3.177, p<.002 for the RT dissociation between ACT anti-causatives and
unergatives, \( t(43)=3.461, p<.001 \) for the RT dissociation between NACT anti-causatives and unergatives, and \( t(43)=6.531, p<.0001 \) for the RT dissociation between NACT and ACT anti-causatives for GCH, and \( F(2, 43)=3.314, p<.04, t(43)=2.544, p<.01 \) for the RT dissociation between ACT anti-causatives and unergatives, \( t(43)=1.698, p<.09 \) for the RT dissociation between NACT anti-causatives and unergatives for PAPAL, and for position 2: \( F(2, 43)=5.369, p<.008, t(43)=3.248, p<.001 \) for the RT dissociation between NACT anti-causatives and unergatives, \( t(43)=2.097, p<.04 \) for the RT dissociation between NACT anti-causatives and ACT anti-causatives for GCH). Moreover, the same RT performance pattern was registered for the patients DENT and THR, such that related probes in the NACT anti-causative verb condition tended to elicit slower RTs relative to both ACT anti-causatives and unergatives, while related probes in the unergative verb condition tended to elicit faster RTs relative to the ACT anti-causative verbs at position 3 only (3422 msecs for the NACT anti-causatives > 2820.7 msecs for the ACT anti-causatives > 2560.6 msecs for the unergatives for DENT, and 7007.5 msecs for the NACT anti-causatives > 6409.6 msecs for the ACT anti-causatives > 5790.6 msecs for the unergatives for THR). Though neither of the aforementioned RT dissociations was found to be statistically significant, the specific findings imply that the processing of ACT voice morphology was relatively easier for half of the patients at least, while ACT anti-causatives posed less processing demands to the aphasic parser relative to NACT anti-causatives.

7.2.1.3 Summary of the CMLP experiment

The present on-line task has investigated both the aphasics’ and the controls’ sensitivity to the unaccusativity features of intransitive verbs in Greek by replicating Burkhardt et al.’s (2003) and Friedmann et al.’s (2008) CMLP experiment (a.o.). Most importantly, both the aphasics and the controls provided reliable experimental evidence in favour of the distinct structural properties of unergatives and anti-causatives, with significant priming post-verbal effects being reported only for the latter verb category. Furthermore, the task has provided interesting results in relation to language-specific factors
that may have an effect on the processing of anti-causative verbs by the aphasics. Following the results of the current study, we may assume that the NACT morphological marking – most productively used in Greek to encode a transitivity alternation – functioned as a stabilizing factor in the syntactic computation of the A-movement involved in the relevant anti-causative structures, which represent the maximally transparent interface between form and syntax. On the other hand, the verification of unaccusativity at the lexicon-syntax interface, as is the case with ACT voice anti-causative verbs, was more difficult for the patients to compute. The aphasics' deficient access to the lexicon was compensated for by the [+voice-alternating] property of a specific subclass of ACT voice anti-causatives. Most crucially, the [+voice-alternation] property was found to strengthen the priming effect for the specific verbal set to a considerable degree. Finally, the investigation of the [±animacy] information encoded in the subject-antecedents of the anti-causative verbs provided evidence in favour of the important role played by animacy in the thematic role assignment during the processing of anti-causative verbs in real-time.
7.2.2 The sentence picture matching task

The aim of the specific experiment was to investigate the effects of three independent variables, more specifically, verbal morphology (two levels: ACT vs. NACT voice morphology), the animacy feature of the syntactic subject (two levels: [+animate], [-animate]), and the derivational status of the subject (two levels: [+Derived subject], [-Derived subject]) on the interpretation of reflexive and anti-causative verbs by the eight aphasics and the fifteen language-unimpaired subjects. The dependent measure was the experimental subjects’ interpretation of the verbs and this was measured through their choice of the picture (among three pictures, the two being foils) that most felicitously portrayed the action denoted by the critical verb. The task has also included transitive verbs of ACT morphology in order to test for any possible deficit in the processing of ACT voice morphology by the aphasic patients.

As in the previous tasks, we analyse the aphasic performance at an individual level due to the heterogeneity observed in the aphasic patients’ responses. Each of the Figures that follow illustrates the percentage data of each aphasic subject’s and controls’ target and non-target responses. Moreover, the same Figures provide additional information on the type of the non-target readings which were infelicitously (as is the case with reflexive and anti-causative verbs) or erroneously (as is the case with transitive verbs) assigned to the verbs in question. The participants’ ratings were tested statistically.

43 What should be repeatedly stressed is that the non-target readings assigned to the reflexives and the anti-causative in the present study are not ungrammatical in pure syntactic terms but rather correspond to less preferred readings which are allowed by grammar (for more details see the “Linguistic Framework of the Study” & the “Subjects and Methodology” chapters). As such, the assignment of a passive/reflexive reading to a NACT anti-causative verb, or the assignment of a passive reading to a reflexive verb instantiates the participants’ tendency to choose a less preferred reading, with its preference status being largely determined by pragmatic effects, like frequency of occurrence and real-world knowledge. On the other hand, the active reading in reflexives constitutes a pure case of an ungrammatical interpretation.
with variance analyses (ANOVAs) for each subject with animacy, voice and derivation (of the subject) as the repeated measures, so that the effect of the testing variables on the participants’ ratings could be checked for statistical significance. Further variance analyses were run so that the effect of the verb category on the experimental subjects’ accuracy ratings could also be checked for significance. Significant F-tests were followed up with pair-wise comparisons. Descriptive values for each condition as well as data on the participants’ types of non-target interpretations are presented in Table 7.8.

Table 7.8. Controls’ and aphasics’ mean accuracy ratings (%), SDs (in the parentheses), and type of non-target readings across all the conditions in the sentence-picture matching task.

<table>
<thead>
<tr>
<th>Participants</th>
<th>Reflexives</th>
<th>ACT Anti-causatives</th>
<th>NACT Anti-causatives-Inanimate subject</th>
<th>NACT Anti-causatives-Animate subject</th>
<th>ACT Transitives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>Target (S.D.)</td>
<td>Non-target</td>
<td>Target (S.D.)</td>
<td>Non-target</td>
<td>Target (S.D.)</td>
</tr>
<tr>
<td>GCH</td>
<td>80 (.547)</td>
<td>PASS</td>
<td>60 (.547)</td>
<td>PASS</td>
<td>80 (.447)</td>
</tr>
<tr>
<td>VSK</td>
<td>60 (.547)</td>
<td>PASS</td>
<td>40 (.547)</td>
<td>PASS</td>
<td>60 (.547)</td>
</tr>
<tr>
<td>SP</td>
<td>100 (.0)</td>
<td>PASS</td>
<td>60 (.547)</td>
<td>PASS</td>
<td>80 (.447)</td>
</tr>
</tbody>
</table>

Note: PASS indicates no non-target readings, 20% indicates 20% non-target readings, and so on.
Detailed analyses of the performances of the controls and each aphasic individual in the present off-line task are presented below.

<Controls>

Figure 7.46. Control group: Target and non-target readings (%) for the reflexive, the anti-causative and the transitive verbs.
The variance analysis of the controls' data has revealed a main effect for the verb category variable \( F(4, 370) = 23.125, p < .0001 \). Such an effect stemmed from the control subjects' poor performance in NACT anti-causative verbs with animate subjects (68%). In fact, paired-t tests showed that the controls' accuracy rate for the specific verb class was significantly lower relative to reflexives \((t(370) = 8.021, p < .0001)\), transitives \((t(370) = 8.021, p < .0001)\), NACT anti-causative verbs with inanimate subjects \((t(370) = 7.019, p < .0001)\), and ACT anti-causative verbs \((t(370) = 8.021, p < .0001)\). The dominant non-target reading assigned by the controls to NACT anti-causative verbs with animate subjects in the present study was the reflexive reading. Furthermore, the ANOVA analysis performed on the control subjects' responses has yielded statistically significant effects for the \([\pm \text{animacy}]\) of the subject, and the derivation variable \((F(1, 370) = 56.456, p < .0001\) for both variables). More specifically, the structures with an inanimate subject yielded significantly more accurate readings relative to the structures with an animate subject, with the anti-causative structures with inanimate subjects being more successfully interpreted relative to the anti-causative verbs with animate subjects \((F(1, 370) = 90.729, p < .0001\) for the animacy by derivation interaction). Moreover, ACT voice morphology was significantly easier to interpret than NACT voice morphology \((F(1, 370) = 18.424, p < .0001)\), yet, reflexives were interpreted more successfully than NACT anti-causatives \((F(1, 370) = 8.188, p < .004\) for the voice by derivation interaction. Finally, according to the derivation effect details, derived (i.e. anti-causative) structures were more poorly interpreted in comparison to non-derived (i.e. reflexive and transitive) structures.
Figure 7.47. GCH: Target and non-target readings (%) for the reflexive, the anti-causative and the transitive verbs relative to the control group.

The variance analysis has not revealed a significant effect for any of the three variables on GCH’s performance. As one can see in Figure (7.47.), GCH has achieved the highest success scores in reflexives and in anti-causative verbs with NACT morphology and inanimate subjects (80% for both), while the lowest score was reported for the NACT anti-causative verbs with animate subjects (40%). His performance in the interpretation of ACT transitive verbs and ACT anti-causatives with inanimate subjects was slightly above chance level (60%). Further ANOVA analyses have revealed significant dissociations between the patient’s and the controls’ performance in both derived and non-derived structures ($F(1, 395)=35.427, p<.0001$), which have mainly stemmed from GCH’s significantly poorer performance in ACT anti-causative and ACT transitive verbs. With respect to the patient’s non-target
responses, he tended to interpret more than half of the NACT anti-causative verbs with animate subjects as reflexives, while his preferred non-target reading for the ACT anti-causative and transitive verb classes was the passive and the reciprocal interpretation, respectively. What should also be noted is that one of the two transitive verbs which were erroneously ‘read’ as reciprocals by GCH was the verb *agaliazo/hug* which may be treated as a typical reciprocal verb in terms of frequency of occurrence.

**<VSK>**

**Figure 7.48. VSK: Target and non-target readings (%) for the reflexive, the anti-causative and the transitive verbs relative to the control group.**

The statistical analysis of VSK’s data from the SPM task has not revealed a main effect for any of the three variables. His performance in the reflexive and the anti-causative verb category was qualitatively similar to that of GCH, yet, it appeared to be more severely impaired as the sums of VSK’s non-target
responses have increased by one infelicitous reading for each of the respective categories. As such, VSK’s lowest score in the task was reported for the NACT anti-causative verbs with animate subjects (20%), thus, corroborating the fragile interpretive status of the specific verb category. The patient’s success score for the ACT transitive verb category was equally low (20%) and one of the lowest in the aphasic group. In fact, VSK’s performance in the specific class, as well as in ACT anti-causatives, was found to be significantly lower relative to the control group ($F(4, 395)=36.267, p<.0001$). Non-target readings in the transitive verb category consisted of θ-role reversals and reciprocal readings, with the latter being triggered by verbs prone to a reciprocal reading, such as agialiaζol‘hug’ and filao’kiss’. VSK’s low score in ACT transitives combined with his below-chance (and significantly worse than the controls) performance in ACT anti-causative verbs (40%) gives important evidence in favour of a syntactic deficit in the processing of ACT voice morphology. On the other hand, the patient’s highest success scores were reported for reflexives and NACT anti-causative verbs with inanimate subjects, wherein he has performed at an above chance level (60% for both). Non-target responses across all verbal categories (except from transitives) mostly consisted of passive readings.
Figure 7.49. SP: Target and non-target readings (%) for the reflexive, the anti-causative and the transitive verbs relative to the control group.

The ANOVA analysis has revealed a highly significant effect for the verb category \((F(4, 20)=4.625, p<.008)\) and the voice variable \((F(1, 23)=5.148, p<.03)\). The verb class effect stems from SP’s poor performance in the transitive verb class (0%) which was significantly worse than reflexives \((t(20)=3.952, p<.0008)\), ACT anti-causatives \((t(20)=2.371, p<.02)\), and NACT anti-causatives with inanimate subjects \((t(20)=3.162, p<.004)\). Moreover, SP’s score in reflexives (100%) was found to be significantly higher relative to NACT anti-causatives with animate subjects \((t(20)=6.749, p<.0001)\). More analytically, the lowest scores in SP’s performance in the SPM task were reported for NACT anti-causative verbs with animate subjects (40%), ACT anti-causatives (60%) and ACT transitives (0%), with the latter score being the lowest in the aphasic group for the relevant verb class. The dissociation between the controls’
and SP’s performance was found to be highly significant ($F(4, 395)=11.165, p<.0001$), and it has mainly stemmed from SP’s poor performance in the NACT anti-causative verbs with an animate subject ($t(395)=2.381, p<.01$), ACT anti-causatives ($t(395)=3.401, p<.0004$), and ACT transitives ($t(395)=8.503, p<.0001$).

The dominant non-target reading for the anti-causative verbs with NACT morphology and animate subjects was the reflexive, while transitive verbs were systematically misinterpreted through a series of θ-role reversal errors. On the other hand, reflexives were exclusively interpreted as such (100%), while the dominant non-target reading for ACT and NACT anti-causative verbs with inanimate subjects (which were interpreted as such at an above-chance level (≥60%)) was the passive interpretation. With respect to the voice effect, NACT voice tended to yield significantly higher accuracy scores than ACT voice (73.33% vs. 30%). The voice by derivation interaction was also found to be significant ($F (1, 23)=5.000, p<.03$), with the greatest performance gaps being registered betweentransitives and ACT anti-causatives (0% vs. 60%, $t(23)=2.060, p<.05$), as well as between reflexives and NACT anti-causatives (100% vs. 60%, $t(23)=2.060, p<.05$).
The analysis of THP’s performance showed no main effect for any of the testing variables. His lowest scores were reported for the ACT transitives and the NACT anti-causative verbs with inanimate subjects (60% for both), while his performance dropped at a below-chance level (40%) when the syntactic subjects in the latter verb category were animate. A comparison between THP’s and the controls’ mean performances in the transitive and the NACT anti-causative verb category has revealed a statistically significant between-subject dissociation ($t(395)=7.409$, $p<.0001$ for the transitive verb class, $t(395)=2.947$, $p<.003$ for the NACT anti-causatives with inanimate subjects, and $t(395)=2.292$, $p<.02$ for the NACT anti-causatives with animate subjects, though the overall dissociation effect
between the patient and the controls was not found to be statistically significant, \( p=.594 \). What should be mentioned, though, is that all the non-target responses in the transitive verb category consisted of reciprocal readings assigned to the verbs *agialiazɔ*-‘hug’ and *filao*-‘kiss’ which, as already mentioned, are treated as typical reciprocal verbs in the Greek language, i.e. they are most productively used in constructions with a reciprocal meaning. As such, SP’s deficit seemed to be limited to the interpretation of anti-causative verbs with NACT voice morphology. THP’s performance in the rest of the verbal categories (i.e. ACT anti-causative and reflexive verbs) was near ceiling level (80%). The majority of THP’s non-target responses for the reflexive and the anti-causative verbs consisted of passive readings.

Figure 7.51. DENT: Target and non-target readings (%) for the reflexive, the anti-causative and the transitive verbs relative to the control group.
The effect of the testing variables on DENT’s performance in the SPM task was not found to be statistically significant. The most problematic verb categories appeared to be the anti-causative and the transitive verbs with ACT voice morphology, wherein DENT has performed at a below-chance level (40%). The dissociation between the aphasic’s and the controls’ performance was highly significant \((F(4, 395)=20.058, \ p<.0001)\), and it mainly stemmed from DENT’s considerably poorer performance in ACT anti-causatives \((t(395)=5.600, \ p<.0001)\), and ACT transitives \((t(395)=4.941, \ p<.0001)\).

The patient’s non-target responses for these two classes consisted exclusively of passive and reciprocal readings, respectively. The reciprocal readings have probably stemmed from probabilistic factors, since the transitive verbs being misinterpreted by the patient as reciprocals were predicates typically occurring in reciprocal configurations. DENT’s performance in the NACT anti-causative verbs with an animate subject was slightly higher (80%) relative to the NACT anti-causatives with an inanimate subject (60%), while the interpretation of reflexives was almost target-like (80%). DENT’s non-target responses for the reflexive and the anti-causative verbs consisted of passive readings.
The ANOVA analysis run on THR’s data from the SPM task has not yielded a significant effect for any of the three testing variables. As one can see from Figure (7.52.), with the exception of NACT anti-causative verbs with inanimate subjects which were interpreted as such most of the times (80%), THR scored at a below-chance level (40%) in all the rest of the verbal categories. In fact, he was the only patient that has shown evidence of difficulty in identifying voice morphology distinctions; though the active reading was encountered only once in the reflexive verbal category, the systematic misinterpretation of ACT transitive verbs (not being classified as typical reciprocal verbs) as reciprocals or passives suggests a general deficit in the computation of voice morphology. THR was the patient with the highest degree of between-subject dissociations registered between his performance and that
of controls ($F(4, 395)=16.737, p<.0001$). More specifically, THR was found to score significantly lower than the control group in reflexives, ACT anti-causative verbs and ACT transitives ($t(395)=6.289, p<.0001$, $t(395)=7.252, p<.0001$, and $t(395)=6.931, p<.0002$, respectively). The majority of THR’s non-target responses in the reflexive and the anti-causative verb categories consisted of passive readings.

**THEX**

Figura 7.53. THEX: Target and non-target readings (%) for the reflexive, the anti-causative and the transitive verbs relative to the control group.

The analysis performed on THEX’s scores has not revealed a main effect for any of the three testing variables. In spite of the fact that the verb class effect was not statistically significant ($p=.292$) THEX’s performance for the transitive verb category was found to be significantly worse relative to the interpretation of the NACT anti-causative verbs with an inanimate subject ($t(20)=2.236, p<.03$). More
analytically, THEX’s performance across all the verb classes was almost target-like (80%-100%), except from the ACT transitive verb category wherein he has scored at a below-chance level and significantly worse relative to the controls ($F(4, 395)=5.581$, $p<.0002$). What should be mentioned though is that two of the non-target (reciprocal) readings in the specific class were assigned to the verbs *agaliazo*’’*hug’* and *filaol’*’*kiss’* which, as already stressed, are most productively used in Greek in constructions with a reciprocal meaning. As such, his low score in the transitive verb class may be attributed to frequency effects rather than a deficit in the computation of ACT voice morphology. Most of THEX’s non-target responses for the rest of the verbal categories consisted of passive readings.

**Figure 7.54. PAPAL: Target and non-target readings (%) for the reflexive, the anti-causative and the transitive verbs relative to the control group.**
The ANOVA analysis performed on PAPAL’s scores in the SPM task has not revealed a main effect for any of the three testing variables. PAPAL’s performance in the task was rather deviant relative to the rest of the patients: the specific patient has scored slightly above chance-level in reflexives, ACT anti-causatives, and NACT anti-causatives with inanimate subjects (i.e. 60%), but he was the most competent relative to the rest of the aphasic participants in interpreting NACT anti-causative verbs with animate subjects (80%) and ACT transitive verbs (100%). Furthermore, the dissociation between the controls’ and the patient’s performance was found to be statistically significant ($F(4, 395)=4.031$, $p<.003$); such an effect was mainly attributed to PAPAL’s score in the ACT anti-causative verb class which was significantly worse relative to the controls (60% vs. 100%, $t(395)=3.323$, $p<.001$). With respect to his non-target responses across the verb classes, they were all classified under the passive-type reading.

7.2.2.1 Discussion

Figure (7.55.) below illustrates the scores of the aphasic patients and the controls for each of the five verb categories in the SPMT.

Figure 7.55. The aphasic patients’ and controls’ accuracy rates (%) across the four verb classes in the SMPT.
The ANOVA analysis with subject and verb class as the repeated measures has revealed a significant effect for the subject variable, as well as a significant subject by verb class interaction ($F(8, 530)=26.236, p<.0001$, and $F(32, 530)=2.249, p<.0001$, respectively). Overall, the control group was found to score significantly higher than the eight aphasic participants in the task ($t(530)=4.053, p<.0001$ for the dissociation between GCH and the controls, $t(530)=7.527, p<.0001$ for the dissociation between VSK and the controls, $t(530)=5.211, p<.0001$ for the dissociation between SP and the controls, $t(530)=4.053, p<.0001$ for the dissociation between THP and the controls, $t(530)=3.474, p<.0006$ for the dissociation between DENT and the controls, $t(530)=5.790, p<.0001$ for the dissociation between THR and the controls, $t(530)=2.316, p<.02$ for the dissociation between THEX and the controls, and $t(530)=2.895, p<.003$ for the dissociation between PAPAL and the controls). With respect to the significant subject by verb class interaction, this was largely due to the fact that the overwhelming majority of the aphasic subjects performed significantly worse than the control subjects in the interpretation of ACT anti-causative and transitive verbs. More specifically, the patients GCH, VSK, SP, DENT, THR, and PAPAL were found to score significantly lower than the controls in ACT anti-causatives, with their errors consisting exclusively of passive readings. On the other hand, all the patients (but PAPAL) were found to score considerably lower than the controls in ACT transitives, thus, initially suggesting that the aphasic individuals had probably problems with the processing of simple transitive sentences over and beyond any problems with verbs of alternating transitivity per se. Their errors in the transitive verb class had a high rate of reciprocal readings (63.60%) and a lower rate of θ-role reversal errors (36.30%).

The aphasic subjects’ observed difficulty with the processing of ACT voice structures in the task was further corroborated by the highly significant subject by voice interaction effect ($F(8, 557)=3.324, p<.001$), which was largely due to the fact that the controls have scored significantly higher than the aphasic individuals in ACT voice structures ($t(557)=3.481, p<.0005$ for the performance dissociation between the controls and GCH, $t(557)=6.092, p<.0001$ for the performance dissociation
between the controls and VSK, \( t(557) = 6.092, p < .0001 \) for the performance dissociation between the controls and SP, \( t(557) = 2.611, p < .009 \) for the performance dissociation between the controls and THP, \( t(557) = 3.581, p < .0005 \) for the performance dissociation between the controls and DENT, \( t(557) = 4.351, p < .0001 \) for the performance dissociation between the controls and THR, and \( t(557) = 3.481, p < .0005 \) for the performance dissociation between the controls and THEX). Further ANOVA analyses have yielded a significant voice by subject by derivation interaction (\( F(8, 548) = 2.988, p < .002 \)), revealing that the performance gap between the controls and the overwhelming majority of the aphasics in ACT voice structures stemmed from both derived (i.e. anti-causative) and non-derived (i.e. transitive) sentences to an equal extent (\( t(548) = 3.155, p < .001 \) for anti-causatives and \( t(548) = 2.862, p < .004 \) for transitives for GCH, \( t(548) = 5.090, p < .0001 \) for anti-causatives and \( t(548) = 5.441, p < .0001 \) for transitives for VSK, \( t(548) = 4.015, p < .0001 \) for anti-causatives and \( t(548) = 6.516, p < .0001 \) for transitives for SP, \( t(548) = 2.647, p < .008 \) for transitives for THP, \( t(548) = 4.015, p < .0001 \) for anti-causatives and \( t(548) = 2.002, p < .04 \) for transitives for DENT, \( t(548) = 5.090, p < .0001 \) for anti-causatives and \( t(548) = 2.432, p < .01 \) for transitives for THR, \( t(548) = 3.155, p < .001 \) for anti-causatives and \( t(548) = 2.862, p < .004 \) for transitives for THEX, and \( t(548) = 2.940, p < .003 \) for anti-causatives for PAPAL).

To gain a deeper insight into the distinctive features of the verbs belonging to the transitive verb category that rendered them the most challenging for the aphasic patients of the present study, we carried out an item analysis. Our primary goal was to check whether the aphasics’ non-target readings were normally distributed across the five transitive verbs included in the experimental stimuli. These verbs were \( \text{filao}'kiss' \), \( \text{agaliazo}'hug' \), \( \text{deno}'tie' \), \( \text{klotsao}'kick' \), and \( \text{vreho}'hose' \). As one can see from Table 7.9. below, the aphasic participants’ errors were considerably more in the first two verbs, i.e. \( \text{filao}'kiss' \) and \( \text{agaliazo}'hug' \) relative to the rest of the transitive verbs. As has been stressed in the analyses of the patients’ individual performances in the SPMT, these two verbs were systematically misinterpreted by the aphasics as reciprocals, which might probably stem from the predicates’ high frequency of occurrence in reciprocal (rather than in transitive) constructions in the Greek language. On
this view, the finding that the parsing of ACT transitive verbs was the hardest for the aphasic subjects in the SPMT could be nothing but the epiphenomenon of a basic frequency effect. As such, it is highly likely that the aphasic individuals have over-relied on probabilistic form estimates based on past linguistic input as a compensatory means to process linguistic information in a rapid and efficient way.

Table 7.9. The distribution of the aphasics' accuracy rates (%) across the items in the transitive verb category of the SPMT.

<table>
<thead>
<tr>
<th>Transitive verbs</th>
<th>Aphasic group, Mean accuracy ratings (%)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>filao/'kiss'</td>
<td>12.50</td>
<td>0.3535534</td>
</tr>
<tr>
<td>agaliazo/'hug'</td>
<td>12.50</td>
<td>0.3535534</td>
</tr>
<tr>
<td>deno/'tie'</td>
<td>50</td>
<td>0.5345225</td>
</tr>
<tr>
<td>klotsao/'kick'</td>
<td>50</td>
<td>0.5345225</td>
</tr>
<tr>
<td>katavreho/'hose'</td>
<td>62.50</td>
<td>0.5175492</td>
</tr>
</tbody>
</table>

On the basis of this finding, the aphasics appeared to be most impaired in the processing of the ACT anti-causative verbs. The high occurrences of non-standard (mainly passive) readings for the ACT anti-causatives may have stemmed from the verbs' highly idiosyncratic lexically-constrained properties, since they denote a causative relation without an anticipated overt morphological marking on the verb's stem.

Furthermore, the ANOVA analysis has yielded a marginally significant subject by animacy interaction ($F(8, 557)=1.812$, $p=.07$), which has mainly stemmed from the fact that the controls' accuracy rates for the structures having an animate entity in subject position were significantly higher relative to the patients VSK, SP, and THR ($t(557)=5.789$, $p<.0001$ for the performance dissociation between the controls and VSK, $t(557)=4.377$, $p<.0001$ for the performance dissociation between the controls and SP, and $t(557)=4.377$, $p<.0001$ for the performance dissociation between the controls and THR). Further analyses adding the derivation variable to the repeated measures have yielded a marginally significant subject by animacy by derivation interaction effect ($F(8, 556)=1.783$, $p<.0001$)
which was mainly attributable to the fact that the controls tended to score higher than the aphasic patients in the conditions having an inanimate derived subject ($t(556)=3.524$, $p<.0005$ for the performance dissociation between GCH and the controls, $t(556)=6.671$, $p<.0001$ for the performance dissociation between VSK and the controls, $t(556)=4.783$, $p<.0001$ for the performance dissociation between SP and the controls, $t(556)=3.524$, $p<.0005$ for the performance dissociation between THP and the controls, $t(556)=4.154$, $p<.0001$ for the performance dissociation between DENT and the controls, $t(556)=5.412$, $p<.0001$ for the performance dissociation between THR and the controls, $t(556)=2.895$, $p<.003$ for the performance dissociation between THEX and the controls, and $t(553)=3.524$, $p<.0005$ for the performance dissociation between PAPAL and the controls) as well as in the conditions having an animate non-derived subject ($t(553)=3.524$, $p<.0005$ for the performance dissociation between GCH and the controls, $t(553)=6.671$, $p<.0001$ for the performance dissociation between VSK and the controls, $t(553)=4.783$, $p<.001$ for the performance dissociation between SP and the controls, $t(553)=3.524$, $p<.0005$ for the performance dissociation between THP and the controls, $t(553)=4.154$, $p<.0001$ for the performance dissociation between DENT and the controls, $t(553)=5.412$, $p<.0001$ for the performance dissociation between THR and the controls, $t(553)=2.895$, $p<.005$ for the performance dissociation between THEX and the controls, and $t(553)=3.524$, $p<.0005$ for the performance dissociation between PAPAL and the controls). On the other hand, the performance gap between the controls and the aphasics in the derived (i.e. anti-causative) structures having an animate subject was evidently narrower; the controls were found to score significantly higher than a single patient, namely, the patient VSK ($t(553)=3.021$, $p<.002$).

We should also mention that the NACT anti-causative verbs with an animate subject have yielded the lowest overall scores for both groups (Mean: 68% for the controls, Mean: 52.50% for the aphasic group)\textsuperscript{44}. Indeed, the specific verb class has illustrated a high rate of non-target readings

\textsuperscript{44} The specific conclusion only holds on the precondition that the aphasics’ overall lower scores in the ACT transitive verb class (Mean: 45%) are exempted for the frequency-based reasons explained earlier.
across both the controls and the overwhelming majority of the patients (32% non-target readings for the controls, 60% non-target readings for GCH, 80% non-target readings for VSK, 60% non-target readings for SP, 60% non-target readings for THP, 60% non-target readings for THR). These qualitatively similar performance patterns probably stem from the underspecification of the NACT voice morphology in Greek, which--when enhanced by the [+animacy] of the syntactic subject--gives rise to interpretational ambiguity among a reflexive, an anti-causative and a passive reading in the absence of any disambiguating cues from the discourse context. The finding that the experimental participants’ performance for the same NACT anti-causative verbs with an inanimate entity in subject position was at an above-chance level (96% for the controls, 100% for THEX, 80% for GCH, SP, and THR, and 60% for VSK, THP, DENT, and PAPAL) is particularly telling of the important role played by the animacy of the subject in the interpretation of verbs of alternating transitivity.

Finally, the interpretation of the reflexives did not appear to pose any considerable difficulty to either the controls or the overwhelming majority of the aphasics (96% success score for the controls, 80% for GCH, THP, DENT, and THEX, 100% for SP). Unlike the rest of the aphasics, THR was the only patient that has performed significantly lower than the controls in the reflexives by scoring at a below-chance level (40%). The specific patient appeared to ignore reflexive NACT morphological marking by interpreting once a reflexive verb as a transitive. In contrast, the non-target readings assigned by the rest of the aphasics to the reflexives were passive interpretations, thus, suggesting that the specific patients faced no problem with the identification of voice morphology distinctions. We believe that the specific finding strongly corroborates our assumption that grammatical knowledge in the agrammatic aphasics was relatively spared.
7.2.2.2 Summary of the results in the SPMT

The results of the SPMT have revealed that the overwhelming majority of the aphasic patients performed very close to the controls in the interpretation of the reflexives and the NACT anti-causatives. Both groups did well in the interpretation of the reflexives and the NACT anti-causatives with an inanimate subject, while they appeared to be negatively affected by the animacy effect in the processing of the NACT anti-causative verbs with an animate subject. On the other hand, the aphasic performance significantly deviated from that of the controls with respect to the interpretation of the ACT anti-causative and transitive verbs wherein the patients have performed considerably more poorly. These results suggest that the anti-causative properties of the ACT intransitive verbs were harder to perceive for the agrammatic patients of the present study probably because they relate to an idiosyncratic lexical property which has to be learned and used as a ‘filter’ for each verbal item. On the other hand, the aphasics’ deficient performance in the ACT transitive sentences may be an artefact of a probabilistic effect: we hypothesize that the aphasic parser may have infelicitously assumed a reciprocal reading due to the strong contextual bias imposed by the patients’ past linguistic input; the most frequent (i.e. the reciprocal) reading of the verbs in question was preferred in an effort to avoid the cost of retrieving global information from both the verbs’ sub-categorization entries and the syntactic frame wherein the verbal predicates were integrated.
7.2.3 The picture naming task (PNT)

The reader is reminded that the analysis of the data from the PN task has focused on quantifying the participants' target and non-target responses across the same verb categories used in the SPMT (i.e. reflexives, ACT anti-causatives, NACT anti-causatives with animate and inanimate subjects, and ACT transitives), with the non-target responses referring to the use of voice morphology other than the one of the target verb. In other words, the experimental subjects' non-target responses included the production of the right verb (or of another verb which was semantically close to the target) but with inappropriate voice morphology (either ACT or NACT). The reader is also reminded that the NACT anti-causative verb class included three voice-alternating verbs, namely, tripieremel/pierce-NACT', leronomel/spill-NACT', and zestenome/heat-NACT', which could also take ACT voice morphology, while the ACT anti-causative verb class included a single instance of a voice-alternating verb, i.e. stegnono/drie-ACT', which could also surface with NACT voice morphology. Phonological or semantic paraphasias that wrongly described the picture as well as zero responses were classified as inappropriate and were coded as "other" responses. Figures (7.56.)-(7.64.) visualize the distribution (%) of the target, non-target and "other" naming productions for the controls and each of the aphasic patients. Descriptive values for each condition are presented in Table 7.10.
Table 7.10. Controls’ and aphasics’ mean accuracy ratings (%), SDs (in the parentheses), and type (i.e. non-target/’other’) of inaccurate naming responses across all the conditions in the picture-naming task.

<table>
<thead>
<tr>
<th>Participants</th>
<th>Reflexives</th>
<th>ACT Anti-causatives</th>
<th>NACT Anti-causatives-Inanimate subject</th>
<th>NACT Anti-causatives-Animate subject</th>
<th>ACT Transitives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Target (S.D.)</td>
<td>Non-target/other</td>
<td>Target (S.D.)</td>
<td>Non-target/other</td>
<td>Target (S.D.)</td>
</tr>
<tr>
<td>Controls</td>
<td>87 (.324)</td>
<td>13</td>
<td>92 (.273)</td>
<td>1 non-target</td>
<td>73 (.445)</td>
</tr>
<tr>
<td>GCH</td>
<td>89 (.500)</td>
<td>11 non-target</td>
<td>80 (.447)</td>
<td>20 non-target</td>
<td>40 (.547)</td>
</tr>
<tr>
<td>VSK</td>
<td>100 (.0)</td>
<td>-</td>
<td>60 (.547)</td>
<td>40 non-target</td>
<td>20 (.447)</td>
</tr>
<tr>
<td>SP</td>
<td>100 (.0)</td>
<td>-</td>
<td>100 (.0)</td>
<td>-</td>
<td>80 (.447)</td>
</tr>
<tr>
<td>THP</td>
<td>11 non-target</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>60 (.547)</td>
</tr>
<tr>
<td>Language</td>
<td>Accuracy</td>
<td>Non-Target</td>
<td>Target</td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>----------</td>
<td>------------</td>
<td>--------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td><strong>DENT</strong></td>
<td>78 (.440)</td>
<td>80 (.447)</td>
<td>40 (.547)</td>
<td>60 (.60)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>22 non-target</td>
<td>20 non-target</td>
<td>40 non-target</td>
<td>100 (.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11 other</td>
<td>20 other</td>
<td>20 other</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>THR</strong></td>
<td>44 (.527)</td>
<td>100 (.0)</td>
<td>60 (.547)</td>
<td>80 (.447)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>44 non-target</td>
<td>-</td>
<td>40 non-target</td>
<td>20 other</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11 other</td>
<td>20 other</td>
<td>20 other</td>
<td>60 (.516)</td>
<td></td>
</tr>
<tr>
<td><strong>THEX</strong></td>
<td>67 (.500)</td>
<td>100 (.0)</td>
<td>60 (.447)</td>
<td>40 (.547)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>33 non-target</td>
<td>20 non-target</td>
<td>40 non-target</td>
<td>100 (.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11 other</td>
<td>20 other</td>
<td>20 other</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>PAPAL</strong></td>
<td>56 (.527)</td>
<td>80 (.447)</td>
<td>20 (.547)</td>
<td>80 (.447)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>33 non-target</td>
<td>20 non-target</td>
<td>20 non-target</td>
<td>100 (.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11 other</td>
<td>20 other</td>
<td>20 other</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Detailed analyses of the performances of the controls and each aphasic individual in the present task are presented below.
The ANOVA analysis with verb class, animacy, voice, and derivation as the repeated measures has yielded significant effects for each one of the four variables. More specifically, the verb class factor appeared to significantly affect the controls' performance in the naming task ($F(4, 529)=12.278$, $p<.0001$), with significant differences emerging between the NACT verbs with an inanimate subject and reflexives ($t(529)=3.641$, $p<.0003$), ACT anti-causatives ($t(529)=4.046$, $p<.0001$), NACT anti-causatives with an animate subject ($t(529)=3.179$, $p<.001$), and transitives ($t(529)=6.834$, $p<.0001$). Moreover, the controls' naming scores in the transitives were found to be significantly higher relative to the reflexives ($t(529)=3.658$, $p<.0003$), the ACT anti-causatives ($t(529)=2.050$, $p<.04$), and the NACT anti-causatives with an animate subject ($t(529)=3.075$, $p<.002$). As expected, the voice factor was found to be highly
Significant ($F(1, 530)=19.976, p<.0001$) with the ACT voice predicates being more easily named than the NACT predicates irrespective of whether the subject of the verbal predicates was derived or not (i.e. the voice by derivation interaction effect was not found to be significant, $p=.920$). On the other hand, the derivation effect ($F(1, 530)=8.906, p<.003$) has yielded significant differences between the structures with a derived and a non-derived subject, with the former being considerably more problematic than the latter. Finally, the animacy effect was found to be highly significant as well ($F(1, 532)=14.981, p<.0001$), with the structures with an animate subject yielding considerably more accurate naming responses than the structures with an inanimate subject. Further ANOVA analyses have revealed a significant animacy by derivation by voice interaction effect ($F(1, 530)=28.271, p<.0001$), whereby the anti-causative structures with an inanimate subject tended to yield more accurate responses relative to the anti-causative structures with an animate subject ($t(530)=5.317, p<.0001$).

Overall, the reflexives and the NACT anti-causative verbs have yielded a considerable number of non-target (i.e. ACT voice) naming responses on behalf of the control subjects. Such a finding may be attributed to the morpho-phonological complexity associated with the NACT voice marking. As such, the reflexive verbs tended to be replaced by ACT transitive structures, while all the non-target ACT voice namings for the NACT anti-causative class were registered for the verbs *tripiemel*/'pierce-NACT', *leronome*/'spill-NACT', and *zestenome*/'heat-NACT', which, as already mentioned, are voice-alternating verbs, i.e. they can take either NACT or ACT voice morphology. What was also interesting was the finding that the number of the non-target responses by the controls nearly doubled (from 12% to 27%) once the NACT anti-causative verbs took an inanimate entity in subject position. The performance contrast in naming the NACT anti-causative verbs depending on whether their subject was animate or inanimate is clearly shown; [+animacy] of the subject in the NACT anti-causative predicates tended to facilitate the retrieval of NACT voice morphology.
Figure 7.57. GCH: Target, non-target, and ‘other’ naming responses (%) for the reflexive, the anti-causative and the transitive verbs relative to the control group.

The ANOVA analysis run on GCH’s data has not yielded a main effect for any of the testing variables. Nevertheless, pair-wise comparisons have revealed a significant gap between the performance of the controls and GCH in the NACT anti-causatives with an inanimate subject as well as in the ACT transitive verbs ($t(558)=2.445$, $p<.01$, and $t(558)=2.943$, $p<.003$, respectively). More specifically, half of GCH’s naming responses for the ACT transitive verb category consisted of the same verbs marked with NACT voice morphology. The greatest number of non-target responses, though, was reported for the NACT anti-causative verbs with an inanimate subject, such that more than half (60%) of the patient’s responses consisted of ACT voice naming productions (78).
Given that GCH was able to name actions requiring NACT voice morphology in the NACT anti-causative verb class with an animate entity in subject position (80%), it is plausible to assume that the relatively higher number of non-target responses for the verb class targeting the same NACT anti-causative verbs, yet with an inanimate entity in subject position, was due to the semantic information encoded in the syntactic subject. It is possible that the lack of animacy weakened the transitivity effect brought about by NACT voice morphology or, to put it differently, that the thematic properties of inanimate syntactic subjects were too feeble to support the presence of an implicit causer. The latter assumption was indirectly supported by the frequent presence of the ‘by itself’ phrase in the non-target responses for the class targeting NACT anti-causative verbs with inanimate subjects, as well as in the target responses for the ACT anti-causative verb class. The ‘by itself’ phrase was probably used to stress the absence of an implicit external argument (e.g. to lastiho eskase mono tu/ ‘the tyre blew-ACT by itself’, to trapezomadilo lerose mono tu/‘the tablecloth got spilled-ACT by itself’, ta avgα vrazun mona tus/ ‘the eggs boil-ACT by themselves’, to kladi espase mono tu/ ‘the branch broke-ACT by itself’, ta malia stegnosan mona tus/ ‘the hair dried-ACT by itself’). On the contrary, the lexicalization of the implicit causer was evident in almost every instance of naming either a NACT anti-causative verb with an animate subject (e.g. o adras lerothike apo tis laspes/ ‘the man got spilled-NACT by the mud’, i gineka tripathike me to veloni/ ‘the woman pricked-NACT with the needle’, to pedhi krivete apo tus protus/ ‘the child is hidden-NACT by the boys in the first lines’, o adras zestenete apo ton ilio/ ‘the man is heated-NACT by the sun’) or an ACT transitive verb with an animate patient which was
passivized, i.e. it was marked with NACT voice morphology (e.g. *i gineka filithike apo ton antra* ‘the woman was kissed-NACT by the man’, *to koritsi dethike apo to agori* ‘the girl was tied-NACT by the boy’, *o antras agaliazete apo ti gineka* ‘the man is hugged-NACT by the woman’, *to koritsi katavrexete apo to agori* ‘the girl is hosed-NACT by the boy’, and *i gineka klotsiete apo ton antra* ‘the woman is kicked-NACT by the man’). The most viable account for such a performance is probably GCH’s identification of the use of NACT voice morphology with a transitivity change encoded on the verb, which was further strengthened by the presence of an animate entity in subject position.

GCH’s data has also included some instances of non-target, grammatically illicit responses across the NACT anti-causatives with both animate and inanimate subjects (e.g. *i petra vithise* ‘the stone sank-ACT’ & *i gineka vithise* ‘the woman sank-ACT’, instead of *vithistike/sank-NACT*). Such a finding implies that the formation of NACT voice in the anti-causatives posed greater difficulty to the patient in comparison to the ACT voice irrespective of whether the subject was animate or not. GCH’s naming productions across the various verb classes have also revealed a deficit associated with the morpho-phonological realization of tense and aspect on NACT verbs, e.g. *plinete* ‘wash-NACT’ instead of *plenete*, *tripete* ‘pierce-NACT’ instead of *tripiete*, *htenithike* ‘comb-NACT’ instead of *htenistike*, *katavrehike* ‘get wet-NACT’ instead of *katavrahike*). GCH has demonstrated the specific pattern of errors only with NACT verb forms, which implies that the crucial factor that impeded these items’ appropriate morpho-phonological realization was probably the increased morpho-phonological and morpho-syntactic complexity of NACT voice morphology in the production modality. On the other hand, the formation of ACT voice verbs (in the transitives and the anti-causatives targeting ACT voice morphology) was relatively spared.

Finally, GCH’s responses for the ACT transitive verb class has revealed a problem with the mechanism of structural case assignment on nominals by the transitive verbs: while the patient was able to assign accusative case to the object, the definite article was systematically prefixed with the preposition ‘se/in’ (e.g. *o adras filise sti ginekal* ‘the man kissed-ACT to the woman’, *to agori klotsai sti*
The patient's responses for the same verbal set have also included a single theta-role reversal error (i.e. o adras agailazi ti ginekal 'the man hugs-ACT the woman', instead of I gineka agailazi ton adral 'the woman hugs-ACT the man'). Theta-role reversals in structures wherein both agents and patients are animate (thus, production is made critically dependent upon the correct use of syntactic information) are frequently encountered in Broca’s aphasics’ production data (e.g. Grodzinsky, 1990). According to Grodzinsky (1990), the specific pattern of performance evinces a mapping deficit, i.e. inability to map the semantic roles onto their appropriate structural positions.

Figure 7.58. VSK: Target, non-target, and ‘other’ naming responses (%) for the reflexive, the anti-causative and the transitive verbs relative to the control group.
The verb class and the animacy variable were found to influence VSK’s performance in the naming task in significant ways ($F(4, 29)=3.944, p<.01, F(1, 29)=5.019, p<.03$). Further analyses have also yielded a significant voice by derivation interaction $F(1, 29)=9.125, p<.005$). More analytically, VSK’s score in the reflexive verb category was significantly higher relative to both ACT transitives ($t(29)=3.083, p<.004$) and NACT anti-causative verbs with inanimate subjects ($t(29)=3.387, p<.002$). Furthermore, naming NACT anti-causative verbs with animate subjects was found to be significantly more target-like than naming NACT anti-causative verbs with inanimate subjects ($t(29)=2.240, p<.03$). The animacy effect has stemmed from the fact that the structures with an animate subject were named in a more target-like manner relative to the structures with an inanimate subject. With respect to the significant voice by derivation interaction effect, this has mainly stemmed from the fact the NACT anti-causatives were more poorly named relative to both reflexives and ACT anti-causatives ($t(29)=2.560, p<.01$).

What should also be stressed is that the dissociation between the patient’s and the controls’ performance was found to be highly significant ($F(1, 558)=27.259, p<.0001$); such an effect is mainly attributable to the aphasic’s considerably lower performance in NACT anti-causatives with an inanimate subject, ACT anti-causatives, and transitives ($t(558)=2.593, p<.009, t(558)=2.376, p<.01$ and, $t(558)=6.329, p<.0001$, respectively). In fact, the class with the NACT anti-causative verbs with an inanimate subject has received the highest number of non-target, i.e. ACT voice naming responses (80%) on behalf of the patient. Given that VSK’s non-target responses for the NACT anti-causatives were limited to those verbs having an ACT voice morphological alternant, we may assume that the critical performance dissociation observed between the NACT anti-causative verbs with an animate and an inanimate subject is attributable to the [-animate] feature of the syntactic subject taking priority over transitivity effects forced by NACT voice morphology. This finding is of great importance as it suggests that the specific patient’s naming performance was differentially affected by the semantic information encoded in the syntactic subject in the NACT anti-causatives. Apart from the frequent target-like use of
NACT morphology in the naming of anti-causatives with an animate subject, VSK has also appeared to identify the use of NACT voice morphology with reflexives, whereby he performed at ceiling level.

On the other hand, VSK’s frequent marking of the ACT anti-causatives with NACT voice morphology (i.e. 40% non-target, i.e. NACT voice naming responses) is particularly interesting since the registered inaccurate namings were applied to non-voice-alternating verbs, i.e. verbs that can not surface with NACT voice morphology (mavrizo/‘blacken-ACT’ and plateno/‘widen-ACT’). It is possible that the patient’s responses for the specific category were not lexically constrained, such as VSK tended to systematically use the NACT suffix to encode a transitivity alternation (e.g. o tihos mavristike/ ‘the wall blackened-NACT’, o dromos platinete/ ‘the road widens-NACT’). Finally, what is rather strange is that the overwhelming majority of the specific patient’s non-target naming responses in the transitive verb class consisted of the same verbs marked with NACT morphology (e.g. i kopela denete/ ‘the woman is tied-NACT’, vrehete /’is hosed-NACT, i kopela klotsite apo ton antra/ ‘the woman is kicked-NACT by the man’).
Figure 7.59. SP: Target, non-target, and ‘other’ naming responses (%) for the reflexive, the anti-causative and the transitive verbs relative to the control group.

The ANOVA analysis did not show a main effect for any of the testing variables \((p=.135)\). Nevertheless, paired t-tests have revealed a significant dissociation between SP’s scores in the reflexive and the ACT transitive category \(t(29)=2.233, p<.04\), as well as a marginally significant performance dissociation between the reflexives and the NACT anti-causative verbs with an animate subject \(t(29)=1.840, p<.07\). More specifically, SP’s error-free performance in the reflexive verb category shows that the NACT verb forms were relatively easier to produce when an unambiguous reflexive reading (i.e. a prototypically reflexive activity with an agent-subject) was targeted. On the other hand, the anti-causative verbs targeting NACT voice morphology appeared to be more demanding such that SP’s performance dropped in the relevant categories (60% and 80% for the anti-causative verbs with an
animate and an inanimate subject, respectively). In fact, SP’s performance in the NACT anti-causatives with an animate subject was found to be significantly poorer relative to the controls ($t(558)=2.097$, $p<.03$). All of the patient’s non-target (i.e. ACT) responses in the anti-causatives targeting NACT morphology were limited to voice-alternating anti-causative verbs. The presumably higher processing cost inflicted by NACT voice forms in the anti-causative verb category was indirectly confirmed by the fact that each time SP attempted to name the target NACT verbs, he systematically produced ill-formed perfective stems (e.g. $\text{vi$t$}i$k/\text{vi$t$}i$ke ‘sank-NACT’, instead of $\text{vi$}t$ih$\text{vi$}t$i$ke$). The presence of an inanimate subject appeared to ameliorate SP’s naming performance in the NACT anti-causatives, yet, not to a significant extent.

On the other hand, SP’s naming performance in the anti-causative verbs targeting ACT voice morphology was target-like. Such a performance may be largely due to the lower processing cost inflicted by the computation of ACT voice morphology or/and to the lexically-constrained use of ACT morphology in the specific verb class. Finally, SP’s relatively poor performance in the transitive verb class (40%) was mainly attributable to the high rate of pragmatically irrelevant/’other’ responses, consisting of four uses of the light, semantically underspecified verbal predicate $\text{pi$}g$e/‘he went-ACT’ and two semantic paraphasias (e.g. $\text{vi$}a$t$i$ke/‘he hastened-NACT’, instead of $\text{de$}n$il ‘he ties’). The patient’s score in the ACT transitives was also found to be significantly lower relative to the control subjects ($t(558)=4.255$, $p<.0001$). What should also be mentioned is the lack of syntactic arguments reported for the total of SP’s verbal productions in the naming task. Such a pattern is consistent with SP’s syntactic profile sketched by the BDAE battery (see Figure (6.5.), whereby the specific patient’s productions were strictly limited to single-word utterances.
The ANOVA analysis of THP’s naming responses has revealed a main effect for the derivation and the animacy variable ($F(1, 31)=3.915$, $p<.05$, and $F(1, 31)=4.558$, $p<.04$, respectively). Such an effect was largely due to the fact that the structures with a derived subject, i.e. the anti-causatives, were significantly more poorly named relative to the structures with a non-derived subject, i.e. the transitive and the reflexive verbs. Indeed, as one can see from Figure (7.60.), THP’s highest performance was observed for the reflexive (77.77%) and the ACT voice transitive verb class (80%), while the specific patient seemed to face pronounced difficulty with the naming of anti-causative verbs. While THP’s errors in the ACT anti-causatives consisted exclusively of ‘other’ responses, half of the inaccurate responses in the NACT anti-causatives with an animate subject consisted of non-target responses,
while all of the patient’s inaccurate namings for the class targeting NACT anti-causatives with an inanimate subject consisted of non-target, i.e. ACT voice verbs (all of them, yet, being applied to voice-alternating verbs). As confirmed by the statistically significant animacy effect, inanimate subjects appeared to slightly impede the realization of NACT voice morphology on the anti-causative verbs (relative to the same verbs with an animate entity in subject position), while THP’s naming accuracy for the ACT and NACT anti-causative verbs with an inanimate subject was equally poor (40%) irrespective of the voice morphology of the verbs in question.

Though the dissociation between THP’s and the controls’ performance was not found to be significant (p=.100) across the verb classes, further pair-wise analyses have yielded significant dissociations between their performances in the NACT anti-causatives (t(558)=2.436, p<.01 for the inanimate subject class, and t(558)=2.436, p<.04 for the animate subject class), and ACT anti-causatives (t(558)=3.800, p<.0001). It is worth noting that THP’s inaccurate responses for the ACT anti-causative verb class consisted exclusively of the appropriate ACT voice verbs having though a CLLDed DP in object position (e.g. ta stegnoni ta mallia/‘she dries-ACT the hair-CLLDed’, ton aniksas to droma/‘they widened-ACT the road-CLLDed’, to hun kopsi to dentro/‘they have cut-ACT the tree-CLLDed’). The specific pattern implies that THP’s below-chance naming performance in the anti-causative verbs targeting ACT voice morphology stemmed from the processing cost inflicted by the derived status of the verbs’ syntactic subject. This finding is consistent with the widely reported difficulty that Broca’s aphasics face with movement-stimuli, in general. THP’s naming data in (79) is particularly telling of his failure to verify the grammatical features of the subject by moving it to a local Spec/Head dedicated position in order for the derived subject to be marked with the plural number.

(79)

Epesan ke o karposi/‘fell-ACT-PL the fruit-NOM-plsg’., instead of

Epesan ke i karpili/‘fell-ACT-PL the fruit-NOM-plpl’
The ANOVA analysis has yielded significant effects for the verb class, the animacy and the voice variable (F(4, 29)=2.825, p<.04, F(1, 29)= 7.297, p<.01, and F(1, 29)=4.841, p<.03, respectively). More specifically, the verb class effect mainly stemmed from the patient’s poor naming performance in NACT anti-causatives with an inanimate subject (40%) which was significantly worse relative to ACT transitives (100%) (t(29)=3.128, p<.004), NACT anti-causatives with an animate subject (100%) (t(29)=2.709, p<.01), reflexives (78%) (t(29)=1.934, p<.05), and transitives (t(29)=3.128, p<.004). On the other hand, the voice effect stemmed from the fact that the ACT verbs were more accurately named than the NACT verbs, while the animacy effect stemmed from the fact that the structures with an
inanimate subject tended to yield considerably more non-target naming responses relative to the structures with an animate subject.

In general, DENT’s naming performance was roughly target-like across all the verbal categories except from the NACT anti-causatives with an inanimate subject wherein he has scored at a below-chance level (40%). In fact the specific class was the only one wherein a significant performance dissociation was registered between the patient and the control group (t(558)=2.519, p<.01). It seems that an explanation in terms of the facilitating role played by the [+animacy] of the subject in the retrieval of NACT morphology is the most plausible line of attack with regard to DENT’s naming performance in anti-causative verbs targeting NACT voice morphology. Given that the total of DENT’s non-target responses for the NACT anti-causatives were exclusively reported for the verbs having an ACT voice alternant, we may assume that the contrast in the naming choice between ACT and NACT voice morphology in NACT voice-alternating anti-causative verbs depended on the animacy of the subject. On the other hand, DENT’s single non-target (i.e. NACT) response in ACT anti-causatives corresponded to the verb vuliazo/’sink-ACT’ which is non-alternating.

Finally, what should also be mentioned is DENT’s difficulty to form the perfective stem of a considerable number of anti-causative verbs irrespective of their voice morphological marking (ACT/NACT) (e.g. tripathike/’she pierced-NACT’, instead of tripithike, platise/’It widened-ACT, instead of platine).
The ANOVA analysis with verb class, animacy, voice and derivation as the repeated measures has not yielded a main effect for any of them. Nevertheless, paired t-tests have revealed a significant performance dissociation between ACT anti-causative verbs and reflexives (100% vs. 44.44%, t(29)=2.084, p<.05). More specifically, THR was the patient with the poorest performance in the reflexive verb class relative to the rest of the aphasic subjects. Moreover, his performance in the reflexives was found to be significantly worse relative to the controls (t(558)=4.291, p<.0001). Anti-causative verbs with NACT voice morphology and animate subjects were named accurately at an almost target-like level (80%), yet, THR’s naming performance slightly dropped (60%) when the animacy of the syntactic subject of the voice-alternating verbs turned to the [-animacy] value (40% non-target naming responses). On the other hand, the naming of the anti-causative verbs targeting ACT...
morphology has reached ceiling performance (100%). Also, THR’s naming accuracy in transitive verbs was slightly above chance level (60%), with the patient’s errors being equally divided between non-target and zero responses. The patient’s score in transitives was also found to be significantly worse relative to the control subjects ($t(558)=4.158, p<.0001$).

Finally, THR was found to systematically refrain from lexicalizing any nominal argument in his naming data, while he also tended to produce verbs with number and person features other than the 3rd person singular targeted by the experimental stimuli (e.g. luzomel ‘shampoo-NACT-1sg.’, instead of luzetel ‘shampoo-NACT-3sg.’, krivotel ‘hide-NACT-3pl.’, instead of krivetel ‘hide-NACT-3sg.’). With respect to the total lack of arguments in his responses, this was probably due to his need to minimize the use of additional functional projections that by hypothesis was difficult for him (see THR’s BDAE profile, Figure (6.8.). THR has also made a considerable number of semantic paraphasias in the reflexive and the ACT anti-causative verb class (e.g. fortonete san to vivlio ‘he loaded-NACT like a book’, to kladema espasel ‘the trimming broke-ACT’) as well as a few tense errors (e.g. tha vuliazil ‘it will be sinking-ACT-FUT’ instead of vuliazi ‘it sinks-ACT-PRS’).
Figure 7.63. THEX: Target, non-target, and ‘other’ naming responses (%) for the reflexive, the anti-causative and the transitive verbs relative to the control group.

The ANOVA analysis run on THEX’s naming data has revealed main effects for the verb class ($F(4, 29)=5.541, p<.001$) and the voice variable ($F(1, 29)= 12.188, p<.001$). More specifically, the verb class effect was mainly attributable to THEX’s poor performance in naming anti-causatives targeting NACT voice morphology. More specifically, significant dissociations have emerged between the NACT anti-causatives with inanimate subjects and reflexives ($t(29)=2.252, p<.03$), ACT anti-causatives ($t(29)=3.405, p<.002$), and transitives ($t(29)=3.932, p<.0005$). THEX’s performance in the NACT anti-causatives was also found to be significantly worse relative to the controls ($t(558)=4.012, p<.0001$ for the NACT anti-causatives with an inanimate subject, and $t(558)=3.611, p<.0003$ for the NACT anti-causatives with an animate subject). Moreover, there were significant differences registered between the NACT anti-causatives with an animate subject and the ACT anti-causatives ($t(29)=2.554, p<.01$),
the NACT anti-causatives with an animate subject and the transitives ($t(29)=2.949, p<.006$), as well as between the reflexives and the transitives ($t(29)=1.953, p<.05$). With respect to the voice effect, this mainly stemmed from the fact that the ACT verbs were considerably more successfully named relative to the NACT verbs.

The total of the patient’s non-target responses for the NACT anti-causative verbs were applied to voice-alternating verbs. As such, THEX’s naming performance was amenable to a straightforward error analysis whereby ACT voice morphology was considerably less problematic relative to NACT voice morphology. The fact that THEX’s accuracy scores for the NACT anti-causatives were at a below-chance level (i.e. Mean: 30% for both types of NACT anti-causatives) and tended to rise in reflexives (67%) implies that the patient faced difficulty with the production of NACT voice morphology. In fact, the patient’s score in reflexives (along with NACT anti-causatives) was found to be significantly worse relative to the controls ($t(558)=2.168, p<.03$). The difficulty associated with NACT morphology became even more pronounced when the structures targeted were derived.

Finally, what should be mentioned is that THEX tended to systematically omit lexical arguments in all of his naming productions except from those targeting ACT transitive verbs.
The ANOVA analysis run on PAPAL’s naming data has revealed main effects for the verb class, the voice and the derivation variable ($F(4, 29)=5.344, p<.002$, $F(1, 29)=11.558, p<.001$, $F(1, 29)=6.602, p<.01$, respectively), as well as a significant animacy by derivation interaction effect ($F(1, 29)=6.602, p<.01$). More specifically, the verb class effect on PAPAL’s naming performance was largely derived from the patient’s poor performance in the verbs marked with NACT voice morphology, with all of his non-target responses corresponding to voice-alternating verbs. Paired t-tests yielded significant differences between the NACT anti-causatives (irrespective of the $\pm$animacy feature of the syntactic subject) and the ACT anti-causatives ($t(29)=2.376, p<.02$), the NACT anti-causatives and the transitives ($t(29)=3.658, p<.001$), as well as between the reflexives and the transitives ($t(29)=2.422, p<.02$).
More analytically, PAPAL’s pattern of performance in the naming task was largely associated with difficulty in the retrieval of NACT voice morphology which was mainly evident in his significantly below-chance performance (Mean accuracy rate: 20%) in the anti-causative verbs targeting NACT voice morphology. The patient’s low score in the specific verb class did not appear to be affected by the semantic information of animacy encoded in the syntactic subject of the relevant structures. On the other hand, the retrieval of NACT voice morphology appeared to be facilitated by prototypically reflexive activities having an agent as a subject, such that the animate subjects in non-derived reflexive structures tended to yield significantly higher accuracy scores than the derived (i.e. the NACT anti-causative) structures with an animate subject (t(29)=2.569, p<.01). Moreover, PAPAL’s naming scores for both reflexives and NACT anti-causative verbs were found to be significantly worse relative to the controls (t(558)=3.267, p<.001 for the reflexives, t(558)=3.985, p<.0001 for the NACT anti-causatives with an inanimate subject, and t(558)=5.081, p<.0001 for the NACT anti-causatives with an animate subject). On the other hand, ACT voice morphology was successfully identified with transitive verbs whose naming accuracy was at ceiling level (100%), while the naming of anti-causative verbs targeting ACT voice morphology was significantly above chance-level (80%).

Finally, PAPAL’s naming data included some instances of person and number feature misuses in the verbal domain, since the patient tended to produce verbs with number and person features other than the 3rd person singular targeted by the experimental stimuli (e.g. **ntinome**/‘I dress-NACT-1sg.’ instead of **ntineta**/‘she dresses-NACT-3sg.’, **vromisame**/‘we spilled-ACT-1pl.’ instead of **vromise**/‘he spilled-ACT-3sg.’). What was also observed in PAPAL’s naming data was a single instance of an ill-formed perfective stem (i.e. **tripese**/‘it pierced-ACT-PERF’, instead of **tripise**/‘he spilled-ACT-3sg.’). What was also observed in PAPAL’s naming data was a single instance of an ill-formed perfective stem (i.e. **tripese**/‘it pierced-ACT-PERF’, instead of **tripise**/‘he spilled-ACT-3sg.’) as well as two instances of semantic paraphasias in the NACT anti-causative verb categories (i.e. **lios…zesta**/‘sun…heat’ instead of **zesteneta**/‘he heats-NACT’, and **lekes**/‘spot’, instead of **lerothikel**/‘it spilled-NACT’).
7.2.3.1 Discussion

Figure (7.65) illustrates the target scores of both the aphasics and the controls for each of the five verb classes in the PNT.

**Figure 7.65. The aphasics’ and controls’ target-like performance (%) across the five verb classes in the picture-naming task.**

The ANOVA analysis with subject as the repeated measures has yielded a highly significant subject effect ($F(8, 797)=9.138, p<.0001$), as well as a significant subject by verb class interaction ($F(32, 761)=3.076, p<.0001$). The subject effect stemmed from the fact that the controls’ naming responses were significantly higher relative to the majority of the aphasic individuals in the task, and more specifically, to the patients GCH ($t(797)=3.133, p<.001$), VSK ($t(797)=4.525, p<.0001$), THP ($t(797)=4.061, p<.0001$), THR ($t(797)=4.061, p<.0001$), THEX ($t(797)=3.133, p<.001$), and PAPAL ($t(797)=4.525, p<.0001$). On the other hand, the significant subject by verb class interaction was largely attributable to the aphasics’ poor naming performance in the NACT anti-causatives with an inanimate subject, whereby six of the patients have performed considerably worse relative to the controls ($t(797)=2.175, p<.02$ for GCH, $t(797)=3.480, p<.0005$ for VSK, $t(797)=2.175, p<.02$ for THP, $t(797)=2.175, p<.02$ for DENT, $t(797)=3.480, p<.0005$ for THEX, and $t(797)=2.175, p<.02$ for PAPAL).

Furthermore, an ANOVA analysis with subject and derivation as the repeated measures has yielded a significant subject by derivation interaction effect ($F(8, 788)=2.814, p<.004$), whereby the
patients GCH, VSK, THP, THEX, and PAPAL have scored significantly lower than the controls in the conditions having derived subjects, i.e. anti-causative verbs \((t(788)=1.901, p<.05\) for GCH, \(t(788)=3.326, p<.0009\) for VSK, \(t(788)=4.039, p<.0001\) for THP, \(t(788)=3.326, p<.0009\) for THEX, and \(t(788)=4.752, p<.0001\) for PAPAL). Further ANOVA analyses with subject, voice and derivation as the repeated measures have revealed that NACT voice morphology in derived structures posed exceedingly greater naming difficulty than ACT voice morphology for the aphasics relative to the controls \((F(8, 779)=2.044, p<.03)\). More specifically, the naming scores of half of the patients in the NACT derived condition were considerably lower than the controls \((t(779)=4.159, p<.0001\) for VSK, \((t(779)=3.331, p<.0009\) for THP, \(t(779)=3.157, p<.001\) for THEX, and \(t(779)=4.137, p<.0001\) for PAPAL). On the other hand, THP and PAPAL were the only patients whose naming scores in ACT anti-causatives were significantly lower relative to the controls for the respective condition \((t(779)=3.689, p<.0001\) for THP, and \(t(779)=4.193, p<.0001\) for PAPAL). These findings are particularly telling of the fact that ACT voice morphology in anti-causatives was less challenging for the aphasic individuals relative to NACT morphology (at least in production), thus, supporting our assumptions (i) of the processing difficulty associated with morphologically marked forms and (ii) of the greater processing resources taxed on the aphasic parser by the realization of marked NACT verbs. On the other hand, the use of NACT morphology appeared to be identified with the naming of prototypical reflexive predicates whereby the naming accuracy for both the controls and five of the aphasic patients (VSK, SP, THP, THEX, and PAPAL) was the highest relative to the anti-causative verbs also targeting NACT voice morphology.

The dissociation observed between ACT and NACT voice morphology seems to be inconsistent with the naming results from Stavrakaki et al.’s (2006) study wherein NACT morphological marking on anti-causative verbs appeared to facilitate the naming performance of one of the two Greek-speaking Broca’s aphasics participating in their study (the second patient could not name anti-causative verbs altogether irrespective of their voice morphological marking). According to Stavrakaki et al. the problem with the naming of anti-causative verbs of ACT morphology is mainly attributable to a
grammatical encoding deficit preventing the patient from mapping the thematic roles onto syntax. The reason why the aphasic patient found naming of NACT anti-causatives easier was that the additional layer in anti-causatives with passive morphology functioned as a marker of intransitivity and, thus, facilitated grammatical encoding. In the present naming task, on the contrary, the only instances wherein the naming of NACT verbs was considerably error-free for the majority of the aphasic patients and the controls was when the verbs targeted prototypical reflexive activities with non-derived syntactic subjects.

Another interesting finding with respect to the aphasics’ naming data derived from the reflexive verbal set is related to the systematic lexicalization of the monos/i tu/tis ‘by his/her own’ phrase. This finding is rather surprising taking into the account the fact that ‘the use of an overt agent-phrase in reflexives is considered to be marked, even marginally acceptable in many cases’ in the Greek language at least (Tsimpli, 2006; Laskaratou & Philippaki-Warburton, 1984; Joseph & Philippaki-Warburton, 1987, a.o.). Its frequent lexicalization by the overwhelming majority of the aphasic individuals (more specifically, by seven of the eight patients) participating in the present task could be attributed to a compensation strategy they have developed to communicate the thematic properties of the relevant verbal predicates in the most explicit manner.

Finally, an ANOVA analysis with subject, animacy, and derivation as the repeated measures has yielded a significant interaction effect ($F(8, 787)=2.321, p<.001$). According to the effect’s details, five of the patients had scored significantly lower than the controls in derived/anti-causative structures with inanimate subjects ($t(787)=3.216, p<.001$ for GCH, $t(787)=4.754, p<.0001$ for VSK, $t(787)=3.729, p<.0002$ for THP, $t(787)=4.241, p<.0001$ for THR, $t(787)=2.191, p<.001$ for THEX, and $t(787)=3.216, p<.001$ for PAPAL), while there were only two patients found to score significantly lower than the controls in derived/anti-causative structures with animate subjects ($t(787)=2.957, p<.003$ for THEX, and $t(787)=4.189, p<.0001$ for PAPAL). The addition of the voice variable into the repeated measures analysis ($F(8, 779)=6.453, p<.0001$) has revealed that the majority of the patients’ difficulty with the
naming of derived structures within an inanimate subject was limited to the NACT anti-causative verbs ($t(779)=5.181, p<.0001$ for VSK, $t(779)=2.035, p<.04$ for SP, $t(779)=2.628, p<.008$ for THR, $t(779)=2.628, p<.008$ for THEX, and $t(779)=3.405, p<.007$ for PAPAL).

The statistically significant naming performance dissociation between NACT unaccusatives with an animate and an inanimate subject, which was registered for both controls and the majority of the patients, suggests that both the language-unimpaired subjects and the aphasics were affected by the animacy of the subject in qualitatively similar ways in the naming task. More specifically, both groups have shown a marked preference to project a Voice head mainly when naming anti-causative verbs with an animate derived subject. On the contrary, their tendency to project a Voice head when naming the same verbs, yet, with an inanimate entity in subject position appeared to diminish considerably. The fact that the non-target (i.e. ACT voice) responses for both the controls and most of the aphasics for the NACT anti-causative verb class with an inanimate subject were almost always applied to verbs having an ACT voice morphological alternant implies that the Voice projection was crucially dependent upon the semantic information encoded in the syntactic subject. It is likely that the animacy of the subject in the relevant class forced the parser to denote a syntactically implicit external cause or agent, hence, the NACT voice marking of the anti-causative verb.

7.2.3.2 Summary of the results of the PNT

The results from the naming task provide evidence in favour of processing similarities between the aphasic patients and the controls. We found a main effect of voice morphology and derivation on both groups' naming responses. More specifically, we found that the non-target response rates were the highest for the NACT structures, and more particularly, the derived ones for both the controls and the majority of the aphasic individuals. Nevertheless, the aphasics' non-target response rates were considerably higher relative to the controls in the expected direction. These results suggest that at
least part of the voice morphology and the derivation effects may reflect the greater processing cost inflicted by the realization of NACT voice morphology and the derivation of the syntactic subject in the anti-causative structures, respectively. Additionally, we found a marked trend towards non-target responses for the NACT anti-causative verbs with an inanimate subject across both groups. The hypothesis that the animacy of the subject is relevant in the morphological realization of anti-causative verbs corroborates the widely reported assumption that the lexical feature of animacy is a crucial parameter that drives syntactic predictions about voice realization and not a separate non-combinatorial stream of information that works independently from the mechanism that computes syntactic relations. This is crucial experimental evidence that the aphasics (along with the language-unimpaired subjects) maintained and utilized lexically-relevant information in their production modality.
7.2.4 The sentence repetition task

The reader is reminded that the repetition task has focused on quantifying the experimental participants’ target and non-target responses, the difference between them referring exclusively to the inappropriate use of ACT/NACT voice morphology. For example, non-target responses for the ACT anti-causative verbal set would be the repetition of the verb *vuliaz* ‘sink-ACT’ as *vuliazete* ‘sink-NACT’ or, alternatively for the NACT anti-causative verb category, the repetition of the verb *lerothike* ‘spill-NACT’ as *lerose* ‘spill-ACT’. Non-target responses for the reflexive set would be the repetition of *ntini* ‘dress-ACT’ without an object, the target response being *ntinete* ‘dress-NACT’. Finally, with respect to the class of ACT transitive verbs, the production of a reciprocal verb like *filiunte* ‘kiss each other-NACT’ instead of *filai* ‘kiss-ACT’ was considered to be a non-target response. The repetition task involved the same verb classes also employed in the SPM and the naming task. Likewise, the variables investigated were the same with the ones checked in the SPM and the naming task, i.e. verb class, voice morphology, animacy, and derivation of the syntactic subject.

Repetitions which were pragmatically irrelevant to the action described by the verb as well as zero responses were classified under the ‘other’ errors category. Figures (7.66.)-(7.74.) that follow visualize the distribution (%) of the target, non-target and ‘other’ repetitions for the controls and each of the eight aphasic patients.

Descriptive values for each condition are presented in Table 7.11.
Table 7.11. Controls’ and aphasics’ mean accuracy ratings (%), SDs (in the parentheses), and type (i.e. non-target/’other’) of inaccurate repetitions across all the conditions in the repetition task.

<table>
<thead>
<tr>
<th>Participants</th>
<th>Reflexives</th>
<th>ACT Anti-causatives</th>
<th>NACT Anti-causatives-Animate subject</th>
<th>NACT Anti-causatives-Inanimate subject</th>
<th>ACT Transitives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>Target (S.D.)</td>
<td>Non-target/other</td>
<td>Target (S.D.)</td>
<td>Non-target/other</td>
<td>Target (S.D.)</td>
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<td></td>
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<td>-</td>
<td>100 (.0)</td>
<td>-</td>
<td>95 (.229)</td>
</tr>
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<td>74 (.452)</td>
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<td>67 (.492)</td>
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<tr>
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<td>-</td>
<td>95 (.229)</td>
<td>5 other</td>
<td>100 (.0)</td>
</tr>
<tr>
<td>VSK</td>
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<td>-</td>
<td>95 (.229)</td>
<td>5 other</td>
<td>100 (.0)</td>
</tr>
<tr>
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<td>-</td>
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<td>-</td>
<td>84 (.374)</td>
<td>11 other</td>
<td>84 (.389)</td>
</tr>
<tr>
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<td>58 (.507)</td>
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<td>17 (.447)</td>
<td>-</td>
<td>17 (.447)</td>
<td>other</td>
<td>17 (.447)</td>
</tr>
</tbody>
</table>
Detailed analyses of the performance of the controls and each aphasic individual in the present task are presented below.
Figure 7.66. Control group: Target, non-target, and ‘other’ repetitions (%) for the reflexive, the anti-causative and the transitive verbs in the repetition task.

As one can see from Figure (7.66.), the control subjects’ repetition rates were near/at ceiling level across all the verb classes. As such, no main verb class effect was found.
The ANOVA analysis with verb class, voice, animacy and derivation of the subject as the repeated measures has not revealed a main effect for any of the testing variables. As one can see from Figure (7.67.), GCH seems to have identified the unambiguous use of NACT voice morphology with the reflexives whereby his repetition performance has reached ceiling level (100%). His repetition scores for the rest of the verbal categories were almost target-like, except from the set of the anti-causative verbs with an inanimate subject targeting NACT morphology wherein the specific patient has performed at not a considerably above chance level (66.67%). His error types for both NACT anti-causative verb classes consisted exclusively of non-target repetitions applied only to voice-alternating verbs, while the patient’s non-target (i.e. NACT) responses for the ACT anti-causatives were all applied to non-alternating verbs.
A variance analysis with subject and verb class as the repeated measures has yielded a significant dissociation between GCH and the controls ($F(4, 838)=10.368$, $p<.0001$), which has stemmed from the patient’s significantly lower repetition performance in ACT anti-causatives ($t(838)=10.827$, $p<.0001$), NACT anti-causatives with inanimate subjects ($t(838)=10.899$, $p<.0001$), NACT anti-causatives with animate subjects ($t(838)=5.449$, $p<.0001$), and transitives ($t(838)=4.221$, $p<.0001$).

The ANOVA analysis has yielded main effects for the verb class ($F(4, 48)=3.815$, $p<.009$), and the voice ($F(1, 48)=4.032$, $p<.05$) variable. Both effects were attributable to VSK’s poor performance in the repetition of transitive verbs (60%), whereby the patient’s erroneous repetitions consisted exclusively of
pragmatically irrelevant (i.e. ‘other’) productions. His score for the relevant category was found to be significantly worse than the patient’s repetition scores in all the rest of the verb classes ($t(48)=2.990$, $p<.004$ for the performance dissociation between transitives and reflexives, $t(48)=3.267$, $p<.002$ for the performance dissociation between transitives and ACT anti-causatives, and $t(48)=3.552$, $p<.0009$ for the performance dissociation between transitives and NACT anti-causatives with an inanimate or an animate subject). Moreover, his performance in transitives was significantly worse relative to the controls ($t(838)=17.108$, $p<.0001$). Except from VSK’s repetition performance in the transitive verb class, the patient’s overall repetition capacity was target-like.

<SP>

Figure 7.69. SP: Target, non-target, and ‘other’ repetitions (%) for the reflexive, the anti-causative and the transitive verbs relative to the control group.
The ANOVA analysis has not revealed any significant effect for any of the testing variables. As one can see from the distribution of SP’s non-target repetitions in Figure (7.69.), the specific patient seems to have identified the use of ACT and NACT voice morphology with the transitive and the reflexive verbs, respectively. The performance dissociation between the patient and the control group was found to be highly significant ($F(4, 838)=7.234, p<.0001$), with significant differences being registered for the ACT anti-causatives ($t(838)=7.969, p<.0001$), and the NACT anti-causatives ($t(838)=6.685, p<.0001$ for both classes). The patient’s errors for the anti-causative verb classes consisted of both ‘other’ and non-target repetitions, with the latter error type being exclusively applied to voice-alternating verbs.

<THP>

Figure 7.70. THP: Target, non-target, and ‘other’ repetitions (%) for the reflexive, the anti-causative and the transitive verbs relative to the control group.
The analysis run on THP’s repetition data has yielded a main effect for the derivation variable \((F(1, 48)=4.099, p<.04)\), such that the patient’s repetition performance was found to be significantly worse in the structures with a derived subject, i.e. anti-causatives, relative to the structures with a non-derived subject, i.e. transitives and reflexives. As one can see from Figure (7.70.), the patient’s highest scores were reported for the reflexive and the transitive verb class, whereby THP has applied NACT and ACT voice morphology, respectively, at a well above-chance level. THP’s repetition performance in reflexives, though, was found to be significantly worse relative to the controls \((t(838)=3.712, p<.0002)\). On the other hand, THP’s performance in the anti-causative verb categories was relatively less successful, with the lowest accuracy score being reported for the NACT anti-causative verbs with an animate subject (42%). The patient’s scores across the three anti-causative verb classes were found to be significantly worse relative to the control group \((t(838)=15.237, p<.0001\) for the ACT anti-causatives, \(t(838)=7.189, p<.0001\) for the NACT anti-causatives with an inanimate subject, and \(t(838)=16.776, p<.0001\) for the NACT anti-causatives with an animate subject). The overwhelming majority of THP’s erroneous repetitions in the unnacusative verb classes were classified under the ‘other’ responses category (except from a single non-target response registered for the ACT anti-causative verb class, and, more specifically, for the non-voice-alternating verb *platenol’ widen-ACT*).
DENT’s repetition performance did not appear to be significantly affected by any of the testing variables of the experiment. As one can see from Figure (7.71), the use of NACT voice morphology was identified with the unambiguous reflexive meaning. Furthermore, except from a single repetition error classified under the ‘other’ error category in the transitive verbal set, the repetition of ACT transitive verbs was fairly good (80%). On the other hand, the computation of voice morphology during the repetition of anti-causative verbs was less stable across the three classes. Such instability has probably stemmed from the lack of transparency between syntax and meaning characterizing the morphological realization of morphologically unmarked (i.e. ACT) anti-causative verbs. As such, the highest error rate was reported for the anti-causative verbal set targeting ACT voice morphology with 7/19 (36.84%) non-
target responses registered for non-voice-alternating verbs. DENT’s low performance in the specific category was significantly worse than that of the control group ($t(838)=14.890, p<.0001$). Such pattern of performance probably reflects DENT’s tendency to morphologically mark the verbs encoding a transitivity change. On the other hand, DENT’s performance in the two NACT anti-causative classes was also found to be significantly worse relative to the controls ($t(838)=8.030, p<.0001$ for the NACT anti-causatives with an inanimate subject, and $t(838)=5.353, p<.005$ for the NACT anti-causatives with an animate subject). The patient’s non-target responses for the NACT anti-causatives, though, were grammatically licit, since they were exclusively applied to voice-alternating anti-causative verbs.

**<THR>**

Figure 7.72. THR: Target, non-target, and ‘other’ repetitions (%) for the reflexive, the anti-causative and the transitive verbs relative to the control group.
The ANOVA analysis performed on THR’s repetition data has exhibited significant effects for the verb class ($F(4)=4.160, p<.005$), the derivation ($F(1, 48)=3.797, p<.05$), the animacy of the subject variable ($F(4, 48)=4.305, p<.04$), as well as a significant effect for the interaction between the animacy (of the subject), the voice and the derivation variable ($F(1, 51)=5.452, p<.02$). More specifically, the verb class effect has largely stemmed from THR’s near chance level performance in ACT anti-causatives. In fact, the patient’s score for the specific class was found to be significantly lower than reflexives ($t(48)=2.463, p<.01$), NACT anti-causatives with an inanimate subject ($t(48)=3.358, p<.001$), NACT anti-causatives with an animate subject ($t(48)=2.693, p<.009$), and transitives ($t(48)=2.463, p<.01$). Half of the patient’s erroneous responses for the ACT anti-causative verb category were non-target (i.e. NACT) repetitions applied to non-voice-alternating verbs. Also, the patient’s score for ACT anti-causatives was considerably lower relative to the controls ($t(838)=21.839, p<.0001$). A significant between-subject performance dissociation was also registered for the NACT anti-causative verbs with an animate subject ($t(838)=3.435, p<.0006$). Furthermore, the significant animacy by voice by derivation interaction effect has corroborated the finding that the NACT anti-causative verbs with an inanimate subject were repeated in a more target-like manner than the ACT anti-causatives with an inanimate subject ($t(51)=2.335, p<.02$).
Figure 7.73. THEX: Target, non-target, and ‘other’ repetitions (%) for the reflexive, the anti-causative and the transitive verbs relative to the control group.

Except from a single instance of a pragmatically irrelevant repetition for the verbal set targeting anti-causative verbs with ACT morphology, THEX’s performance across the rest of the verbal classes has reached ceiling level (100%). As such, THEX’s performance in the repetition task did not appear to be differentially affected by any of the testing variables of the task.
The ANOVA analysis run on PAPAL’s repetition data has revealed a significant voice by derivation interaction effect ($F(1, 48)=6.338, p<.01$). Though the verb class effect was not found to be significant ($p=.08$), pair-wise analyses have yielded significant dissociations between the patient’s score in ACT anti-causatives and NACT anti-causatives with an animate subject ($t(48)=2.083, p<.04$), ACT anti-causatives and transitives ($t(48)=2.236, p<.03$), as well as between reflexives and transitives ($t(48)=2.026, p<.04$). As one can see from Figure (7.74,) these dissociations have mainly stemmed from PAPAL’s below chance performance in ACT anti-causative and reflexive verbs (47.37% and 40%, respectively). Further variance analyses have revealed that PAPAL’s repetition performance in reflexives, ACT anti-causatives, and NACT anti-causatives with an inanimate or an animate subject was
significantly worse relative to the controls ($t(838)=11.593, p<.0001$, $t(838)=19.825, p<.0001$, $t(838)=12.473, p<.0001$, and $t(838)=4.989, p<.0001$ respectively). The only verbal set wherein PAPAL’s repetition performance was error-free was the ACT transitive verbs. As expected, the ACT verbs with a non-derived subject, i.e. transitives, were easier to repeat for the patient than the ACT verbs with a derived subject, i.e. ACT anti-causatives ($t(48)=2.220, p<.03$). The same finding, though, did not apply to the NACT predicates, since there was no significant dissociation found between the NACT verbs with a non-derived subject, i.e. reflexives, and the NACT verbs with a derived subject, i.e. NACT unnacussatives ($p=.18$).

Overall, what most characterized PAPAL’s repetition performance across the five verbal sets was a severe disturbance of his repetition skills, most problems lying in accessing the appropriate lexical items. PAPAL’s lexical access deficit and highly disturbed repetition capacity is consistent with the patient’s low scores in the Boston Naming and Repetition capacity assessment tasks of the BDAE battery (see ‘Table 4.4.’). Indeed, the overwhelming majority of the patient’s erroneous repetitions registered for the task were literal paraphasias and they were all classified under the ‘other’ responses category (there was only a single non-target repetition in the ACT anti-causative verb category which was applied to a non-voice-alternating verb).

7.2.4.1 Discussion

Figure (7.75.) below illustrates the accuracy rates of both the controls and the aphasic patients for each of the five verb categories in the sentence repetition task.
The performance gap reported between the control and the aphasic performances in the verbal repetition task was more pronounced relative to the SPM (7.2.2) and the naming task. More specifically, the subject effect was highly significant \( F(8, 1210)=44.676, p<.0001 \), with significant differences emerging between the controls and the overwhelming majority of the aphasic individuals \( t(1210)=7.144, p<.0001 \) for GCH, \( t(1210)=1.786, p<.07 \) for VSK, \( t(1210)=4.167, p<.0001 \) for SP, \( t(1210)=11.907, p<.0001 \) for THP, \( t(1210)=7.740, p<.0001 \) for DENT, \( t(1210)=5.358, p<.0001 \) for THR, and \( t(1210)=11.907, p<.0001 \) for PAPAL). This was an anticipated pattern of performance since the inability to orally repeat others' speech is a common impairment observed in patients with agrammatic aphasia.

The ANOVA analysis with subject and verb class as the repeated measures has revealed that the greatest number of between-subject dissociations \( F(32, 1174)=4.373, p<.0001 \) was reported for the ACT anti-causative class. More specifically, six of the patients (namely, GCH, THP, DENT, THR, and PAPAL) were found to score significantly lower than the controls in the respective category \( t(1174)=5.206, p<.0001 \) for GCH, \( t(1174)=3.123, p<.001 \) for SP, \( t(1174)=8.329, p<.0001 \) for THP, \( t(1174)=7.288, p<.0001 \) for DENT, \( t(1174)=8.329, p<.0001 \) for THR, and \( t(1174)=10.412, p<.0001 \) for PAPAL). Such a finding comes into sharp contrast with the PNT which evinced that the naming of NACT voice morphology was harder than the naming of ACT voice morphology. It thus appears that
NACT voice morphology was more easily elicited when supported by the auditory stimulus of the repetition task or, alternatively, that the production of ACT anti-causative verbs was less problematic when the aphasic subjects were presented with an image portraying the action described by the anti-causative verb. Given that the repetition errors of the patients GCH, DENT, and (at a secondary level) THR involved a high number of non-target (i.e. NACT) responses, we could assume that their non-target-like performance in the ACT anti-causative verb category has probably stemmed from the patients’ deficient access to the interface-conditioned properties of these verbs imposing ACT voice morphology on the verb’s stem.

Furthermore, an interesting error pattern systematically registered for some of the patients’ repetition data in the ACT anti-causative verb category was the inappropriate marking of the pre-verbal derived subject with accusative (instead of nominative) case, as well as its repetition in post-verbal position with the accusative case marking being preserved (80). The double spelled-out copies demonstrated by some of the aphasics in the repetition paradigm may not be coincidental but they presumably reflect a resort strategy aiming at lowering the processing cost inflicted by the obligatory deletion of the copy of the internal argument which has to move to pre-verbal position. On the other hand, the nominative case violation evinces impairment in the mechanism checking the uninterpretable Case feature carried by the Tense˚ functional projection45.

(80)
Examiner: I limni pagose.
“The lake-NOM freezed-ACT”

45 The specific error pattern could also be attributed to a ‘self-reflection’ strategy the patients have employed to estimate the accuracy of their response. The specific strategy has been reported to be extensively used in a series of sentence repletion tasks (Agathopoulou, p.c.).
With respect to the subjects’ performance for the rest of the verb classes, the most pronounced between-subject performance dissociations were registered for the NACT anti-causative verbs. More specifically, five of the patients (namely, GCH, DENT, THP, and PAPAL) were found to score significantly lower than the controls. Except from the patients GCH and DENT who tended to repeat NACT voice-alternating anti-causative verbs with ACT voice morphology, the majority of THP’s and PAPAL’s erroneous repetitions for the NACT anti-causative class consisted of pragmatically inappropriate output. Furthermore, the performance of the overwhelming majority of the aphasic patients in the reflexives was very close to that of the controls, except from the subjects PAPAL and THP who have made few repetition errors that consisted exclusively of ‘other’ responses. Finally, the only highly outlying performance registered for the transitive verb class was demonstrated by the patient VSK whose errors consisted exclusively of ‘other’ responses.

As expected, the subject by derivation interaction effect ($F(8, 1201)=3.817$, $p<.0002$) was highly significant. More specifically, six of the patients (namely, GCH, SP, THP, DENT, THR, and PAPAL) have performed considerably worse than the controls in the structures having a derived subject ($t(1201)=7.350$, $p<.0001$ for GCH, $t(1201)=4.677$, $p<.0001$ for SP, $t(1201)=12.28$, $p<.0001$ for THP, $t(1201)=8.019$, $p<.0001$ for DENT, $t(1201)=6.014$, $p<.0001$ for THR, and $t(1201)=11.360$, $p<.0001$ for PAPAL), and only two of the patients (namely, THP, and PAPAL) have performed worse than the controls in structures with a non-derived subject ($t(1201)=2.771$, $p<.005$ for THP, and $t(1201)=4.157$, $p<.0001$ for PAPAL). As already mentioned, the aphasics’ relatively poorer performance in the verbs having a derived subject (i.e. anti-causatives) was also significantly modulated by the voice factor ($F(8, 1200)=5.165$, $p<.0001$), such that the repetition of ACT derived structures was more problematic than the repetition of NACT derived structures for the aphasics relative to the controls.
Finally, the overwhelming majority of the aphasic individuals was found to score significantly worse than the controls in the repetition of anti-causatives with an inanimate (vs. animate) subject ($F(8, 1200)=4.213, p<.008$, $t(1200)=6.856, p<.0001$ for GCH, $t(1200)=2.056, p<.03$ for VSK, $t(1200)=3.428, p<.0006$ for SP, $t(1200)=8.913, p<.0001$ for THP, $t(1200)=7.542, p<.03$ for DENT, $t(1200)=5.485, p<.0001$ for THR, and $t(1200)=2.056, p<.03$ for PAPAL).

7.2.4.2 Summary of the repetition task

The results of the repetition task have demonstrated that the overwhelming majority of the aphasic patients that have participated in the present study had relatively preserved their ability to repeat non-derived structures, i.e. reflexives and transitives, in a target-like manner. On the contrary, the repetition task has revealed poorer repetition capacities for the anti-causatives, and especially for the ACT anti-causative verb class, such that the specific verbs were usually repeated with NACT voice morphology. In fact, such a performance was manifested by more than half (more specifically, six) of the aphasic participants. One viable account for the specific pattern of performance is that the specific aphasic individuals faced difficulty applying lexical constraints in the repetition of ACT anti-causatives, such that they failed to apply the lexicon-filtered ACT voice morphology as required. In addition, the specific finding implies that the procedures underlying the repetition of ACT voice anti-causatives is qualitatively different from those underlying their naming (the reader is reminded that the scores of the aphasics for the ACT anti-causatives in the PNT were well above chance level (Mean of the aphasic group: 80%)). As such, the repetition task exemplifies more directly the aphasic limitation in accessing the lexicon-syntax interface constraints imposing the application of ACT voice morphology relative to the naming task, whereby the production of ACT voice morphology was less challenging. The patients’ poor repetition of ACT anti-causatives appears to be the locus of the dissociation between the patients and the controls in the repetition task, thus, suggesting that the interface-conditioned properties crucially
implicated in the computation of ACT voice anti-causatives was readily available to the normal speakers, but not to the majority of the aphasic subjects.
7.3 BETWEEN-TASK DISSOCIATIONS AT EACH INTERFACE

7.3.1 The discourse-syntax interface

7.3.1.1 Ambiguous subject pronoun resolution at the discourse-syntax interface: the online self-paced listening sentence-picture matching task and the online self-paced listening antecedent identification task

The present study allows a direct comparison between the subjects’ online performance (i.e. their antecedent preferences for the null and the overt subject pronouns) in ambiguous inter-sentential contexts with backward anaphora, and their online performance in ambiguous intra-sentential contexts with backward anaphora. This time the responses of the eight aphasic individuals were merged as we did with the controls across the various tasks. Descriptive values of the two groups’ referential preferences (%) (identified with the main clause subject/object for the intra-sentential task and with the first clause subject/object in the inter-sentential task) are presented in Table 7.12. and they are also depicted in Figure (7.76.) below. We should mention that the testing conditions involving an extra-sentential referent in the intra-sentential task (i.e. the “null pronoun-other” and the “overt pronoun-other” condition), as well as the OcIVS trials with a CLLDed object in the inter-sentential task were removed from the between-task analysis due to the fact that no corresponding conditions existed in both tasks.
Table 7.12. Mean ratings (%) of both groups’ referential preferences across the conditions of the two tasks.

<table>
<thead>
<tr>
<th>Group</th>
<th>INTRA-Sentential task</th>
<th>INTER-Sentential task</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Co-reference condition</td>
<td>Mean rating</td>
</tr>
<tr>
<td>Controls</td>
<td>null pronoun-subject</td>
<td>89 (SD:.180)</td>
</tr>
<tr>
<td></td>
<td>null pronoun-object</td>
<td>56.12 (SD:.306)</td>
</tr>
<tr>
<td></td>
<td>overt pronoun-subject</td>
<td>36.11 (SD:.218)</td>
</tr>
<tr>
<td></td>
<td>overt pronoun-object</td>
<td>79.50 (SD:.289)</td>
</tr>
<tr>
<td>Aphasics</td>
<td>null pronoun-subject</td>
<td>87.50 (SD:.332)</td>
</tr>
<tr>
<td></td>
<td>null pronoun-object</td>
<td>45 (SD:.500)</td>
</tr>
<tr>
<td></td>
<td>overt pronoun-subject</td>
<td>53.75 (SD:.501)</td>
</tr>
<tr>
<td></td>
<td>overt pronoun-object</td>
<td>82.50 (.382)</td>
</tr>
</tbody>
</table>
Figure 7.76. The aphasics’ and the controls’ subject & object antecedent rates (%) across the intra-sentential and the inter-sentential task during the disambiguation of the critical null & overt subject pronouns.

A within-group comparison between the matching scores which was done by the ANOVA analysis with task and reference condition as the repeated measures yielded significant effects for both variables.

More specifically, the aphasic subjects’ matching scores for the intra-sentential task were found to be significantly higher relative to the inter-sentential task (67.18% vs. 50%, $F(1, 56)=19.973$, $p<.0001$). This finding was largely due to the fact that the aphasics’ preference for the ‘null pronoun-object’ and the ‘overt pronoun-object’ links in the intra-sentential task was considerably greater relative to the inter-sentential task ($F(3, 56)=10.266$, $p<.0001$, $t(56)=2.938$, $p<.004$, and $t(56)=6.188$, $p<.0001$, respectively).
respectively). The ‘null pronoun-subject’ condition was the highest scored condition for the aphasic group (82.55%, $F(3, 56)=26.918$, $p<.0001$). In fact, the aphasics’ score in the ‘null pronoun-subject’ condition was found to be significantly higher relative to the ‘null pronoun-object’ ($t(56)=8.982$, $p<.0001$), the ‘overt pronoun-subject’ ($t(56)=4.251$, $p<.0001$), and the ‘overt pronoun-object’ ($t(56)=4.385$, $p<.0001$) condition.

Likewise, the controls’ matching scores for the intra-sentential task were considerably higher relative to the inter-sentential task (65.18% vs. 48.71%, $F(1, 196)=17.448$, $p<.0001$). This effect has mainly stemmed from the fact that their matching scores for the ‘null pronoun-subject’ and the ‘null pronoun-object’ conditions were significantly higher in the intra-sentential relative to the inter-sentential task ($t(196)=3.771$, $p<.0002$, and $t(196)=1.848$, $p<.05$, respectively). The highest scores for the controls across the two tasks were registered for the ‘null pronoun-subject’ (73.67%) and the ‘overt pronoun-object’ (74.80%) condition, which were found to have significantly higher matching scores relative to both the ‘null pronoun-object’ and the ‘overt pronoun-subject’ condition ($F(3, 196)=26.361$, $p<.0001$, $t(156)=4.362$, $p<.0001$ for the ‘null subject’ vs. ‘null object’ dissociation, $t(196)=7.306$, $p<.0001$ for the ‘null subject’ vs. ‘overt subject’ dissociation, $t(196)=4.557$, $p<.0001$ for the ‘overt object’ vs. ‘null object’ dissociation, and $t(196)=7.501$, $p<.0001$ for the ‘overt object’ vs. ‘overt subject’ dissociation).

A further comparison between the matching scores in each reference condition, which was done by ANOVA analyses with task and group as the repeated measures yielded no difference between the two groups for the ‘null pronoun-object’ and the ‘overt pronoun-subject’ reference conditions across the two tasks, but yielded a significant group by task interaction effect for the ‘null pronoun-subject’ and the ‘overt pronoun-object’ reference condition ($F(3, 255)=25.131$, $p<.0001$). More specifically, while the aphasics’ and the controls’ scores for the ‘null pronoun-subject’ condition were positively correlated in the intra-sentential task (89% matching scores for the controls and 87.50% matching scores for the aphasics, Controls-Aphasics: $r=.868$, $p<.01$), the patients’ matching scores for the ‘null pronoun-subject’ condition in the inter-sentential task were found to be significantly higher.
relative to the controls (77.60% for the aphasics vs. 58.35% for the controls, t(255)=5.634, p<.0001). Likewise, while the two groups’ performances for the ‘overt pronoun-object’ reference condition were positively correlated in the intra-sentential task (79.50% matching scores for the controls and 82.50% matching scores for the aphasics, Controls-Aphasics: r=.842, p<.01), the between-group dissociation in the inter-sentential task for the ‘overt pronoun-object’ condition was found to be highly significant (t(255)=12.840, p<.0001), with the controls’ matching scores being considerably higher relative to the aphasics (70.10% vs. 34.89%).

These results have important implications for (i) methodological issues of ambiguous pronoun resolution assessment, and (ii) the evaluation of the nature and the cause of the language deficit in the patients with Broca’s aphasia. First, the interface features regulating the interpretation of overt subject pronouns appeared to be more active for the aphasics in the intra-sentential task whereby the overt subject pronouns were systematically interpreted as referring to the main clause object relative to the inter-sentential task, wherein the Topic-Shift feature carried by the overt pronouns was rarely satisfied (i.e. the aphasic group preferred to interpret the overt pronoun as referring to the syntactic subject instead). On the other hand, the widely reported ‘default choice’ effect reported for language-unimpaired populations in several NSLs, whereby subject pronoun drop is particularly pervasive when the referent is identified with the syntactic subject, did not appear to hold for the control group in the inter-sentential task of the present study; null pronouns in the referentially ambiguous inter-sentential contexts were almost randomly assigned to either the syntactic subject or the object of the first clause (subject antecedent rates (58.35%) ≈ object antecedent rates (41.65%)). We hypothesize that both groups’ behaviours stem from the specific processing requirements posed by the inter-sentential task and that it is possible (at least on principled grounds) to attribute both controls’ and the aphasics’ different patterns of performance in the inter-sentential task to its methodological design.

More specifically, what seemed to differentiate the two pronoun resolution tasks in the present study was (i) the greater spatial verbal interference between the candidate antecedents and the critical
pronoun in the inter-sentential relative to the intra-sentential task, and (ii) the greater structural complexity of the trials in the inter-sentential task caused by the non-canonical word-order alternations forced by the CLLD of the syntactic object across both the null and the overt pronoun trials (i.e. OclVS-null pronoun & OclVS-overt pronoun trials). The topicalization of the syntactic object by means of CLLD and the need to maintain and retrieve from memory one of the two NP-candidate antecedents until the critical pronoun in the second discourse was encountered might have increased processing difficulty, thus, negatively influencing the participants' ability to resolve pronoun ambiguity online. This implies that verbal working memory (WM) may be especially important for adjudicating between candidate structures in cases of referential ambiguity. We believe that the results of the WM task (see 7.4) shed more light into how verbal WM has been deployed during syntactic processing and single-word retrieval processes by both the controls and the eight Broca’s aphasic individuals participating in the present study.
7.3.2 The lexicon-syntax interface

7.3.2.1 The processing of verbs of alternating transitivity at the lexicon-syntax interface: 
the offline sentence-picture matching, the picture-naming and the repetition task

As already analyzed, the group of the eight patients with Broca’s aphasia and the group of the fifteen 
age-matched control participants were also submitted to a battery which has tested the same verbal 
stimuli (i.e. reflexives, ACT transitives, and anti-causatives with [±ACT] morphology and [±animate] 
subject) across three offline tasks: a SPMT, a picture-naming and a repetition task. Table 7.13.
presents the descriptive values for each task and for each of the two groups, while Figure (7.77.) 
displays the performance of the two groups across the three tasks. The reader is reminded that the 
aphasic patients’ data were subjected to a merging operation.

Table 7.13. Mean ratings (%) of both groups’ performance across the verb classes of the three 
tasks.

<table>
<thead>
<tr>
<th>Group</th>
<th>SPMT Verb category</th>
<th>PNT Verb category</th>
<th>RT Verb category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean rating</td>
<td>Mean rating</td>
<td>Mean rating</td>
</tr>
<tr>
<td>Controls</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reflexives</td>
<td>96.26 (SD:.197)</td>
<td>87.40 (SD:.324)</td>
<td>100 (SD:.0)</td>
</tr>
<tr>
<td>ACT Anti-causatives</td>
<td>100 (SD:.0)</td>
<td>91.60 (SD:.273)</td>
<td>100 (SD:.0)</td>
</tr>
<tr>
<td>NACT Anti-causative-Inanimate subject</td>
<td>96.26 (SD:.197)</td>
<td>73.93 (SD:.445)</td>
<td>95.33 (SD:.00)</td>
</tr>
<tr>
<td>NACT Anti-causatives-Animate subject</td>
<td>68.33 (SD:.469)</td>
<td>87.80 (SD:.327)</td>
<td>100 (SD:.00)</td>
</tr>
<tr>
<td>ACT transitives</td>
<td>100 (SD:.0)</td>
<td>100 (SD:.0)</td>
<td>100 (SD:.0)</td>
</tr>
<tr>
<td>Aphasics</td>
<td>Reflexives</td>
<td>72.50 (SD:.452)</td>
<td>73.75 (SD:.443)</td>
</tr>
</tbody>
</table>
Before analyzing the two groups’ performances across the relevant tasks, it should be underlined that the latter required very different processing abilities and involved two different sensory modalities: visual and auditory. The first two tasks, i.e. the SPMT and the PNT used both modalities.

<table>
<thead>
<tr>
<th></th>
<th>ACT anti-causatives</th>
<th>NACT anti-causative-Inanimate subject</th>
<th>NACT anti-causatives-Animate subject</th>
<th>ACT transitives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>57.50 (SD:.500)</td>
<td>72.50 (SD:.452)</td>
<td>52.50 (SD:.505)</td>
<td>45 (SD:.501)</td>
</tr>
<tr>
<td></td>
<td>80 (SD:.405)</td>
<td>40 (SD:.496)</td>
<td>65 (SD:.483)</td>
<td>77.50 (SD:.420)</td>
</tr>
<tr>
<td></td>
<td>71.75 (SD:.448)</td>
<td>83.50 (SD:.383)</td>
<td>83.25 (SD:.374)</td>
<td>87.50 (SD:.334)</td>
</tr>
</tbody>
</table>

Figure 7.77. The aphasics’ and the controls’ target-like rates (%) across the three tasks investigating the processing of verbs at the lexicon-syntax interface.
More specifically, with respect to the SPMT, in order for the participant to do the correct matching he should be influenced by the sentential properties at the spoken level (such as verb class, [±ACT] voice morphology, [± animacy] of the syntactic subject), derive the meaning of the verb in question and, finally, choose the picture that best depicted the action portrayed by the verb after rejecting the two foils. On the other hand, in the PNT the subject should recognize the concept from the picture, derive its meaning and then link that meaning to its appropriate morpho-phonological form, which in turn should be orally produced. While also visual, both the SPM and the PN tasks were strongly dependant on semantic properties, since both tasks (arguably more so than the repetition paradigm) required from the subjects to process the meaning behind the pictures in order to give the appropriate response. Another factor considered to influence both tasks was ‘goodness or complexity of depiction’ of the pictures used. Crucially, a badly sketched drawing could disorient the patient’s intended response. As such, the specific tasks were potentially more heavily influenced by the ambiguity caused by extra-linguistic parameters than the repetition task. This fact should be kept in mind when analyzing the two groups’ performances, as it represents another level at which interesting between-group differences with respect to their processing abilities, difficulties and strategies could be found. On the other hand, the repetition paradigm varied from the other two tasks in that it was purely auditory. As such, performance on repetition was significantly influenced by the same sentential properties which were yet manifested only at the spoken level. Most importantly, each participant should repeat the sentence produced by the examiner without necessarily accessing the verb’s meaning.

A within-group comparison of the accuracy scores across tasks which was done by ANOVA analyses with task and verb class as the repeated measures has yielded significant effects for both variables for the control group (F(2, 210)=136.879, p<.0001, and F(4)=99.120, p<.0001, respectively), as well as a significant task by verb class interaction (F(8, 210)=73.524, p<.01). On the other hand, the variance analysis has yielded a significant task effect and a significant task by verb class interaction effect for the aphasics (F(2, 105)=13.350, p<.0001, and F(8, 105)=3.625, p<.0009, respectively).
Beginning with the control subjects, the verb class effect has mainly stemmed from their relatively lower performance in the NACT anti-causatives (88.51% for the NACT anti-causatives with an inanimate subject, and 85.37% for the NACT anti-causatives with an animate subject). In fact, the control performance in the specific class was found to be significantly lower relative to the rest of the verbal categories \((t(210)=7.013, p<.0001\) for the dissociation between NACT anti-causatives with an inanimate subject and reflexives, \(t(210)=10.082, p<.0000\) for the dissociation between NACT anti-causatives with an inanimate subject and ACT anti-causatives, \(t(210)=13.331, p<.0001\) for the dissociation between NACT anti-causatives with an inanimate subject and transitives, and \(t(210)=10.649, p<.0000\) for the dissociation between NACT anti-causatives with an animate subject and reflexives, \(t(210)=13.718, p<.0000\) for the dissociation between NACT anti-causatives with an animate subject and ACT anti-causatives, and \(t(210)=16.967, p<.0001\) for the dissociation between NACT anti-causatives with an animate subject and transitives). On the other hand, the task effect was largely due to the controls’ performance rates in the repetition task (99.06%) which were considerably higher relative to the SPM (92.17%) and the naming (88.14%) task \((t(210)=10.326, p<.0001\) for the dissociation between the repetition task and the SPMT, and \(t(210)=16.358, p<.0001\) for the dissociation between the repetition task and the naming task). Finally, the task by verb class interaction analysis has yielded significant differences with respect to the NACT anti-causative verbs. More specifically, the control comprehension of the NACT anti-causative verbs with an animate subject was significantly worse relative to both their naming and repetition (68.33% vs. 87.80%, \(t(210)=13.041, p<.0001\) for the SPMT vs. naming task dissociation, and 68.33% vs. 100%, \(t(210)=21.215, p<.0001\) for the SPMT vs. RT dissociation). Furthermore, the control performance in the NACT anti-causative verbs with an inanimate subject in the naming task was significantly worse relative to both the SPM and the repetition task (73.93% vs. 96.26%, \(t(210)=14.962, p>.0000\) for the naming task vs. SPMT dissociation, and 73.93% vs. 95.33%, \(t(210)=14.337, p<.0001\) for the naming vs. repetition task dissociation).
With respect to the aphasics, the task effect was attributable to the patients' considerably more accurate performance in the repetition task (83.20%) which was found to be significantly easier to perform than both the SPM (60%) and the naming task (67.25%) \((t(105)=5.050, p<.0001\) for the dissociation between the repetition task and the SPMT, and \(t(105)=3.472, p<.0008\) for the dissociation between the repetition and the naming task). As mentioned above, we expected a lower performance in the SPM and the PN task due to the higher difficulty and ambiguity levels inherent to these tasks relative to the repetition measure. The finding that both the controls and the aphasics performed significantly worse in the PN and the SPM task (relative to the repetition task) suggests that the dissociations detected between the verb classes (assumingly attributed to their lexicon-syntax interface-conditioned properties) may be specific only to meaning retrieval processes.

Furthermore, the highly significant task by verb class interaction reported for the aphasics is very important as it implies that the patients' performance in the five verb classes was differentially affected by the tasks employed. In fact, the greatest variance was reported for the transitive verbs and the NACT anti-causative verbs. More specifically, the comprehension of transitive verbs was significantly worse than both their repetition and naming \((87.50\% \text{ vs. } 45\%, t(105)=4.137, p<.0001\) for the repetition vs. SPMT dissociation, and \(77.50\% \text{ vs. } 45\% \ t(105)=3.163, p<.002\) for the picture naming vs. SPMT dissociation). In fact, the transitive verbs constituted the set with the greatest number of between-verb class dissociations within the SPMT \((t(105)=2.667, p<.008\) for the performance dissociation between transitives and reflexives, and between transitives and NACT anti-causatives with an inanimate subject). In other words, the pictures corresponding to the transitive verbs were less accurately comprehended than the rest of the verbal sets, but their repetition and naming did not differ significantly from most of the other verb classes. As already stressed, the difficulty that the aphasics experienced with the comprehension of the transitive verbs may be accounted for in terms of a frequency effect such that most of the patients tended to choose the interpretation most close to their lexical preferences i.e. the reciprocal meaning, ignoring thus grammatical constraints, i.e. ACT voice
morphology. Such an option was not offered by the visual stimuli in the picture naming or in the repetition task, therefore, the aphasic performance in the transitives tended to rise significantly in these two tasks.

Furthermore, the patients’ performance in the NACT anti-causatives with an inanimate subject was found to be significantly more problematic in the naming than in the SPM and the repetition task (40% vs. 72.50%, $t(105)=3.163$, $p<.002$ for the picture naming vs. SPMT dissociation, and 40% vs. 83.50%, $t(105)=4.234$, $p<.0001$ for the picture naming vs. repetition task dissociation). It is worth adding that the mean naming score (40%) for the ‘NACT anti-causative-inanimate subject’ class was the lowest among the verbal sets, such that the NACT anti-causative verbs with an inanimate subject were better comprehended and repeated than named relative to the rest of the verb classes. The specific result may be attributed to the [-animacy] of the subject probably disallowing the implication of a syntactically implicit external cause or agent that would have probably forced the NACT morphological marking of the anti-causative verb. Our assumption appears to be confirmed by the finding that the naming of the exact same verbs with an animate entity in subject position was significantly more target-like (65%). The finding though that the naming of the NACT anti-causatives with an animate subject was not significantly above-chance level renders the morpho-phonological complexity of the NACT morpheme susceptible for the aphasics’ low naming performance in NACT anti-causative verbs, in general.

With respect to the aphasics’ performance in the NACT anti-causative verbs with an animate subject, the analysis has revealed that their repetition was significantly better than both their comprehension and naming (83.25% vs. 52.50%, $t(105)=2.993$, $p<.003$ for the repetition vs. SPMT dissociation, and 83.25% vs. 65%, $t(105)=1.776$, $p<.06$ for the repetition vs. picture naming task dissociation). In fact, the comprehension of NACT anti-causative verbs with an animate subject was the lowest scored condition among the verbal sets examined. Such a pattern, as already mentioned, is due to the increased interpretive ambiguity caused by the underspecified NACT morpheme, further reinforced by the [+animacy] feature of the syntactic subject.
The only between-task dissociation reported for the ACT anti-causative verb class was the one registered between the picture naming and the SPMT (80% vs. 57.50%, \(t(105)=2.190, p<.03\)). More specifically, the comprehension of ACT anti-causative verbs was significantly worse than their naming, while no notable performance dissociation was found between the naming and the repetition task. On the other hand, the reflexive verbs constituted the verb category with the most highly correlated, though not at a significant level, aphasic performance scores across the three tasks (SPMT-PNT: \(r=.612, p=.106\), SPMT-RT: \(r=.218, p=.602\), PNT-RT: \(r=.333, p=.420\)).

Finally, as one can see from Figure (7.77.), the aphasic group has exhibited the lowest scores (relative to the control group) across all three tasks. Indeed, the group effect was found to be highly significant (\(F(1, 331)=195.698, p<.0001\)) with the accuracy scores for the aphasic individuals being considerably lower relative to the controls (70.15% vs. 93.12%). Further ANOVA analyses with verb class and task as the repeated measures have yielded significant interactions with the group factor for both variables (\(F(4, 331)=2.616, p<.03\), and \(F(2, 331)=8.614, p<.0002\), respectively). First, the verb class by group interaction was highly attributable to the fact that the controls have scored significantly higher than the aphasics in the ACT transitive (100% vs. 70%) and the ACT anti-causative verb class (97.66% vs. 65.61%, \(t(331)=8.167, p<.0001\) for the between-group dissociation in the transitives, and 92.20% vs. 69.75%, \(t(331)=7.473, p<.0001\) for the between-group dissociation in the ACT anti-causatives). With respect to the significant group by task interaction effect, this was largely due to the controls’ significantly higher accuracy scores in the SPM task (92.17% mean accuracy score for the controls vs. 60% mean accuracy scores for the aphasics, \(t(331)=11.308, p<.0001\)). This finding is important as it implies that the patients’ performance fell short of the controls’ range mainly with respect to the patients’ receptive (vs. production) capacities. Nevertheless, there are two plausible counterarguments to this. First, the aphasics’ low performance in the SPMT has been shown to mainly draw on frequency effects imposing a reciprocal reading of otherwise ACT transitive verbs, such that the patients’ accuracy scores for the transitive verb category were significantly lower relative to the controls.
(45% vs. 100%, t(323)=8.406, p<.0001). A second potentially viable account is related to the increased processing requirements inherent to the SPMT. It is possible that the processing resources of the individuals with aphasia were taxed to the maximum by the task’s requirement to choose among the three images, such that the SPM task demands have increased overall ambiguity and complexity. Such ‘less straightforward’ tasks (like the SPMT) probably require more processing steps thus inflicting a stronger ‘weight’ on the parser of individuals with more compromised abilities like the Broca’s aphasics.
7.4 THE WORKING MEMORY TASK

The reader is reminded that the participants in the WM task were asked to listen to sentences and remember a separate set of words for subsequent recognition. Length (two levels) and complexity (two levels) of the auditorily and visually presented sentences were manipulated creating the following four conditions: (i) short and simple (ACT transitive), (ii) short and complex (passives), (iii) long and simple (SRCs), and finally, (iv) long and complex (ORCs). Along with the auditory and visual presentation of each sentence, participants were required to do a SPMT, whereby they were presented with an array of three pictures (the target and two foils) and were asked to point to the image that best matched the sentence they have heard. In addition, at the end of a set of four sentences, an array of images was presented for recognition.

The dependent variable was the aphasics’ and the controls’ performance indexed by the following two measures (computed for each sentence-type condition): (i) the storage component score, whereby items were scored as the proportion of correctly recognized lexical items per sentence-type; for the final score a mean of these proportions was calculated, and (ii) the processing component score expressed as the proportion of items for which the target picture was correctly selected (for more details see the ‘Subjects and Methodology’ chapter). The controls’ data was once again merged, while the patients’ data was analyzed on an individual basis. Table 7.14 presents both the controls’ and the aphasics’ accuracy scores (%) across the processing and the storage component conditions.
Table 7.14. Controls’ and aphasics’ mean accuracy ratings (%) and SDs (in the parentheses) of their responses across the processing and the storage component in the WM task.

<table>
<thead>
<tr>
<th>Participants</th>
<th>PROCESSING COMPONENT</th>
<th>STORAGE COMPONENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sentence-type</td>
<td>Accuracy Rates</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(%)</td>
</tr>
<tr>
<td>Controls</td>
<td>Long &amp; Complex</td>
<td>90 (.302)</td>
</tr>
<tr>
<td></td>
<td>Long &amp; Simple</td>
<td>100 (.0)</td>
</tr>
<tr>
<td></td>
<td>Short &amp; Complex</td>
<td>100 (.0)</td>
</tr>
<tr>
<td></td>
<td>Short &amp; Simple</td>
<td>100 (.0)</td>
</tr>
<tr>
<td>Controls</td>
<td>Long &amp; Complex</td>
<td>50 (.577)</td>
</tr>
<tr>
<td></td>
<td>Long &amp; Simple</td>
<td>75 (.50)</td>
</tr>
<tr>
<td></td>
<td>Short &amp; Complex</td>
<td>50 (.577)</td>
</tr>
<tr>
<td></td>
<td>Short &amp; Simple</td>
<td>100 (.0)</td>
</tr>
<tr>
<td>GCH</td>
<td>Long &amp; Complex</td>
<td>25 (.50)</td>
</tr>
<tr>
<td></td>
<td>Long &amp; Simple</td>
<td>100 (.0)</td>
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<tr>
<td></td>
<td>Short &amp; Complex</td>
<td>0 (.0)</td>
</tr>
<tr>
<td></td>
<td>Short &amp; Simple</td>
<td>100 (.0)</td>
</tr>
<tr>
<td>VSK</td>
<td>Long &amp; Complex</td>
<td>0 (.0)</td>
</tr>
<tr>
<td></td>
<td>Long &amp; Simple</td>
<td>50 (.577)</td>
</tr>
<tr>
<td></td>
<td>Short &amp; Complex</td>
<td>0 (.0)</td>
</tr>
<tr>
<td></td>
<td>Short &amp; Simple</td>
<td>100 (.0)</td>
</tr>
<tr>
<td>SP</td>
<td>Long &amp; Complex</td>
<td>0 (.0)</td>
</tr>
<tr>
<td></td>
<td>Long &amp; Simple</td>
<td>50 (.577)</td>
</tr>
<tr>
<td></td>
<td>Short &amp; Complex</td>
<td>0 (.0)</td>
</tr>
<tr>
<td></td>
<td>Short &amp; Simple</td>
<td>100 (.0)</td>
</tr>
<tr>
<td>THP</td>
<td>Long &amp; Complex</td>
<td>0 (.0)</td>
</tr>
<tr>
<td></td>
<td>Long &amp; Simple</td>
<td>Short &amp; Complex</td>
</tr>
<tr>
<td>-----------</td>
<td>---------------</td>
<td>-----------------</td>
</tr>
<tr>
<td><strong>DENT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>75 (.50)</td>
<td>0 (.50)</td>
</tr>
<tr>
<td></td>
<td>100 (.0)</td>
<td>100 (.0)</td>
</tr>
<tr>
<td><strong>THR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 (.0)</td>
<td>0 (.0)</td>
</tr>
<tr>
<td></td>
<td>25 (.50)</td>
<td>25 (.50)</td>
</tr>
<tr>
<td></td>
<td>100 (.0)</td>
<td>100 (.0)</td>
</tr>
<tr>
<td><strong>THEX</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>25 (.50)</td>
<td>25 (.50)</td>
</tr>
<tr>
<td></td>
<td>100 (.0)</td>
<td>100 (.0)</td>
</tr>
<tr>
<td><strong>PAPAL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 (.0)</td>
<td>0 (.0)</td>
</tr>
<tr>
<td></td>
<td>50 (.577)</td>
<td>25 (.50)</td>
</tr>
<tr>
<td></td>
<td>100 (.0)</td>
<td>50 (.577)</td>
</tr>
</tbody>
</table>
In order to investigate within- and between-subject differences, a repeated measures ANOVA was performed on the processing and storage scores for the four testing conditions of the task. The analysis for the controls has yielded a significant effect for both the sentence- and the component-type variable ($F(3, 475)=11.140, p<.0001$, and $F(1, 475)=5.921, p<.01$, respectively), which has mainly stemmed from the controls’ significantly poorer performance (i) in long & complex sentences/ORCs (accuracy performance: 85.83%) relative to the rest of the sentence-type conditions, $t(475)=4.692$, $p<.0001$ for the long & complex vs. short & simple (accuracy: 98.33%) dissociation, $t(475)=4.379$, $p<.0001$ for the long & complex vs. short & complex (accuracy: 97.50%) dissociation, and $t(475)=5.005, p<.0001$ for the long & complex vs. long & simple (accuracy: 99.16%) dissociation), and (ii) in the storage component (accuracy rate: 92.91%) relative to the processing component (accuracy rate: 97.50%), $t(475)=2.433, p<.01$ for the storage vs. processing component dissociation). Though the sentence by component-type interaction was not found to be statistically significant ($p=.63$), further pairwise analyses have revealed that the controls have found considerably harder the retrieval of the individual words appearing after the long & complex sentences relative to the rest of the three sentence-types ($t(472)=3.976, p<.0001$ for the long & complex storage capacity vs. short & simple storage capacity dissociation, $t(472)=3.534, p<.0004$ for the long & complex storage capacity vs. short...
& complex storage capacity dissociation, and t(472)=4.418, p<.0001 for the long & complex storage capacity vs. long & simple storage capacity dissociation).

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Figure 7.79. VSK: Accuracy rates (%) in the processing and in the storage component of the WM task.

Figure 7.80. SP: Accuracy rates (%) in the processing and in the storage component of the WM task.

Figure 7.81. THP: Accuracy rates (%) in the processing and in the storage component of the WM task.

Figure 7.82. DENT: Accuracy rates (%) in the processing and in the storage component of the WM task.

Figure 7.83. THEX: Accuracy rates (%) in the processing and in the storage component of the WM task.
As one can see from Figures (7.79.)-(7.83.), five out of the eight aphasic patients (namely, the patients VSK, SP, THP, DENT, and THEX) have exhibited similar patterns of performance in the WM task, such that they have found complex sentences significantly harder to parse irrespective of their length, while their performance in the storage component was considerably better relative to the processing component. More specifically, the repeated measures analysis on the specific patients' data have yielded significant effects for both the sentence-type and the processing/storage component variable for each one of the five aphasic individuals ($F(3, 24)=17.000, p<.0001$ and $F(1, 24)=49.000, p<.0001$, respectively, for VSK; $F(3, 24)=7.428, p<.001$ and $F(1, 24)=3.428, p<.05$ for SP; $F(3, 24)=11.333, p<.0001$ and $F(1, 24)=32.000, p<.0001$ for THP; $F(3, 24)=5.666, p<.004$ and $F(1, 24)=8.333, p<.008$ for DENT; and $F(3, 24)=6.666, p<.002$ and $F(1, 24)=32.000, p<.0001$ for THEX).

The sentence-type effect was attributed to the patients' low accuracy scores in both the short & complex and long & complex sentences (for patient VSK: 50% and 62.50% accuracy scores, respectively, $t(24)=5.656, p<.0001$ for the short & complex vs. short & simple dissociation, $t(24)=5.656, p<.0001$ for the short & complex vs. long & simple dissociation, $t(24)=4.242, p<.0003$ for the long & complex vs. short & simple dissociation, and $t(24)=4.242, p<.0003$ for the long & complex vs. long & simple dissociation, for patient SP: 37.50% and 12.50% accuracy scores, respectively, $t(24)=3.273, p<.0003$ for the short & complex vs. short & simple dissociation, $t(24)=4.582, p<.0001$ for the long & complex vs. short & simple dissociation, and $t(24)=1.963, p<.05$ for the long & complex vs. long & simple dissociation, for patient THP: 50% and 37.50% accuracy scores, respectively, $t(24)=4.000, p<.0005$ for the short & complex vs. short & simple dissociation, $t(24)=3.000, p<.006$ for the short & complex vs. long & simple dissociation, and $t(24)=5.000, p<.0001$ for the long & complex vs. short & simple dissociation, and $t(24)=4.000, p<.0005$ for the long & complex vs. long & simple dissociation, for patient DENT: 62.50% and 50% accuracy scores, respectively, $t(24)=2.449, p<.02$ for the short & complex vs. short & simple dissociation, $t(24)=2.449, p<.02$ for the short & complex vs. long & simple dissociation, $t(24)=3.265, p<.003$ for the long & complex vs. short & simple dissociation, and $t(24)=3.265, p<.003$ for
the long & complex vs. long & simple dissociation, and for patient THEX: 50% and 62.50% accuracy scores, respectively, \( t(24)=3.000, p<.006 \) for the short & complex vs. short & simple dissociation, \( t(24)=4.000, p<.0005 \) for the short & complex vs. long & simple dissociation, \( t(24)=2.000, p<.05 \) for the long & complex vs. short & simple dissociation, and \( t(24)=3.000, p<.006 \) for the long & complex vs. long & simple dissociation).

Contrary to the control group, the component effect for the specific aphasics has mainly stemmed from their considerably poorer performance in the processing relative to the storage component (for patient VSK: 56.25% accuracy score for the processing component vs. 100% accuracy score for the storage component, and \( F(1, 24)=49.000, p<.0001 \) for the processing vs. storage component dissociation, for patient SP: 37.50% accuracy score for the processing component vs. 62.50% accuracy score for the storage component, and \( F(1, 24)=3.428, p<.05 \) for the processing vs. storage component dissociation, for patient THP: 43.75% accuracy score for the processing component vs. 93.75% accuracy score for the storage component, and \( F(1, 24)=32.000, p<.0001 \) for the processing vs. storage component dissociation, for patient DENT: 62.50% accuracy score for the processing component vs. 93.75% accuracy score for the storage component, and \( F(1, 24)=8.333, p<.008 \) for the processing vs. storage component dissociation, and, finally, for patient THEX: 50% accuracy score for the processing component vs. 100% accuracy score for the storage component, and \( F(1, 24)=32.000, p<.0001 \) for the processing vs. storage component dissociation).
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With respect to the rest of the Broca’s aphasic patients (see Figures (7.84.)-(7.86.)), PAPAL and THR have also exhibited processing and word-retrieval difficulties with the structurally more complex sentences, yet, these difficulties were less pronounced relative to the patients VSK, SP, THP, DENT, and THEX whose difficulties with both complex sentence-types (i.e. passives and ORCs) were more striking. More specifically, ANOVA analyses on PAPAL’s data have yielded a sentence-type effect ($F(3, 24)=5.000, p<.007$), with complex sentences posing relatively greater difficulty to the patient than structurally simpler sentences (25% accuracy score for the short & complex condition, and 0% accuracy rate for the long & complex condition, $t(24)=2.529, p<.01$ for the short & complex vs. short & simple dissociation, and $t(24)=3.794, p<.0009$ for the long & complex vs. short & simple dissociation). On the other hand, PAPAL’s scores for the processing and the storage component were equally poor (37.50% and 31.25%, respectively). THR, on the other hand, appeared to be negatively influenced mainly by the length of the sentences ($F(3, 24)=6.750, p<.001$), with both long & complex (accuracy: 0%), and long & simple sentences (accuracy: 25%) being performed more poorly relative to the rest of the sentence-types ($t(24)=3.674, p<.001$ for the long & complex vs. short & simple dissociation, $t(24)=3.674, p<.001$ for the long & complex vs. short & complex dissociation, $t(24)=3.449, p<.02$ for the long & simple vs. short & complex dissociation, and $t(24)=2.449, p<.02$ for the long & simple vs. short & complex dissociation).
dissociation). THR’s accuracy score in the storage component was slightly poorer relative to his score in the processing component of the WM task, yet, the difference between them was not found to be statistically significant (37.50% and 50% accuracy performance in the storage and the processing component, respectively). Finally, with respect to the patient GCH, he was the only aphasic subject that has not yielded any significant effect for either the sentence-type or the processing/storage component variable.

One of the most interesting findings of the statistical analysis run on the experimental participants’ data pertains to the significant sentence-type by processing/storage component interactions registered for five of the patients \( (F(3, 24)=17.000, p<.0001 \) for VSK, \( F(3, 24)=6.666, p<.002 \) for THP, \( F(3, 24)=3.000, p<.05 \) for DENT, \( F(3, 24)=6.666, p<.002 \) for THEX, and \( F(3, 24)=2.333, p<.07 \) for PAPAL). This effect has mainly stemmed from the specific aphasic individuals’ parsing difficulty with structurally complex sentences. More particularly, the patients VSK, THP, DENT, and THEX were found to score significantly lower in both passives and ORCs relative to the ACT transitives and the SRCs, while the patient PAPAL was found to perform considerably poorer in passives and ORCs relative to the ACT transitives. Intriguingly, the few significant sentence-type by storage score interaction effects were registered for the long & complex sentence-type condition (for patient SP: \( t(24)=2.777, p<.01 \) for the storage score dissociation between the long & complex and the short & simple condition, and for patient THR: \( t(24)=2.598, p<.01 \) for the storage score dissociation between the long & complex and the short & simple condition). The fact that such an effect was registred only for two of the patients suggests that the aphasics’ retrieval capacity was not negatively influenced by the degree of each sentence’s structural complexity and length.

Finally, a close look at both the controls’ and the aphasics’ image retrieval errors at the recognition display phase of the WM task reveals interesting findings with respect to the type and the distribution of both groups’ misidentification patterns. More specifically, the language-unimpaired subjects tended to pick objects that were mainly semantically-related to the target word, while the
aphasics’ erroneous choices consisted of images that were either semantically or phonologically-related to the target word, with only one patient (namely, PAPAL) exhibiting a mixture of erroneous responses, i.e. both semantically and phonologically-related errors. More specifically, the patient THR tended to pick objects that were phonological neighbours of the target words (e.g. the patient chose the picture corresponding to the word *faros* ‘lighthouse’ in response to the word *glaros* ‘sea gull’), while the patients GCH, SP, THP, and DENT tended to pick images that belonged to the same semantic class with the target word (e.g. the patients chose the picture corresponding to the word *tileskopio* ‘telescope’ in response to the word *kialia* ‘opera glasses’).

Table 7.15. below presents both the controls’ and the aphasic patients’ number, type and distribution of response errors in the recognition task across the various sentence-type conditions.

**Table 7.15. The number, distribution, and type of the retrieval errors of the controls and the aphasic subjects in the recognition phase of the WM task.**

<table>
<thead>
<tr>
<th>Experimental Subjects</th>
<th>Number of Retrieval Errors</th>
<th>Type of Response Errors</th>
<th>Distribution of Response Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCH</td>
<td>3</td>
<td>3 [+semantically related]</td>
<td>1 [long &amp; simple] condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 [long &amp; complex] condition</td>
</tr>
<tr>
<td>VSK</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SP</td>
<td>6</td>
<td>4 [+semantically related]</td>
<td>1 [short &amp; complex] condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 [long &amp; simple] condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 [irrelevant]</td>
<td>3 [long &amp; complex] condition</td>
</tr>
<tr>
<td>THP</td>
<td>1</td>
<td>1 [+semantically related]</td>
<td>1 [long &amp; complex] condition</td>
</tr>
<tr>
<td>DENT</td>
<td>1</td>
<td>1 [+semantically related]</td>
<td>1 [long &amp; complex] condition</td>
</tr>
<tr>
<td>THR</td>
<td>6</td>
<td>4 [+phonologically related]</td>
<td>1 [short &amp; simple] condition</td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
<td>-----------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 [irrelevant]</td>
<td>2 [short &amp; complex] condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 [long &amp; simple] condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 [long &amp; complex] condition</td>
</tr>
<tr>
<td>THEX</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PAPAL</td>
<td>11</td>
<td>4 [+phonologically related]</td>
<td>2 [short &amp; simple] condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 [+semantically related]</td>
<td>2 [short &amp; complex] condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 [irrelevant]</td>
<td>3 [long &amp; simple] condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 [long &amp; complex] condition</td>
</tr>
<tr>
<td>Controls</td>
<td>17</td>
<td>2 [+phonologically related]</td>
<td>2 [short &amp; simple] condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 [+semantically related]</td>
<td>3 [short &amp; complex] condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 [long &amp; simple] condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11 [long &amp; complex] condition</td>
</tr>
</tbody>
</table>

### 7.4.1 Discussion

The aphasic performance in the WM task appeared to differ from the performance of the control group in significant ways across both the storage and the processing component. For the language unimpaired controls only the difference in the storage scores between the long & complex and the rest of the three sentence-type conditions (i.e. short & simple, short & complex, long & simple) was significant, while for the overwhelming majority of the participants with Broca’s aphasia the processing scores in both the short & complex and the long & complex condition were significantly lower relative to the short & simple and the long & simple condition. As such, the impact of the structural complexity of the linguistic stimuli for the language unimpaired subjects was detected only on their storage scores. On the other hand, the performance of the aphasic patients was negatively affected by the structural
complexity of the testing sentences but this effect was only evident in the processing component. The aphasics’ storage scores were not significantly influenced by variations in either linguistic length or structural complexity.

These results give credence to the view that the influence of WM on linguistic information processing was more relevant for the control (vs. the aphasic) subjects of the study. More specifically, there was reliably more difficulty over the parsing of ORCs relative to the ACT transitives, the passives, and the SRCS for the controls, thus, implying that the long-distance dependency between the head-DP and the embedded verb in ORCs has made the retrieval of the noun phrases more difficult to accomplish. Under the assumption that mental resources are shared between language processing and retention, the greater processing cost associated with ORCs was also reflected in the controls’ poor storage performance for the specific sentence-type condition (Just & Carpenter, 1992; King & Just, 1991). This finding indicates that occupying verbal WM has attenuated the controls’ ability to maintain and retrieve linguistic information on-line; under extrinsic memory load, the language-unimpaired individuals were more likely to misidentify the target words that immediately appeared after the long & complex sentences. On the other hand, most of the aphasics’ performance patterns in the processing component evince difficulty with the parsing of structurally complex sentences in general (i.e. passives & ORCs) irrespective of the length of the dependency between the head-DP and the post-verbal trace. Intriguingly, there was no drop of performance in the storage component; reliable differences were observed only in the processing component contra expectations pointing towards more accentuated retrieval difficulty for the structurally more complex conditions.

Finally, the aphasic patients’ patterns of recall errors at the recognition display phase of the WM task are problematic for theoretical models proposing that naming deficits in aphasia result from global lesions to all levels (i.e. semantic and phonological) of the lexical access system (e.g. Dell et al., 1997). These models can not account for the dissociation of semantic and phonological misidentification responses registered for the majority of the aphasic patients. Thus, the performance
profile of the patient THR, who tended to make phonological errors, and of the patients GCH, SP, THP, and DENT, who tended to make semantic errors, support the hypotheses that either brain damage can selectively disrupt distinct subcomponents of the lexical processing system or other factors, such as a deficient short-term memory affecting the aphasics’ ability to maintain the activation of the words’ phonological or/and semantic representations, is responsible for the aphasics’ recall errors. Further research in aphasics’ naming errors under memory load variations is definitely needed to reach more reliable conclusions on the matter.
Part V

GENERAL DISCUSSION AND CONCLUSIONS
Chapter 8 General Discussion

Given that the results obtained from each of the tasks have been briefly discussed in the ‘Results’, this chapter seeks to provide more conclusive answers to the research questions set from the beginning of this study.

Thus, the first research question focuses on the competence/performance dilemma in Broca’s aphasia viewed through the evidence provided by the eight aphasic patients at the two interfaces. The present study lends support to the hypothesis that the linguistic deficit in Broca’s aphasia is an impoverishment of procedural capacities and not a partial or a total loss of grammatical knowledge representations. This impoverishment is most explicitly evidenced in most of the aphasics’ poor performance in the interface-conditioned structures requiring the integration of information beyond the narrow syntax\textsuperscript{46}. More specifically, the between-subject data analysis showed that the processing of the interface-conditioned structures was significantly worse for the aphasics relative to the controls, while no great differences were attested between the two populations with respect to the processing of structures which are fully specified in grammar, e.g. the NACT reflexive verbs, or the clitic pronouns in referentially unambiguous contexts. Further evidence in favor of a performance breakdown in the aphasics is provided by the finding that there was a graded difficulty in the computation of the interface-conditioned configurations that depended on the task. Indeed, one of the most notable findings of the present study is the drop of the aphasic performance in the tasks that were most demanding in terms of

\textsuperscript{46} This finding appears to be similar to many early L1 acquisition studies that document delayed sensitivity of children to interface-based properties (e.g. Papadopoulou et al., 2007; Reinhart, 2006; Sekerina & Trueswell, (submitted); Ito, Jincho, Minai, Yamane, & Mazuka, (under revision), a.o.). Under Reinhart’s (2006) Interface Deficit theory, for example, children use a ‘bootstrapping’ approach to complex interface-based phenomena, i.e. they start with reliable syntactic cues and gradually add other sources of information (e.g. prosody and context), over development.
processing resources. If our hypothesis of a radical compromise of the aphasic performance capacities due to cognitive limitations is correct, then the aphasic pattern of performance is not surprising: task conditions which were more demanding in terms of processing load (global attentional or WM), were more difficult to compute, and, thus, hardest to perform by the aphasic patients.

The second research question focuses on the underlying factors motivating the aphasic performance across the various task conditions. As already mentioned, one of the fundamental questions set from the beginning of the present study is the nature of the potentially predictive relations between task-relevant demands and performance in the aphasic subjects. What we hypothesize is that the task conditions which were more demanding in terms of processing load had significantly more negative consequences for the aphasic performance at both interfaces. As such, the aphasic patients were expected to show strong effects of task difficulty relative to the controls, a fact which further corroborates our initial assumption that agrammatic aphasia should best be characterized in terms of a performance rather than a syntactic breakdown. The aphasics’ considerably worse performance in specific (intra-sentential & inter-sentential) conditions requiring access to the discourse-syntax interface is not surprising if one reasons that such information involves processes external to the grammatical module. This necessity automatically renders the patients’ performance more vulnerable to extraneous (non-linguistic, WM and/or resource-allocational) impediments assumingly characterizing Broca’s aphasia. Likewise, the aphasics’ increased processing difficulty upon disambiguating ACT anti-causative verbs in the on-line CMLP task could also be accounted for in terms of the patients’ not normal-like allocation of their limited resources which has probably hindered the patients’ garden path recovery.

The third research question examines the evidence indicating extensive use of heuristics and compensatory strategies on behalf of the control subjects, and especially, the aphasic participants. Fodor’s (1983) modular view on sentence processing entails that there is a single (syntactic/algorithimic) way to derive meaning from sentences, which is invariably followed. The possibility of heuristics, ‘short-
cut’ processing routines that language users may or may not choose to apply, was thereby implicitly denied. Nevertheless, in the aphasia literature, it has repeatedly been proposed that aphasics use such strategies (e.g. Caramazza & Zurif, 1976, and Grodzinsky, 1995b for comprehension; Kolk, 2006 for production). For a long time, these proposals seemed somewhat ad hoc, as heuristics did not seem to have a ‘place’ in normal sentence processing. Recently, however, a number of studies have indicated that normal language users too are employing processing heuristics to offset computational cost under deep processing conditions (e.g. Ferreira, 2003; Townsend & Bever, 2001; Van Herten, Chwilla & Kolk, 2006). Any processing operation implies a certain cost that may be increased in the case of Broca’s aphasics because of their limited processing resources and their supposedly impaired inhibitory mechanism disallowing effective disengagement from first-pass misanalyses. The data in this study does not directly address the issue of what, if any, processing costs underlie the aphasic individuals’ employment of heuristics, nevertheless we believe that future research should address in more depth the interaction between the aphasic linguistic behavior and the status of the patients’ executive system as the basis for the extensive employment of heuristics by Broca’s aphasics.

For reasons of clarity, the aforementioned research questions will be discussed for each of the two interfaces separately.

The fourth research question highlights the interface that appeared to be the most ‘vulnerable’ for the aphasic patients. In parallel to the distinction drawn between spared grammatical knowledge and ‘vulnerable’ interfaces in Broca’s aphasia, the present research question proposes another distinction between the discourse-syntax and the lexicon-syntax interface in terms of processing difficulty. Based on the aphasic performance, we assume that the external discourse-syntax interface involving grammar and the discourse component was more problematic than the internal interface
phenomena which involved the interaction of modules within the grammar, i.e. the lexicon and the narrow syntax\textsuperscript{47}.

Finally, the present chapter ends with a discussion of the potentially predictive relations between the aphasic linguistic performance and a number of non-linguistic factors, including age, educational level and lesion-site, that may have affected the variations observed in the performance of the eight aphasic individuals across the various tasks.

\textsuperscript{47} The terms ’external’ and ’internal’ interface referring to the discourse-syntax and the lexicon-syntax interface, respectively, are adopted from Tsimpli & Sorace’s (2006), as well as White’s (2007) studies on the role of the interfaces in L2 performance.
8.1 THE DISCOURSE-SYNTAX INTERFACE

8.1.1 [1st Research question]: What does the aphasic performance at the discourse-syntax interface evince about the notorious competence/performance deficit dilemma in Broca's aphasia?

The analysis of the aphasic performance in the tasks drawing on a 'narrow-coverage' grammar exempting interface-filtered information is most indicative of the fact that knowledge of grammar in agrammatic aphasia is relatively spared. First, the patients' target-like performance in the off-line SPM task testing antecedent identification in referentially unambiguous sentences gives credence to the patients' intact access to the number and the gender phi-features encoded on DPs. Furthermore, the 'null pronoun-main clause subject' co-reference condition in the on-line intra-sentential task was the only condition whereby both the controls' and the aphasic patients' (high) matching decision rates were positively correlated, thus, suggesting that all the aphasic subjects participating in the present study were equally sensitive to the universally default parsing option of anteceding the null subject pronoun with the DP in subject position. Most interestingly, the highest degree of (positive) correlation between the patients and the control subjects in the inter-sentential task was registered for the 'SVO-null pronoun' condition as well, whereby all the participants' matching preferences were identified with the pre-verbal subject at an above-chance level ((75%≥91.66% for the aphasic subjects, and 58.33% for the controls). The two groups' similar patterns of performance across these two conditions in the two on-line tasks is not surprising if one reasons that the aphasic grammatically-driven parser is intact and that the null pronoun in subject position is easier to parse than the overt pronoun.

Most crucially, the aphasics' and the controls' performance clearly dissociated in the disambiguation of those structures that required the integration of discourse-filtered information,
meaning the [+Topic-shift] feature assumed to regulate the interpretation of the overt subject pronoun in referentially ambiguous environments. More specifically, when comparing the two groups’ matching decisions in the null and the overt pronoun conditions of the on-line intra-sentential task, we see that the ‘overt pronoun-main clause object’ referential link was the most problematic to compute for half of the aphasic patients (i.e. they tended to consider the subject and the object antecedent as equally appropriate for the overt subject pronoun) relative to the language-unimpaired subjects who tended to resolve the overt pronoun in a pragmatically appropriate manner as expected. On a par with this finding, seven of the aphasic patients in the inter-sentential task were found to opt for the subject antecedent significantly more times in the overt pronoun trials relative to the controls who tended to opt for the object antecedent. Both these findings give credence to the view that the aphasic patients had considerably greater difficulty integrating the discourse-filtered information required for the pragmatically felicitous resolution of the overt subject pronoun (i.e. the assignment of a disjoint referent).

The crucial aspect, though, that has differentiated the two groups’ performance across the two on-line tasks was the patients’ abrupt drop of performance in the task conditions assumed to be the most demanding in terms of processing resources. First, the ‘other’/obviate antecedent-type (in the intra-sentential task) was found to be considerably less preferred by four of the aphasic patients relative to the controls. This finding suggests that enlarging the mental model construed to consider an extra-sentential referent was probably not available to the specific patients. The real-time difficulty of constructing [+Topic-shift] interpretations with extra-sentential entities in agrammatic aphasia is also reflected in the RT patterns of six of the patients who tended to respond significantly slower than the controls in the ‘null/overt pronoun-other antecedent’ condition.

The patients’ failure to successfully integrate word-order-derived pragmatic effects in the OclVS trials of the inter-sentential experiment also speaks in favor of performance limitations in agrammatic aphasia. Incorporating information from both pronoun and word-order type alternations in the OclVS
linguistic contexts has negatively influenced the performance of all the aphasic subjects who have either resorted to the subject ‘default’ choice, or performed at chance level. The canonical SVO word-order appeared to alleviate the aphasics’ computational cost, yet, the interface-based properties of the overt pronoun were outranked by the prominence of the syntactic subject. As such, the inter-sentential contexts having a subject in pre-verbal position represented for the aphasics the maximally transparent interface between position and reference, whereby the pronoun was almost always anteceded by the syntactic subject irrespective of the type of the pronoun.

The performance of the controls, on the other hand, appeared to be constrained by both the word-order and the pronoun-type variable, with the strongest preference for the object antecedent being registered for the OclVS-overt pronoun condition. This was the condition whereby both grammatical and structural variables were set to their [+marked] value, i.e. the subject pronoun was overt and the object was moved to pre-verbal position. As such, the pre-verbal (vs. post-verbal) syntactic position for the controls appeared to be an even stronger predictor for prominence than the syntactic function of subjecthood. This finding is consistent with a number of studies (e.g. Arnold, Eisenband, Brown-Schmidt & Trueswell, 2000; Roehm & Schmacher, 2009), claiming that antecedent prominence is not driven from the syntactic function of subjecthood as such, but from its (pre-verbal) surface position in the sentential frame and its subsequent assignment with a topic interpretation (i.e. subject antecedents in non-canonical position are poor topics for normal adults). The finding that the language-unimpaired subjects in the present study tended to pick the pre-verbal antecedent in the object-before-subject order conditions irrespective of the type of the pronoun in subject position further fortifies the assumption that syntactic position is indeed a relevant prominence feature. On the other hand, the finding that the aphasics tended to pick the syntactic subject in non-canonical, i.e. object-before-subject trials speaks for the fact that the patients were less sensitive to word-order related discourse-pragmatic principles that govern the prominence of the antecedent.
8.1.2 [2nd Research question]: What are the underlying factors motivating the aphasic performance within the discourse-syntax interface domain and why?

As already mentioned, the on-line tasks at the discourse-syntax interface set to investigate how the aphasic comprehension system would behave in referentially ambiguous environments in which either dropping or not dropping a subject pronoun is possible. In the intra-sentential task, the two candidate-antecedents were followed by a subject pronoun in single-sentence contexts. Pronoun-type was manipulated in order to examine the possible effects of pronominal lexicalization for antecedenthood. Null subject pronouns are referentially unspecified, i.e. they can refer either to the subject or the object antecedent, while overt pronouns are informationally focused in NSLs, thus, being strong candidates for disjoint reference, i.e. for a referent other than the subject. Indeed, recent ERP research in Turkish-speaking, language-unimpaired adults (Turkish being an SOV language allowing subject drop) has reported P600 effects as an indication of increased referential processing cost when overt pronouns were used to refer to subject antecedents (Demiral, Schlesewsky & Bornkessel-Schlesewsky, 2008). Such a finding offers supporting evidence in favour of the assumption that the language-unimpaired comprehension system prefers redundancy (in other words, a lexicalized pronoun in subject position) only when there is competition for the subject role\(^{48}\).

In addition to the distinct distributional properties of null and overt pronouns in NSLs, it has been widely documented that the *syntactic subject* in free word-order NSLs constitutes the ‘default’ choice for a referentially ambiguous pronoun due to the former’s typical salience and assignment with a default focus (e.g. Branigan, Pickering & Tanaka, 2008, a.o.). However, in the overwhelming majority of the relevant studies, syntactic subjects have always preceded object antecedents and one could argue

\(^{48}\) What should be mentioned though is that Turkish (like Hebrew) is a partially pro-drop language, such that subject-drop has been registered as being particularly pervasive only with 1st- and 2nd-person-subjects, emerging in approximately 70% of transitive sentences (Demiral et al., 2008).
that the syntactic position was not controlled for and might have, therefore, been a possible confound for the experimental subjects’ interpretation preferences. As such, in two of the testing conditions set for the inter-sentential task of the present study, we manipulated the form of the pronoun as well as the word-order of the two candidate antecedents, with half of the syntactic objects being CLLDed. CLLD occurs when the object is pre-posed in the sentence and co-indexed with a morphologically matched clitic, thus, assigning to the Patient entity the status of cognitively highlighted material. Furthermore, we have increased the distance between the pronoun and the two referents (in the inter-sentential task), thus, allowing us to examine whether the aphasic performance in the intra-sentential task would be preserved under conditions of increased WM load.

The results indicate that pronoun resolution for the aphasics was easier in the intra- relative to the inter-sentential task. More specifically, half of the aphasics in the intra-sentential task were able to use the discourse information encoded in the overt pronouns to infer the disjoint reading and thus ‘pick’ the felicitous object antecedent, which has also elicited the shortest RTs for five out of the eight patients. As expected, this pattern occurred only for linguistic input that marked contrast through the integration of overt subject pronouns. Null pronouns, on the other hand, were most of the times co-indexed with the main clause subject. On the other hand, the aphasic performance in the inter-sentential task reveals that it was exceedingly more difficult for the patients to process ambiguous subject pronouns in sentences that had longer (and possibly more complex) intervening lexical material between the pronoun and its candidate antecedents, and this was especially true when the syntactic object was CLLDed. More specifically, six out of the eight aphasic patients tended to identify the referent in the SVO word-order condition with the subject when the pronoun was null, while five of the patients appeared to oscillate between the subject and the object antecedent in the SVO-overt pronoun trials of the inter-sentential task. Their performance though in the OcIVS contexts was highly heterogeneous, with more than half of the patients in the null pronoun trials ‘oscillating’ between the
subject and the object antecedent and half of the patients exhibiting a tendency to prefer the subject antecedent in the overt pronoun trials.

These findings shed light into the parsing strategies employed by the aphasic patients under the deep processing conditions imposed by both pronoun-type and word-order alternations in the OclVS trials. First, the finding that the syntactic subject was readily available in real-time during the unfolding of the overt pronoun trials—even though it was displaced from its canonical, pre-verbal position—evinces (most of the) aphasics' spared sensitivity to nominative-case morphological marking even across clause-boundaries. It is likely that the nominative-marked DP acted as an index of subjecthood to the aphasic parser providing, thus, converging support for the patients’ assumingly preserved sensitivity to morphological case marking even during on-line sentence processing. However, the finding that semantic information, i.e. the [±animacy] of the subject-DP, was more readily available to the aphasic subjects relative to morpho-syntactic information (like the NACT morpheme) in the CMLP task during argument-to-role mapping, points towards a different viable explanation: it may be that the aphasic interpretational preference for the post-verbal syntactic subject in the OclVS trials was guided not by nominative case marking per se but by the agent-specific lexical knowledge about the entity identified with the actor-initiator of the event. Animate, nominative-marked DPs are prototypical actors, and strong candidates for subjecthood, especially when they occur in sentence-initial position (McWhinney, Bates & Kliegl, 1984). Following this reasoning, we may assume that it was the saliency of the agent/actor semantic feature prototypically cued by nominative, morphological case marking rather than structural case by itself that has contributed to the prominence of the subject-DP in the OclVS-overt pronoun trials. These results indicate another parsing mechanism in Broca’s aphasia—one that provisionally assigns referents to thematically prominent entities, like agents—and is interpreted as further support for semantically (vs. morphosyntactically)-based parsing strategies.

49 The reader is reminded that the animacy of the DP cue in the CMLP task has emerged at probe position 2 relative to the NACT morpheme cue that has emerged at probe position 3 for the aphasics.
primarily used by Broca’s aphasics in sentence processing (Saffran, Schwartz & Linebarger, 1998). On the other hand, most of the aphasics’ opportunist/chance-level use of discourse and word-order cues in the OclVS-null pronoun trials appears to agree with the grammatical constraints dictating that the null subject pronoun is underspecified with respect to the referent it may be assigned. Overall, the patients’ comprehension system exhibited a subject-antecedent preference either when the syntactic subject was in the pre-verbal, sentence-initial position (i.e. SVO-null pronoun & SVO-overt pronoun condition) or when the computational cost exceeded their threshold for accessing topicalized object referents (i.e. the OclVS-overt pronoun condition). But which were the factors that made the inter-sentential task exceedingly more difficult for the aphasic patients, especially in the conditions entailing non-canonical word-order alternations?

Using both lexical item-retrieval and sentence processing data, we have examined the phenomenon of verbal WM interference (Grodner, Fedorenko, Hsieh & Glickman, 2009) between sentences of increasing length and structural complexity in both the controls and the aphasics. The only linguistic environment in which interference was observed for the control group was the hardest to parse (in terms of both length and complexity) condition, i.e. the ORC trials, whereby the control subjects’ retrieval and processing capacities were found to be the poorest. On the other hand, the patients’ performance in the processing component significantly differed depending on the complexity of the syntactic structures tested, with the most structurally complex ones, i.e. passives and ORCs, drawing the lowest accuracy scores. Intriguingly, most of the aphasics’ retrieval scores were well above chance-level, while their few misidentification errors were observed independently from the registered difference on their processing capacity50.

50 The reader is reminded that only two of the patients have exhibited a statistically significant WM sensitivity to the systematic variation of linguistic complexity, i.e. the majority of the two patients’ retrieval errors were associated with the lexical item appearing immediately after the ORCs.
We believe that WM limitations are the strongest predictor of the performance pattern of both the controls and the aphasic patients in the WM task but for different reasons. First, the low accuracy scores registered for the control group in the ORCs implies that the necessity to establish a long distance dependency under extrinsic memory load (i.e. the recognition display task) may have impaired the controls' ability to apply thematic role-to-argument mapping online. This suggests that WM may be especially important for several components of the interpretation process, including the adjudication between candidate structures during on-line processing (see Caplan & Waters, 1999; McDonald & Christiansen, 2002 for similar conclusions). WM resources are needed to process incoming language and retain intermediate products of this processing, such that maintaining an extra memory load (like the individual lexical items in the WM task) has increased the processing difficulty.

On the other hand, the aphasics’ specific pattern of performance in the WM task evinces a lack of an adaptive immediate memory system that would allow the patients to keep syntactic information active and accessible during the execution of the retrieval task that has been taking place simultaneously. The inability to appropriately allocate resources in accordance to task-relevant demands has forced most of the aphasics to dedicate their attention to the word-retrieval task, which had cascading consequences for their processing efficiency. As such, a potentially viable account for the lack of a statistically significant complexity effect on the aphasics’ storage scores is that the patients’ processing resources were taxed to the maximum by the short and simple sentences to begin with, such that the increasing complexity of the sentences did not further impact recall. These findings indicate that the aphasic parser failed to appropriately allocate WM resources to both processing and storage components either due to a global attentional deficit or due to limited processing resources forcing the patients to make use of them in a strictly strategic, economy-based manner. Our finding appears to be consistent with the results of Pompon et al.’s (2010) very recent study of the attentional skills of a group of anomic aphasic individuals showing that the patients’ automatic processing was slowed down overall when their processing resources were allocated for multiple tasks.
WM limitations on the controls’ processing and the aphasics’ attention-allocation capacities might be, thus, a partial explanation for the two groups’ performance in the inter-sentential task. More specifically, the reader is reminded that the control subjects have exhibited quasi-random assignment of the referent in the SVO-null pronoun trials, such that the preference for the subject antecedent was slightly higher relative to the object antecedent (58.33% vs. 41.67%, respectively). On the contrary, the same group has exhibited a robust dissociation in the intra-sentential task, with the subject antecedent in the null pronoun trials being significantly more preferred relative to the object antecedent (89% vs. 57.07%, respectively). The controls’ lack of a strong subject preference in the SVO-null pronoun trials of the inter-sentential task may be attributed to the fact that the syntactic subject was the most distant antecedent in the trials, hence more difficult to retrieve from memory while performing the pronoun resolution task. With respect to the remaining three conditions of the inter-sentential task (i.e. ‘SVO-overt pronoun’, ‘OclVS-null pronoun’, and ‘OclVS-overt pronoun’), the controls have exhibited a strong preference towards the object antecedent. We may assume that the subjects’ WM limitations for the relevant conditions have probably been surpassed (i) by the object-antecedent recency in the SVO-overt pronoun trials, making, thus, disjoint reference easier for them, and (ii) the CLLD of the objects in the OclVS null & overt pronoun trials that has invested the object antecedent with a higher prominence status, thus, greater accessibility.

With respect to the aphasics, their systematic choice of the subject antecedent across all the testing conditions of the inter-sentential task (except maybe from the OclVS-null pronoun trials wherein they appeared to oscillate between the subject and the object antecedent candidate) may largely be due to a global attentional deficit. Such a deficit may have prevented them from appropriately evaluating both pronoun-type and word-order cues, thus, allocating a sufficient amount of resources to the reconciliation of these disparate sources of information. The processing resources of the individuals with aphasia were probably taxed to the maximum by the ‘high load’/long-distance dependencies entailed in the inter-sentential discourse sets, such that the patients resorted to a compensatory
strategy, i.e. the syntactic subject as the ‘default’ choice. The aphasics’ overall high subject-antecedent rates in the inter-sentential task suggest that subject prominence was readily available during on-line processing and was fully exploited by the patients.\(^{51}\)

An operationally defined, attention-dependent disorder manifested mainly in specific conditions conventionally thought to constrain attention (e.g. high processing load) has already been reported in the aphasiological literature (Navon & Miller, 2002; McNeil, Matthews, Hula, Doyle & Fossett, 2006; Mayer, Murray, Turkstra & Lorenzen, 2006). In fact, aphasics' limited attentional resources and a tendency to misallocate processing resources in demanding tasks have been proposed to be two of the main factors held responsible for the linguistic impairment in the affected individuals (Clark & Robin, 1995; Granier, Robin, Shapiro, Peach & Zimba, 2000; Murray, Holland & Beeson, 1997a; 1997b; Tseng, McNeil & Milenkovic, 1993). Similar cognitive disorders have been identified in virtually every type of brain damage, including schizophrenia (Honey & Fletcher, 2006), dementia (Baddeley, 2002), and ageing (Salthouse & Miles, 2002). The aphasics' distinct pattern of performance in the WM task of the present study offers another piece of evidence in favor of an executive-processing impairment that taps into domain-general resources associated with executive control rather than into verbal WM alone. Nevertheless, further specification of the underlying WM deficit in Broca’s aphasia is needed to strengthen its impact as an explanatory factor in the aphasic linguistic symptoms.

8.1.3 [3rd Research Question]: Does the aphasic performance at the discourse-syntax interface evince use of compensatory strategies and heuristics instead of a grammar-driven parser?

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\(^{51}\) The specific finding is consistent with Grodner et al.’s (2009) dual-task, self-paced reading experiment checking the resolution of temporarily ambiguous main verb / reduced relative (RR) clause sentences that were plausibly biased toward the RR. Under conditions of extrinsic memory load, the language-unimpaired participants were more likely to pursue the more common main verb structure even though it was highly implausible.
The systematic choice of the subject antecedent in the OclVS and the SVO-overt pronoun trials on behalf of the aphasic subjects constitutes the first important piece of evidence in favor of heuristic processing by the aphasics of the present study. We believe that the specific trials reflect two prototypical cost-inflicting conditions especially if one considers all those operations involved in the interpretation of the critical pronominal expression: the integration of the information deriving from the syntactic frame in which the overt pronoun is inserted, the prolonged verbal distance between the antecedent and the critical pronoun, and the information regarding the discourse status of the referent. The integration of all these informational cues has probably overwhelmed the aphasics’ processing resources. The subject antecedent in such a case was the most economical choice and the cost of computing another antecedent in parallel space was, thus, circumvented. The reader is reminded that the choice of the subject as the ‘default’ is postulated to be cross-linguistically primed by a universally default parsing option, whereby the preferred antecedent of a pronoun is the syntactic subject due to cognitive prominence reasons (Cardinaletti & Starke, 2001).

Failures in the aphasic inhibitory control may also account for the patients’ occasional insensitivity to interface-conditioned and word-order derived prominence cues pointing towards other-than-the subject antecedents. Such were once again the SVO-overt pronoun and the OclVS-overt pronoun conditions which have exhibited high rates of subject antecedent identification rates on behalf of the aphasic subjects. These findings hint at an inhibitory control dysfunction probably preventing the aphasic processor from disengaging from the salient discourse entity identified with the syntactic subject in the first place. Effects of subject prominence in NSLs (e.g. Demiral, Schlesewsky & Bornkessel-Schlesewsky 2008) and executive control deficits in aphasia (e.g. Mayer et al. 2006, McNeil et al. 2010) are now well attested in the literature and may go some way to explain the aphasic over-acceptance of the subject antecedent in the on-line inter-sentential task of the present study.
8.2 THE LEXICON-SYNTAX INTERFACE

8.2.1 [1st Research question]: What does the aphasic performance at the lexicon-syntax interface evince about the notorious competence/performance deficit dilemma in Broca’s aphasia?

Further support in favor of the relatively spared grammatical knowledge in Broca’s aphasia is also provided by the patients’ performance in the second interface tested, i.e. the lexicon-syntax, whereby verbs of alternating transitivity are assumingly valued. The aphasics’ target-like computation of lexical, morphological and semantic cues in some of the tasks testing structures at the lexicon-syntax interface corroborate our initial hypothesis that competence accounts are inadequate in offering a correct characterization of agrammatism.

We initially focus our attention on the on-line CMLP experiment which reveals some interesting findings with respect to the aphasic patients’ target-like processing of lexical, morphological and semantic cues. First, the results indicate that six of the patients performed very close to the controls in the on-line processing of anti-causatives and unergatives. More specifically, both populations exhibited a strong preference to re-activate the antecedent post-verbally in the anti-causative verbs, while no such effect was found in the processing of the unergative verbs. Such performance asymmetries in the RT patterns induced by the different verb category conditions indicate that both the controls and the aphasics were sensitive to the subcategorization information encoded on the verbs. This finding is in line with Friedmann et al.’s (2008) results according to which no priming effect was observed for unergative verbs in language-unimpaired individuals. Most crucially, our assumption on the patients’ preserved access to the anti-causative verbs’ sucategorization specifications is also in line with Burckhardt et al.’s (2003) finding that aphasics’ syntactic knowledge and ability to establish the
dependency relation between the antecedent and its trace in anti-causative verbs is spared, yet, delayed automatic syntactic reflexes caused by the anterior lesions to the patients’ left hemisphere prevent them from responding on time (the Slow Syntax Hypothesis).

An intriguing finding of the present study was that a single aphasic patient (namely, patient THEX) has exhibited a rather unexpected re-activation pattern, with his RTs evincing post-verbal antecedent re-activation for the ACT unergatives. Most crucially, a re-activation pattern at a post-verbal position was also registered for three of the fifteen language-unimpaired subjects in the unergative verb condition of the present research. The same pattern of performance was even encountered in Burkhardt et al.’s (2003) study wherein the unergatives registered a statistically significant priming effect 100 msecs after the verb for the neurologically intact control subjects. This effect was accounted by Burkhardt et al. in terms of the VP Internal Subject Hypothesis. One viable explanation is that the subjects’ specific performance in the current study rather reflects the systematic grammaticalization of transitivity reported for an increasing number of verbs of semi-transparent intransitivity in the Greek language (Roussou & Tsimpli, 2007). There is empirical evidence from Modern Greek showing that lexical transitivization takes place in a specific subclass of unergative/intransitive V-roots (mainly manner of motion and bodily function verbs) in which the correlation between unergativity and intransitivity is not absolute. This semi-transparency allows for the verbs’ causativization, with the ultimate aim of shifting the attentional focus from the causee to the cause of the event portrayed by the verb (e.g. Ta pola eksoda gonatisan ton patera tu Adrea / (literal translation): ‘The many expenses kneeled Adreas’ father’, O dimosiografos dierfese tin idisi oti epikite anashimatismos tis kivernisis/ ‘The journalist leaked the news that a Cabinet shuffle is underway’, Me afta pu foras pos na se kikloforisol ‘How I am supposed to go you out with the clothes that you are wearing?’, I Maria etrekse to programa/ ‘Maria run the programme’). If this transitivization procedure is indeed underway in the Greek language, we may reason that this priming effect is not due to a disruption of information encoded in the subcategorization restrictions of the verbs in question, but rather to a causativization procedure
triggered by discourse-based reasons influencing three of the control subjects and the single aphasic patient in the present study\textsuperscript{52}.

Another finding speaking in favour of both groups’ preserved ability to establish a referential dependency between the antecedent and the gap during the on-line processing of the anti-causatives in the present study was that the unrelated probes yielded significantly longer RTs in the anti-causatives but not in the unergatives, thus, implying that gap-filling was implicated in the former but not in the latter verb category. More specifically, the increase in RTs for the unrelated probes was allocated to both probe positions 2 and 3, for seven of the aphasics along with the controls, which is probably attributed to the gap-filling procedure taking place post-verbally in the anti-causative verbs only. The listener had to compute the co-reference relation between the two positions, as well as fill the position with the antecedent right after the verb, such that the presence of an unrelated probe (rather than the presence of a probe semantically-related to the subject antecedent) may have increased the

\textsuperscript{52} Nevertheless, converging evidence from THEX’s performance across the two interfaces is rather telling of a syntactic deficit that has impeded his full access and utilization of the subcategorization information encoded in the unergative verbs. Indeed, THEX’s outlying performance in the CMLP and the inter-sentential pronoun resolution task hints at a processing deficit associated with the computation of long-distance dependencies, in general. More specifically, THEX was the only individual that has yielded no post-verbal priming effect for any class of the anti-causative verbs in the CMLP task, while his quasi-random assignment of antecedents across all the testing conditions in the inter-sentential task could be carefully interpreted in terms of a WM deficit disallowing the establishment of dependencies over prolonged intervening lexical material. Non-standard occurrences of interpreting unergative verbs as transitives have also been reported in Traxler’s (2002) self-paced reading study with 8-12 year old children who tended to misanalyze the post-verbal NP of unergative verbs as a direct object irrespective of the thematic properties of the verb and the semantic (im)plausibility of the sentences. Traxler accounted for this pattern in terms of the children’s limited exposure to language, and more particularly, to the verbs utilized in his study.
processing load for the participants. On the other hand, no such requirement was posed during the processing of the unergative constructions; as such, the unrelated probes did not appear to increase the task’s processing demands for the experimental subjects at least at a post-verbal position for the unergatives. The specific finding is consistent with Friedmann et al.’s study (2008) which has revealed a post-verbal increase in RTs for the unrelated probes (more specifically, at probe position 3 relative to probe position 2 in Friedmann et al.’s study) for anti-causative verbs but not for unergatives.

Furthermore, the aphasics’ and the controls’ RT patterns during the temporal unfolding of the sentences yield important evidence in favour of both groups’ firm grasp of voice morphology distinctions and intact lexicall access mechanisms. More specifically, NACT morphology on anti-causative verbs appeared to induce a greater processing cost relative to the computation of ACT voice morphology (marking anti-causatives and unergatives) in both controls and half of the aphasics. The CMLP experiment has also successfully detected intact priming for semantically-related words (at probe position 1 right after the subject-DP) for the overwhelming majority of the patients. The only aphasic participant that has provided evidence in favour of lexical access delay was the patient GCH. Love at al. (2008) and Choy and Thompson (2010) have also implicated lexical access as an area of impairment in Broca’s aphasia, further proposing that delayed lexical access disrupts syntactic processes, such as gap-filling, which relies on lexical access to be completed. Following the specific reasoning, the patient’s lexical access deficit may be held responsible for his unruly performance in the anti-causatives, whereby he has shown evidence of antecedent re-activation only in the ACT anti-causatives at probe position 3. Setting GCH’s performance pattern aside, the findings that lexicall access and integration processes were intact for the rest of the patients along with the total lack of semantically implausible non-target readings at the SPM task indicates that the patients did not suffer from a severely (at least) impaired lexical-semantic network and that their lexical access capacities were normal-like.
Most crucially, some of the aphasics’ data from the off-line tasks at the same interface appear to replicate some of the previous findings of the CMLP experiment, especially with respect to the patients’ firm grasp of voice distinctions and semantic constraints in both production and comprehension. With respect to the patients’ grasp of voice-morphology distinctions, the lack of ‘active’ readings in the reflexive and the NACT anti-causative verb (with [+animate] subject) class in the SPM task evinces that all the patients had preserved voice and its properties as a theta-attractor such that they could appropriately distinguish between the interpretive implications of ACT and NACT voice morphology in the relevant verb classes. Closely related to the aphasics’ awareness of the thematic restrictions imposed by verb sub-categorization information is the finding that the patients tended to lexicalize the monos/i tu/tis ‘by his/her own’ phrase in the reflexive verb condition in the picture-naming task. Bearing in mind that the use of an overt agent-phrase in reflexives is considered to be pleonastic (though not unacceptable) in Greek (Tsimpli, 2006; Laskaratou & Philippaki-Warburton, 1984; Joseph & Philippaki-Warburton, 1987, a.o.), its frequent lexicalization by the aphasics of the present study probably indicates their intention to communicate the thematic properties of the reflexives in the most explicit manner. Furthermore, the finding that the controls and five of the eight aphasic patients have performed poorly in the interpretation of the NACT anti-causatives with an animate subject in the SPMT of the present study further corroborates our initial expectation that the aphasics (along with the controls) were highly aware of the full range of the interpretive options left open by grammar for the relevant verb class (at least when the task was offline).

Finally, most of the aphasics were found to over-rely on the [±animacy] distinctions during the production of the anti-causatives in the naming and the repetition task. More specifically, the animacy of the subject appeared to significantly facilitate the NACT-suffix attachment operation for the (+voice-

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53 The reader is reminded that the underspecification of NACT voice morphology in Greek enhanced by the [±animacy] of the syntactic subject raises the ambiguity among a reflexive, an anti-causative and a passive reading in the absence of any disambiguating cues from the discourse context (Tsimpli, 2006).
alternating) anti-causative verbs targeting NACT morphology for the overwhelming majority of the patients. On the contrary, the patients’ data for the same verbs having an inanimate entity in subject position has mainly consisted of non-target (ACT) responses. This finding indicates that the animacy of the subject in voice-alternating anti-causatives forced the predicate to denote a syntactically implicit external cause or agent (hence, the NACT voice marking), and most importantly, that the specific aphasic subjects were aware of and exploited animacy distinctions. The same pattern of performance was also registered for the controls’ naming performance, though, to a less extent. Such a finding is consistent with previous studies claiming that voice alternating anti-causatives are not freely alternating and that the option between an ACT and a NACT form crucially depends upon the [±animacy] of the subject and the speaker’s intention to focus on the result of the action denoted by the verb or the implicit syntactic argument initiating the action of the verbal predicate, respectively (Tsimpli 2006; Fotiadou 2010).

Still, the bulk of the patients’ data from the whole range of the tasks testing the production and the interpretation of the verbs at the lexicon-syntax interface reveals subtle differences between the aphasics and the control subjects, which can be accounted for in terms of the patients’ performance limitations. Once again, the results indicated a graded effect of task difficulty on the patients’ performance patterns. Such an effect was mainly reflected (i) in the aphasics’ significantly lower performance in the on-line CMLP task relative to the off-line SPM task testing the interpretation of ACT anti-causative verbs, and (ii) in the more efficient decoding of the NACT anti-causative verbs in the CMLP and the SPM tasks relative to the off-line production (naming & repetition) tasks, whereby the NACT morphological forms of the anti-causative verbs were less efficiently computed by the aphasic patients.

The on-line CMLP experiment provides robust support in favor of the existence of a processing deficit in the Broca’s aphasics. First, the verification of unaccusativity on non-alternating ACT anti-causative verbs was most difficult for half of the patients, while the presence of a NACT morphological
alternant in some ACT anti-causatives appeared to facilitate antecedent-reactivation with a priming effect being registered for the patients in the voice-alternating ACT anti-causative verb class only, at probe position 3. On the contrary, the NACT anti-causatives in the CMLP experiment were more easily parsed by the aphasic group, with six of the patients exhibiting significant antecedent re-activation effects immediately after the verb (i.e. at probe position 2) irrespective of the verbs’ [± voice-alternating] properties. This finding suggests that the non-voice-alternating ACT anti-causative structures were more difficult to parse, since they required access to lexicon-filtered information in order to be valued as such. On the other hand, the control subjects have exhibited antecedent re-activation patterns across both alternating and non-alternating classes of anti-causative verbs, yet, at different temporal windows.

More specifically, antecedent re-activation for the non-alternating ACT and NACT anti-causatives verbs took place at a later temporal window, i.e. at probe position 3, relative to the voice-alternating anti-causatives whereby the priming effect was registered earlier at probe position 2. We hypothesize that the language unimpaired subjects were able to identify the gap in the relevant sentences and associate it with the derived DP-referent matching the missing post-verbal argument in the anti-causatives irrespective of the verbs’ voice-alternating property. Nevertheless, real-time access to lexicon-syntactic interface information explains the controls’ delayed parsing of these anti-causative verbs that lack the property of voice-alternation, thus, implying that the language-unimpaired subjects were affected by the optional projection of the Voice head in some ACT anti-causative verbs, yet, to a less extent relative to the aphasics.

Furthermore, the results from the same task evinces significant differences between the aphasics and the controls concerning the voice effect ‘amplitude’ during the on-line processing of the anti-causative verbs, with partial insights into the computational demands that shaped such an effect. More specifically, the aphasic data in the CMLP task provides insight into the higher computational demands posed by the NACT anti-causatives during the temporal unfolding of the sentences. Voice marking appeared to tax the aphasic parser to a great extent, with ACT anti-causatives and unergatives
yielding significantly shorter RTs relative to the NACT anti-causatives. On the other hand, the controls’ processor appeared to be most taxed by the processing of the ACT anti-causatives which were found to elicit significantly higher RTs than both the NACT anti-causatives and the unergatives. Crucially, the voice effect for the aphasics has emerged at probe position 3 (i.e. at least four words after the verb), but at probe position 2 (i.e. immediately after the verb segment) for the controls. The fact that the processing burden inflicted by voice morphology was detected in a successive temporal window for the aphasics relative to the controls could be an indication of a slowing down of formal syntactic operations, such as the Voice˚ head projection in the NACT anti-causatives. This finding is once again reminiscent of Burkhardt et al.’s (2003) Slow Syntax Hypothesis that speaks in favor of aphasics’ preserved ability to establish referential dependencies in anti-causatives which are, yet, slowed down by the patients’ delayed automatic syntactic reflexes.

The finding that the controls spent considerably more time in computing the gap-filling procedure in ACT (vs. NACT) anti-causatives may be traced to the ACT verbs’ unmarked morphological status in the language, forcing, thus, the parser to access lexicon-syntax conditioned information to value them as anti-causative. As such, the higher RTs elicited by the processing of the ACT anti-causatives probably indicates a concerted effort on the part of the language processor to reconcile diverse sources of information, i.e. input about the lexical specification of the intransitive verbs as anti-causatives and the output of the syntactic parser. At least some of the time the outcome of this effort appears to have been a delayed re-activation of the post-verbal antecedent to fit the sub-categorization information of the verb. Furthermore, the fact that the RTs for the unrelated probes were significantly higher in the ACT (vs. NACT) anti-causative verb condition for the controls evinces that both gap-filling identification and lexicon-filtered information interacted when performing the CMLP task which required that both types of information were represented faithfully. On the other hand, the finding that the increase in RTs for the unrelated probes in the present study was considerably more noticeable for the NACT anti-causatives for seven of the aphasics further corroborates the idea that there was greater
computational difficulty implicated in the parsing of the ACT anti-causatives for the patients. The lack of a priming effect in the ACT anti-causatives for three of the patients (namely, the patients GCH, DENT, & THEX) at position 2 implies that access to lexicon-filtered information was never accomplished on-time, but antecedent re-activation was registered at a later temporal window, i.e. at position 3, for two of the aphasic subjects (GCH & DENT), once interface-filtered information and the voice-alternation properties of the verbs in question were probably accessed. Overall, these results suggest that while NACT morphosyntax was indeed being processed by the majority of the aphasic patients, incorrect thematic role assignment was observed for the ACT anti-causatives probably because performance limitations blocked mapping of the syntactic output to an interface-level interpretation.

Finally, an additional difference between the control and the aphasic performance in the CMLP task of the present study refers to the significant RT evidence distinguishing ACT from NACT anti-causatives derived from the control group, but only from two of the aphasic patients. As already mentioned, the CMLP task has yielded a significant voice (ACT vs. NACT) by un accusativity interaction for the control group, whereby the ACT anti-causatives elicited significantly higher RTs relative to the NACT anti-causatives. On the other hand, the NACT anti-causatives tended to elicit considerably higher RTs relative to the ACT anti-causatives for two aphasic subjects. As already analyzed, a possible explanation for the higher RTs elicited by the NACT anti-causative verb condition in the aphasics involves the complexity of the NACT suffix with respect to the ACT one: NACT anti-causatives are considered to be morphologically marked forms, as such they have probably taxed the agrammatic processing mechanisms more than the ACT anti-causatives. The lack of a significant voice effect for the rest of the aphasics in the CMLP task lends credence to three plausible accounts. The first possible explanation is that the individuals with aphasia did not exert more effort as the morpho-phonological complexity of the linguistic material increased. This is consonant with the experimental literature demonstrating that individuals with aphasia have difficulty monitoring their own performance, appropriately evaluating task demands, and, thus, allocating a sufficient amount of resources for
successful processing of the anti-causative sentences (Murray, Holland, & Beeson 1997a; Tseng, McNeil & Milenkovic, 1993). A second potentially viable account is that the processing resources of the individuals with aphasia were taxed to the maximum by the ACT anti-causative sentences to begin with, such that, increasing complexity of the NACT anti-causative sentences did not further impact RTs. Finally, it may be possible that the lack of difference in the RTs induced by ACT and NACT anti-causatives for the aphasics stems from the fact that the patients were insensitive to the finer morphological properties of the verbs in question. As already mentioned, though, NACT morphology was found to both serve as a cue reinforcing antecedent re-activation in NACT and ACT voice-alternating anti-causatives, and induced the highest RTs relative to the predicates with ACT morphology (i.e. the ACT anti-causatives and unergatives used in the task). Based on these findings, we may assume that the lack of a significant difference between the mean RTs elicited by the ACT and the NACT anti-causatives (in the related probe trials) for the aphasic patients may rather stem from a processing limitation favoring an unergative interpretation of the ACT anti-causatives and/or an attention-allocational deficit.

Turning to the results of the off-line tasks, the interpretation of the ACT (vs. NACT) anti-causatives54 in the SPM task was the most problematic for the aphasic group relative to the controls. More specifically, six of the patients tended to interpret them as events implicating the initiation of the action by an external Agent, i.e. they tended to choose the “passive” reading. It is possible that the “passive” reading provided in the ACT anti-causative verb class is due to the lack of (sufficient) access to the verbs’ idiosyncratic lexical properties which would specify the set of verbs that undergo the causative/anti-causative alternation without any change in the morphology of the verb. This finding is similar to Tsimpli’s (2006) study with Greek-speaking children (among other populations), whereby the

54 The reader is reminded that four of the verbs in the SMPT (i.e. *vuliakse* ‘sank-ACT’, *mavrise* ‘blackened-ACT’, *platine* ‘widened-ACT’, *espase* ‘broke-ACT’) in the ACT anti-causative verb class were non-alternating, and a single one (i.e. *stegnose* ‘dried-ACT’) was voice-alternating.
‘passivization’ of the ACT anti-causatives was attributed to the children’s not fully-developed lexicon preventing them from evaluating the options provided by the grammar against lexical constraints online.

The aphasic performance in the (non-alternating) ACT anti-causatives in the SPMT was found to be poorer in the on-line CMLP task, whereby an antecedent re-activation pattern was registered at probe position 3 by half of the patients only for the ACT anti-causative verbs having an optional (NACT) morphological alternant. The off-line measure may have facilitated the patients’ partial success in apprehending the meaning of the non-alternating ACT anti-causatives, and also in tracking morphosyntactic regularities critical for the computation of the specific verb class. With respect to the CMLP task, the real-time processing of the ACT non-alternating anti-causatives is assumed to rely both on routines aligned with lexicon-filtered operations and syntactic mechanisms that involve word-order recovery (like the post-verbal antecedent re-activation), along with the setting of the verb’s subcategorization restrictions, all of these operations taking place simultaneously. As such, one explanation for the aphasics’ worse performance in the ACT non-alternating anti-causatives in the CMLP task relative to the off-line SPM task is that the on-line integration of multiple types of information under time pressure has probably overburdened the patients’ processor, thus, resulting in overall non-target-like patterns of performance. On the other hand, the same aphasic patients in the SPM task were allowed relatively more robust access to the verbs’ lexical representations due to the pictorial support present, such that they could probably compute the predicates more effectively during offline language comprehension.

The patients’ heterogeneous patterns of performance in the repetition task were less indicative of a processing deficit since the overwhelming majority of the aphasic errors across the verb classes consisted of pragmatically irrelevant responses. Overall, the results suggest that the anti-causative verbs did not enjoy a privileged status in boosting their ACT (mainly) and NACT morphological marking through repetition on behalf of the aphasic individuals. Failures in accessing or/and integrating lexical constraints during the repetition of the ACT anti-causative verbs may have contributed to the non-
target-like performance of two of the patients who were found to systematically mark the ACT anti-causatives with NACT voice morphology, yet, this evidence is not necessarily indicative of a performance breakdown associated with the lexicon-syntax interface. Nevertheless, some of the patients’ target-like output (repetition) fragments in the ACT anti-causatives, whereby the theme argument was spelled-out twice in both pre- and post-verbal position with accusative case morphological marking, clearly support a processing limitation: simultaneous access to the lexicon-syntax constraints and realization of the syntactic movement operations required in overlapping time-spans has probably overwhelmed the specific patients’ processing resources, thus, forcing the parser to ‘pass’ the deletion of the internal argument copy in an attempt to alleviate the computational cost\textsuperscript{55}.

The patients’ performance in the naming task reveals that the processing cost increased when the left hemisphere-damaged patients were asked to name actions whose verbalization entailed attachment of the NACT suffix. More specifically, half of the patients in the naming task were found to score significantly lower than the controls in the NACT anti-causative verb condition, which probably has to do with the increased morpho-phonological and morpho-syntactic complexity of NACT morphology attachment in production. The production of NACT morphology in reflexives, on the other hand, was almost target-like for most of the aphasic patients participating in the present study, thus, suggesting that the NACT morpheme attachment procedure was prototypically identified with verbal structures having a base-generated, non-derived agent argument in subject position. Most notably, the aphasic patients’ significantly longer RTs spent on NACT vs. ACT verbs in the CMLP experiment of the present study point towards the same direction, i.e. the increased complexity associated with the computation of NACT voice morphology in anti-causative verbs. These findings come into sharp

\textsuperscript{55} E.g. Examiner: I varka vuliakse.

GCH: ti varka-ACC vuliakse…ti varka-ACC

= the boat-ACC sank… the boat-ACC

“The boat sank”
contrast with Stavrakaki et al.’s (2006) finding that the NACT morphological marking in Greek anti-causatives has facilitated the naming capacity in one of the two Broca’s aphasic patients participating in their off-line study.

The finding that the aphasics were considerably more successful in interpreting NACT anti-causatives relative to their poor capacities in producing them probably implies that the aphasic production was considerably more prone to performance limitations. As already discussed, valuating NACT anti-causative verbs in the CMLP task and interpreting verbs belonging to the same class in the SPM task (especially, in the [-animate] subject condition) were not as problematic for the aphasics as in the naming task given that NACT morphology in the two comprehension tasks was used as a cue to some transitivity change. This contrast highlights the widely-documented disparity registered for the agrammatic patients across production and comprehension tasks, whereby they tend to perform significantly better in the comprehension modality. The present findings reveal that this is probably due to the fact that comprehension (vs. production) tasks permit aphasics to extensively use compensatory strategies that can exploit retrieval cues such as the NACT suffix to form filler-gap dependencies, allowing thus the comprehension of NACT anti-causatives and, yet, explaining the poor naming of the same verbs in the production tasks (e.g. picture-naming, and repetition) that lack such an explicit, highly interpretable transitivity cue.

Overall, the above findings allow us to attribute the cause of the non-target-like performance of the agrammatic participants to performance breakdowns, and more specifically, to their greater difficulty in the computation of interface-based information rather than to a unique representation source for the agrammatic deficit. Following this reasoning, the aphasic linguistic competence is not different to a non-impaired grammatical system. The aphasic patients had the grammatical knowledge to compute ambiguous anaphora and verbs of alternating transitivity respecting phi-features specification processes and thematic restrictions imposed by the verbs’ sub-categorization entries, respectively, but
not in the way the language-unimpaired subjects did due to performance limitations. The necessity to integrate simultaneously cues coming from disparate sources of information while processing interface-conditioned elements might have stronger effects for the aphasic subjects relative to the controls due to processing, WM and attentional deficits. In fact, the results indicated a graded effect of task difficulty for the aphasic performance at both interfaces. First, valuating ACT non-alternating intransitive verbs as anti-causatives proved to be considerably more difficult for the aphasics in the on-line CMLP task relative to the off-line SPM task, thus, suggesting that their performance is compromised by processing limitations and not representational deficiencies. Second, anaphora in OclVS inter-sentential contexts was more difficult to resolve for the aphasics relative to the SVO intra-sentential contexts, whereby anaphora resolution was carried out in a more target-like manner.

Apart from the patients’ processing limitations preventing them from fully accessing interface-conditioned information, such disparities between the control and the aphasic performance across the tasks could be attributed to a WM deficit preventing the patients from allocating attentional resources in accordance to task demands. Indeed, the aphasics in the WM task were found to be less sensitive to the linguistic complexity of certain structures (i.e. ORCs) during the word-retrieval task relative to the healthy adults. With respect to the aphasics, the WM task has revealed a sustained attention effect at retrieving the single-word items irrespective of the degree of the sentences’ structural complexity, while the controls have exhibited a word-retrieval decrement only in the linguistically complex conditions as normally expected. This finding indicates that the controls were able to support both processing and word-retrieval processes in parallel, in contrast to the aphasics who opted to allocate their attention to the word-retrieval task only. Following this reasoning, we may assume that the aphasics’ partial failure to re-activate the antecedent in the ACT non-alternating anti-causatives may be due to a failure to coordinate attention between syntactic output and lexicon-filtered information in overlapping timespans.
8.2.2 [2nd Research question]: What are the underlying factors motivating the aphasic performance within the lexicon-syntax interface domain and why?

The second experimental part of the thesis set out to investigate the aphasics’ processing of verbs of alternating transitivity, i.e. anti-causatives, across both the production and the comprehension modality. More specifically, the production of anti-causatives was explored through an off-line picture-naming and a repetition task, while comprehension was tested through an off-line SPM task and an on-line CMLP experiment. The choice of the anti-causative verb class was purposely made since the processing of the specific verbs (and especially of the morphologically unmarked/ACT ones) necessitates the integration of lexical-semantic information assumingly activated at the lemma level prior to speech onset (Smith & Wheeldon, 1999). Such reasoning appears to support a pre-determined, pre-phrasal scope of unaccusativity irrespective of the features of the rest of the lexical items of the sentences and the hierarchical syntactic relations computed within them. The present research though moves one step forward by integrating several other dimensions that assumingly play a role in the valuation of unaccusativity besides the interface-based information, like the voice morphology of the verb and the animacy feature of the syntactic subject. To this end, the specific experiment has employed both ACT and NACT anti-causative verbs, as well as [±voice-alternating] verbs with their syntactic subject being either an animate or an inanimate entity.

The results indicate that processing ACT (non-alternating) intransitive verbs as anti-causatives was harder for the aphasics in the on-line CMLP experiment relative to the off-line SPM task. Such a finding was explained in terms of the on-line cross-modal nature of the CMLP task requiring from the aphasic subjects to recover the anti-causative meaning of some intransitive verbs via recourse to both the lexical mnemonic representation of the antecedent in the initial part of the sentence, and the voice morphological marking of the anti-causative verb as the sentence unfolded. Antecedent re-activation at a post-verbal position would constitute evidence in favour of the identification of the post-verbal trace which is phonologically absent from the input but crucial for the overall interpretation of the anti-
causative verb. The findings show that the patients had excessive difficulty with re-activating the antecedent in the ACT non-alternating anti-causative verbs, thus, offering evidence in favour of limited on-line access to the specific verbs’ subcategorization specifications in the lexicon. In fact, the lack of a significant RT difference between the related and the unrelated probes at a post-verbal position in the ACT non-alternating anti-causatives provides evidence that the specific verbs were probably treated on a par with ACT unergatives (or else, on a par with ACT transitives with a null object). The same patients’ relatively better performance in the off-line SPM task is not surprising if one reasons that the pictorial stimuli have facilitated access to lexicon-filtered information, thus, the ACT non-alternating anti-causative verbs were easier to interpret in the off-line task.

Though not as reliably as in the discourse-syntax interface, there are reasons to believe that the patients’ worse performance in the CMLP task may be partially attributed to a resource-allocational deficit. Drawing upon cognitively plausible models of sentence comprehension, we assume that the language-unimpaired comprehension system can limit the number of structural interpretations entertained simultaneously during the processing of syntactic ambiguity (Jurafsky, 1996; Crocker & Brants, 2000). Such limited-parallel models can be thought of as having finite resources available to allocate to possible structural interpretations mainly on the basis of expectations for upcoming structure encoded in a probabilistic grammar. Exactly because the parser has finite resources and allocates these resources stochastically in the manner previously described, there is a chance that one of the possible interpretations will be lost entirely in a region of unresolved syntactic ambiguity. Following this reasoning, we may assume that the aphasics’ parse failure would be more common in conditions of increased ambiguity of meaning, and, crucially, even more common when supporting information coming from other-than-the syntax grammatical components would be missing. We believe that the ACT non-alternating anti-causative verbs represent prototypically such a condition, since they are morphologically identical to the ACT unergatives and the aphasics’ on-line access to lexicon-filtered information that would have strengthened the verbs’ underlying thematic properties is assumingly
limited. The patients’ failure to allocate the required resources to the (lexicon-filtered) non-alternating anti-causative verb interpretation in real-time has probably increased the opportunity for a ‘resource-drift’ resulting in the loss of the anti-causative interpretation and the prevalence of the unergative reading that has morphologically matched the verbal input. On the other hand, the control subjects’ successful interpretation of the ACT non-alternating anti-causative verbs in real-time (even at a later temporal point, i.e. at position 3) evinces that the parser of the language-unimpaired individuals has accumulated weights from both the lexicon and the verbs’ morphology in a more efficient manner relative to the aphasic patients.

8.2.3 [3rd Research Question]: Does the aphasic performance at the lexicon-syntax interface evince use of compensatory strategies and heuristics instead of a grammar-driven parser?

The data from the CMLP task offers further support for the application of both compensation strategies and heuristics on behalf of the aphasics. More specifically, syntactic processing in the aphasic individuals was found to be especially sensitive to morphological cues, like the marking of the anti-causative verb with NACT morphology, which proved to be decisive in triggering the re-activation of the antecedent post-verbally. The controls proved to be more sensitive than the aphasics to the structural properties of the anti-causative verbs by showing faster responses when the probe was semantically related to the derived subject across both the ACT and the NACT voice-alternating and non-alternating anti-causative predicates (yet, at distinct probe positions depending on the verb’s [± voice-alternation] property). The aphasics’ antecedent re-activation patterns in the NACT anti-causative verbs were strikingly similar to the normal subjects; a priming effect was observed immediately after the verb in six out of the eight patients that have participated in the task, while the effect was spread to a later temporal point (at probe position 3) for two of the same patients. On the other hand, there were five
patients yielding a priming effect for the ACT anti-causatives (predominantly in the inanimate subject condition) at probe position 2 and a single patient at a later temporal point, i.e. at position 3. The observation that the priming effect for the aphasics in the CMLP task was mainly registered for the NACT anti-causative verb condition suggests that the presence of the medio-passive suffix cueing a transitivity change was a decisive factor in verifying the unaccusativity features of the verbs in question.

Furthermore, the parsing of the ACT non-alternating anti-causative verbs, as already discussed, appeared to be more challenging for the aphasic subjects. The lack of voice-alternation tended to block the post-verbal re-activation of the antecedent predominantly for the ACT anti-causatives in the aphasic group. On the other hand, a priming effect for the voice-alternating ACT voice anti-causatives was registered for half of the patients at probe position 3. The observation that the priming effect for the aphasics was stronger in the voice-alternating condition for the ACT anti-causative verb class suggests that the possibility of the verbs to appear with NACT morphology enhanced the post-verbal re-activation of the antecedent even at a late temporal point during the unfolding of the sentence and not immediately after the verb as it was observed for the control group. We assume that the additional layer of medio-passive morphology in the voice-alternating ACT anti-causative verbs functioned as a marker of transitivity and, thus, facilitated antecedent re-activation, par consequence, grammatical encoding. The reader is reminded that the aphasic patients of the present study have also showed problems with the off-line interpretation of the ACT (non-alternating) anti-causatives which have most of the times been interpreted as passives in the SPM task, so perhaps transitivity changes for the aphasics were always expressed through NACT morphological marking. On the other hand, the

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56 What is interesting is that morphological transparency in languages with rich morphological paradigms has also been found to facilitate early L1 acquisition in children relative to languages with more impoverished inflection, probably because the abstraction of meaning which is represented morpho-syntactically is relatively easier (Phillips, 1996; Crago & Allen, 2001; Austin, (in press)).
controls have demonstrated a main priming effect for both types of anti-causatives irrespective of their [+voice-alternation] property.

At first blush, the finding that half of the aphasics could have access to and managed to retrieve the NACT morphological alternant of the voice-alternating ACT anti-causatives (at position 3) is quite surprising if one considers studies reporting that syntactically complex structures pose a challenge to non-fully active processing systems such as those of aphasics (Garaffa, 2007; Garaffa & Grillo, 2008). Following this line of reasoning, voice-alternating verbs implicating an additional morphological layer should increase the amount of items that either need to be held in memory or be retrieved during integration processes (Van Dyke & McElree, 2006). Nevertheless, the findings of the present study provide evidence in favour of the spared (though delayed) access of the specific aphasic individuals to the NACT morphological alternant of the ACT voice-alternating anti-causatives. One possibility for such pattern of performance is that the [+voice-alternation] property of the anti-causative verbs is relevant in a separate morphological interface, which computes the morpho-phonologically distinct voice forms of a single voice-alternating verbal root, while a different mechanism computes hierarchical syntactic relations. As such, the morphology interface is independent from memory-based limitations, in contrast to the lexicon-syntax interface which is subject to memory constraints. This explanation is consistent with Caplan and Water’s (1996, 1999, 2004) theory of WM specialized only for syntactic processing.

Summing up the findings related to the verification of the derived status of the subject in the anti-causative verbs so far, the aphasics appeared to be more sensitive to the [+voice-alternation] property of the ACT anti-causative verbs, as well as to the transitivity change realized morphologically

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57 A verb-by-verb analysis of the ACT anti-causative verbs has also indicated that the aphasic group was less prone to re-activate the antecedent in the ACT anti-causative verbs lacking a causative counterpart, such as verbs of internal causation like anthizo/ blossom. On the other hand, a systematic antecedent re-activation effect was registered for the ACT anti-causatives having an underlying causative structure. Likewise, the neurologically intact subjects showed a pattern of antecedent re-activation only for the anti-causatives with a causative alternant. The small number (N=2) of the anti-causative
in the form of the medio-passive suffix in the NACT anti-causatives. The NACT morphological marking on the verb though appeared to be more crucial for the interpretation of the post-verbal phonetically unrealized element in the anti-causative verbs for the aphasics; the reader is reminded that a priming effect was registered only in four of the patients for the ACT voice-alternating anti-causatives at probe position 3 and in six patients for the NACT anti-causatives at probe position 2. We presume that the aphasic processor, having to proceed under time pressure and with strong WM constraints, wants a clear indication of the nature of the dependency between the post-verbal trace and the derived subject in the anti-causative verbs. As such, the surface NACT morphology served as a more substantial processing aid to the parsing of the anti-causative verbs probably due to its explicit morphosyntactic value: the morphological marking of the verb after the suppression of the external θ-feature indicates a thematic structure change. In this sense, apart from serving as a morphosyntactic cue to the derivation of the argument structure of a verb (most crucially, an agent is merged into syntax via the Voiceº head), the NACT suffix appeared to be a decisive factor in motivating argument activation during online sentence processing. This effect is probably contingent on the strong interpretability of the NACT morpheme which proved to drive syntactic predictions about argument realization (for the Broca’s verbs of internal causation used in the present study prevents us from making any safe speculations regarding their underlying structure and whether they should be analysed as anti-causative verbs having an underlying causative form. Burkhardt et al. (2003) underline that the two aphasic subjects of their study have also participated in a CMLP experiment with anti-causative verbs of internal causation, but they did not show a clear re-activation pattern (2003: 17 (subnote 8). Unfortunately, no further details are provided with respect to the unruly performance of the two Broca’s aphasics on anti-causative verbs lacking a causative alternant.
aphasics of the present study, at least) in a more decisive manner relative to other cues, e.g. the [voice-alternation] property of certain ACT anti-causative verbs or verb-specific lexical information.

On the other hand, we propose that the verification of unaccusativity on the ACT verbs was not the cheapest processing option for the agrammatic patients, since their parsing demanded access to the lexicon-syntax interface, thus, impeding their ability to re-activate the antecedent in a linguistically principled manner. Occasional access to the NACT morphological alternant of the voice-alternating verbs functioned as a means to compensate for a deficit at the lexicon-syntax interface for some of the patients. On the other hand, the economy hierarchy for the instantiation of dependencies in the anti-causative verbs was different for the language unimpaired individuals since antecedent re-activation in the anti-causative verbs took place after the verb irrespective of their voice morphological marking (yet, the reader is reminded that the temporal locus of the antecedent re-activation depended crucially on the [±voice-alternation] property of the verbs in question).

Most importantly, apart from the NACT morphology-based strategy applied by the aphasics, the re-activation pattern in the anti-causatives was also modulated by the [± animacy] of the antecedent. In fact, the animacy feature appeared to guide to a considerable degree both groups’ syntactic expectations during the on-line processing of both ACT and NACT anti-causative structures. More specifically, the presence of an animate subject in the NACT anti-causatives raised the level of

58 In this sense, the findings of the present study come into sharp contrast with the Impaired Interpretable Features Hypothesis which proposes that functional ‘categories that carry interpretable features cause more difficulties to non-fluent aphasic subjects’ (Varlokosta et al., 2006: 742) and that for these patients ‘the morphophonological realisation of interpretable features [is] not functioning’ (Nanousi et al., 2006: 235). It would be interesting to see whether Wernicke’s aphasics’ performance in tasks testing argument-to-role mappings would also be facilitated by strong interpretable cues, like the NACT suffix. The present study predicts that Wernicke’s aphasics would fail to exploit such cues due to the fact that posterior-lesioned patients show patterns of semantic impairment, and the processing of interpretable features is likely to rely on routines more aligned with semantic operations.
interpretational ambiguity early on at probe position 2, such that the establishment of a referential dependency between the trace and the antecedent in the specific condition was never resolved for half of the aphasic patients. On the other hand, the controls appeared not to be influenced by the animacy variable in the NACT anti-causative verb condition; a post-verbal priming effect was systematically registered for the NACT anti-causatives by the language-unimpaired subjects irrespective of the [+animacy] of the derived DP, thus, implying that the verbs’ subcategorization constraints overcame the animacy bias in the latter case. The reader is reminded that a NACT verb with an animate subject in Greek is ambiguous between a reflexive, a passive, and an anti-causative reading. As such, we expected responses to animate probes to be slower than those to inanimate probes due to the disruption of the syntactic parsing introduced by the [+animacy] of the syntactic subject during the temporal unfolding of the sentence after the NACT verb. The specific finding evinces that the NACT anti-causatives with an animate subject were probably treated as reflexives by the aphasics, thus, impeding the construal of the subject as an underlying object. The possibility that the anti-causative reading of the structures in question would be achieved at a later point in time could be examined in a follow-up priming study that would examine priming of the antecedent at later positions in the sentence.

It is worth noting that the specific finding was replicated in the SPMT task, whereby the NACT anti-causative verbs with an animate subject were most of the times misinterpreted as reflexives by the aphasic subjects.

The results from the CMLP task have also revealed a significant effect of noun animacy in the processing of the ACT anti-causative verbs by both the controls and the aphasics. Most importantly, unmet expectations of an animate subject in the ACT anti-causatives completely blocked the post-verbal re-activation of the antecedent for four out of the five patients that have exemplified an antecedent re-activation effect for the ACT anti-causatives at position 2, and for the language unimpaired subjects at probe position 3. The finding that the animacy effect has emerged earlier for the aphasics relative to the controls provides further support for theories claiming that semantically-based
information somehow has priority for Broca’s aphasics and morpho-syntax is accessed at some later stage during sentence processing (Saffran, Schwartz & Linebarger, 1998). On the other hand, the language-unimpaired processor appeared to be sensitive to morphological cues (i.e. voice morphology) after the verb segment at position 2 and later on, at position 3, to semantic factors (i.e. the [±animacy] of the syntactic subject). Overall, the lack of antecedent re-activation for the ACT anti-causatives with an animate subject in the two groups is probably attributable to a robust heuristic-based strategy of thematic role assignment conflicting with a syntactically determined interpretation construing the subject as originating from an internal argument position in the ACT anti-causatives.

Many linguistic and psycholinguistic studies (e.g. Chang, Bock & Goldberg 2003; Fotiadou & Tsimpi, 2008; Pappert, Zeiske & Pechmann, 2009) treat animacy as an inherent semantic feature that has been shown to play an important role in thematic role assignment (especially in morphologically rich languages), and more specifically, in the parsing of non-canonical constructions (passives, object-clefts, and object-relative sentences), and in the resolution of syntactic ambiguities. According to this knowledge of role-to-argument mappings, animate arguments are prototypical actors, and, thus, are strong candidates for subjecthood, while inanimate nouns are prototypical patients, and, as such, they are strong candidates for the internal argument positions. Crucially, such a heuristic is strongly validated by Fotiadou’s (2010) corpora-based analysis of both ACT and NACT verbs traditionally classified as anti-causatives in the Greek grammar. Most importantly, animacy effects were found to affect verb interpretation in significant ways especially when ACT voice morphology was involved. More specifically, Fotiadou’s overall data shows that when the syntactic subject is animate, transitive uses are more frequent than anti-causative, as well as unergative uses. On the other hand, when the syntactic subject is inanimate, anti-causative uses are significantly more frequent than transitive, as well as unergative uses. Furthermore, the same corpora-based study has revealed that the presence of an animate subject favors the reflexive reading of NACT verbs, which was found to be significantly more frequent than the passive and the anti-causative reading.
Following the specific empirically validated heuristics, we hypothesize that the [+animacy] of the subject in the ACT anti-causatives might have led the parser to assume a non-target-like interpretation, thus, blocking antecedent re-activation post-verbally across both groups. On the other hand, we believe that the presence of an animate subject in the NACT forms has increased the difficulty of garden-path recovery for the aphasics, with the [animate-DP NACT-verb] structures being prone to a reflexive vs. an anti-causative interpretation. On the contrary, the readily use of explicit morphological information by the controls has probably triggered antecedent re-activation for the NACT anti-causatives in a linguistically principled manner, thus, suggesting that the controls’ increased sensitivity to morphological marking cues implicating a transitivity change in the NACT verbs has abolished heuristic-based constraints emanating from the [+animacy] of the subject in the respective condition.

The fact that half of the patients proved unable to establish the required dependency between the antecedent and the gap at a post-verbal position for the anti-causatives with an animate subject suggests that animacy incurred a great cost for both ACT and NACT classes. The clear priming effect registered for the anti-causatives in the [-animate] subject condition for the aphasics gives credence to the decisive role played by the animacy of the subject in constraining the interpretive choices left open for the anti-causative verb class and, especially, for the ACT anti-causative predicates. It appears that constraints other than those encoded on the verbal stem (in our case, the animacy of the subject) caused the aphasic subjects to prefer certain parsing strategies over others, leading to broad interpretational regularities: four out of the five aphasics that have shown evidence in favour of post-verbal antecedent re-activation in the ACT anti-causatives did so only when the critical subject-DP was inanimate. It may be possible that the ACT anti-causative verbs with an animate subject were interpreted either as unergatives or transitives with null objects. On the other hand, four out of the six patients that have shown evidence in favour of post-verbal antecedent re-activation in the NACT anti-causatives did so only when the critical subject-DP was inanimate, thus, implying that the rest of the
predicates with an animate entity in subject position have probably received a reflexive reading. As such, it is likely that the presence of the NACT suffix in the NACT anti-causative verb condition was relatively sufficient to trigger post-verbal antecedent re-activation in both groups (and especially the controls), which may have made the animacy information more crucial for the verification of the ACT intransitive verbs as anti-causatives. Overall, the present findings are interesting in the sense that they promote an understanding of the aphasic and the control individuals’ parsing choices as a function of noun animacy along with other factors traditionally assumed to affect anti-causative verb interpretation, like the verbs’ lexical sub-categorization as anti-causatives. As such, syntactic processing appears to be sensitive to the lexical feature of animacy which has been shown to drive syntactic expectations about argument realization in the aphasic group at least to a considerable extent.

A last piece of evidence in favour of the central role played by heuristics in the aphasic comprehension system has to do with pragmatic plausibility effects outranking syntax in the interpretation of some ACT transitive verbs included in the SPM task. The items we refer to are the verbs *filao* ‘kiss’, and *agaliazo* ‘hug’ which, though integrated into unambiguous transitive SVO syntactic frames, they were systematically interpreted by seven of the eight aphasic participants as reciprocals. Given the high frequency of occurrence of the specific verbs in structures encoding reciprocity, this finding indicates that the patients underused syntax (i.e. morpho-syntactic features) and relied more on lexical-semantic or probabilistic information in sentence processing\(^{59}\). Nevertheless, the fact that morpho-syntax was correctly parsed for the rest of the SVO items included in the transitive verb condition (i.e. *klotsao* ‘kick’, *deno* ‘tie’, and *vreho* ‘hose’) evinces that the patients did not suffer from a syntactic deficit, but rather that the mapping of the syntactic structure to a semantic-level interpretation was blocked by pure probabilistic reasons. Similarly, but somewhat differently, Ferreira, Bailey &

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\(^{59}\) The aphasics’ over-reliance on probabilistic constraints is probably held responsible for the patients’ inability to construe representations for the ACT non-alternating anti-causative verbs in the CMLP task, assuming that these verbs were treated on a par with unergatives or transitives with a null object.
Ferraro’s (2002) *good-enough* processing predicts even language-unimpaired speakers to be affected by syntactic difficulty and frequency of occurrence effects, rather than a full-fledged linguistic representation of sentence meaning. Good-enough representation was originally developed to explain L1 processing, but it does seem to apply to the Broca’s aphasics as well.

As one can see, the heuristics and the compensation strategies employed by the aphasic subjects at the lexicon-syntax interface were considerably more numerous relative to the discourse-syntax interface. This finding may also constitute an additional explanation for the patients’ relatively target-like performance in the tasks testing the processing of verbs of alternating transitivity.
8.3. [4th Research Question: Are the two interfaces equal in terms of processing difficulty or does the aphasic performance differ with respect to each interface tested?]

The results of the experiments investigating the aphasic performance at the two interfaces provide evidence in favour of the patients’ substantially lower processing efficiency at the discourse-syntax relative to the lexicon-syntax interface. More specifically, half of the aphasic subjects in the intra-sentential task appeared to lack ideal knowledge of the discourse conditions (or their implementation) regulating the interpretation of the overt pronoun in [+Topic-shift] contexts, while their performance in the inter-sentential task has highlighted the application of a heuristic in place of a syntactic parser: the pronoun was systematically resolved by the syntactic subject irrespective of the form of the pronoun (null/overt) or the word-order (canonical/non-canonical) of the sentential constituents. On the other hand, the aphasic performance in the tasks investigating access to the lexicon-syntax interface has revealed a relatively target-like parsing mechanism that could exploit retrieval cues such as the NACT voice morphology or the voice-alternating property of the ACT anti-causative verbs, as well as the interaction between the [±animacy] feature of the syntactic subject and voice morphology. Spared access to the aforementioned cues allowed target-like comprehension of reflexives and NACT anti-causative verbs (especially, with an inanimate subject) and, yet, explained the aphasics’ relatively poorer parsing of the anti-causative verbs with an animate subject, as well as of the ACT non-alternating anti-causative verbs that lack the cue of the explicit morphological marking on their stem.

Most importantly, the mapping of lexical information on the verbs’ theta-grids and morphology implicates modules internal to grammar (i.e. narrow syntax, morphology, lexicon/semantics) in contrast to discourse information which mainly deals with how multiple alternative meanings fit together at a post-grammatical interpretive level. The present study proposes four explanations that may account for
the aphasics’ relatively worse performance at the discourse-syntax interface, namely, (i) the grammar-external nature of discourse-level information and the subsequent high computational cost implicated by gaining access to and integrating discourse cues, (ii) an inhibitory deficit preventing the patients from disengaging from ‘default’ options under conditions of ‘deep’ processing, (iii) the linguistic complexity inherent to the stimuli employed at the discourse-syntax interface, and, finally, (iv) the assumingly low frequency of occurrence of referentially ambiguous structures in the input preventing, thus, the patients from utilizing probabilistic constraints during ambiguous referential interpretation.

According to the first account, the distinction between the two interfaces is based on the assumption that the discourse-syntax interface is a ‘higher’ level of language use, integrating properties of pragmatic and language constraints which have been claimed to have different domains of application. Recent experimental work (e.g. Frazier & Clifton, 2006; Kehler, 2000) holds that individual sentence well-formedness is considerably affected by discourse-level pressures that literally access real-world, grammar-external information. Such discourse constraints are claimed to be activated during sentence processing and their role is to incorporate event-construal directly into constraints on interpretation. We typically assume that pronoun interpretation is largely a by-product (i) of language-specific parsing operations constraining the hierarchy (or else, the distinct distributional properties) of the pronouns, as well as (ii) of a universal parsing operation that determines the prominence/salience of the pronoun’s potential antecedents, and thus provides the human parser with appropriate instructions for retrieving the pragmatically felicitous antecedent by indicating how accessible the potential antecedents are in the discourse. Such constraints add content over the syntax of a referentially ambiguous sentential structure and take place at a level way beyond grammar, thus, necessitating high processing resources for their integration. The difficulty in accessing and co-ordinating information from the syntactic output, on the one hand, and the pragmatics-discourse domain, on the other, has been widely reported in the literature, especially in the field of L2 development (Tsimpli & Sorace, 2006; Sorace 2007). The same studies point out that the lexicon-syntax interface is assumed to involve formal
properties of the language system alone, such that the processing of lexicon-filtered structures is predicted to be less costly for the human parser due to the stronger interpretability of the features involved.

The difficulty in gaining access to and co-ordinating discourse-derived inferences about the discourse representations of the events with syntactic information may partially account for the aphasics' worse performance in the tasks testing ambiguous pronoun resolution at the discourse-syntax interface. While the control subjects were able to integrate event structure and discourse cohesion when determining the referent of the overt pronoun in the ambiguous contexts, most of the aphasics failed to do so; in cases where the topic- or the word-order change potentially affected the salience of the antecedent, the patients predominantly preferred the syntactic subject of the sentence, in contrast to the controls who showed a greater preference for the object in the same context. Such a performance may be attributed to the aphasics' inability to integrate online pragmatic principles that govern topic-shift (i.e. an overt pronoun motivates a referential switch to an entity which gets perceptually highlighted with respect to the possible available alternatives). On this view, the high computational cost implicated in discourse integration may have exceeded the aphasic processing resources. The choice between a topic-continuous and a topic-shifted interpretation has been traditionally claimed to be influenced by the cognitive load that the comprehender experiences during sentence processing (Arnold & Griffin, 2007). Following this reasoning, the aphasic parser was probably over-burdened by the need to compute both morpho-syntactic features and event-structure/discourse cohesion information. As such, the syntactic subject appeared to be the most economical choice for the agrammatic parser across all the referentially ambiguous contexts.

The aphasic subjects' characteristically strong dis-preference for the 'other' antecedent in the on-line intra-sentential task also speaks in favour of the patients' pronounced difficulty with integrating information from discourse. Resolving referential relations that occasionally implicate an enlargement of the discourse model (like when the referent of the overt pronoun is identified with a non-topical entity
not mentioned in the sentence) seems to take more cognitive effort relative to a topical or even a non-topical referent that is included in the sentence. Most interestingly, the lowest matching scores for four of the aphasics in the specific task were registered for the overt pronoun trials whereby the proposed candidate was an extra-discourse referent not orally presented but depicted in the visual stimuli on the screen. On the contrary, the controls’ preference for the extra-sentential referent in the overt pronoun condition was equally strong to their preference for the main clause subject (38.10% and 41.34%, respectively). Such data implies that the need to enlarge the discourse model in order to establish reference to entities which were not orally presented was too costly for the aphasic group. It appears that the properties of the referents that were included in the sentences were more salient than the properties of the mental representations corresponding to entities not linguistically expressed, thus, suggesting that the development of mental images not encoded via language were probably more semantically impoverished for the aphasics. On the contrary, the mental representations of both syntactic subjects and objects were richer in semantic detail than would probably be the case if the aphasic listeners had only visual knowledge about them. For probably most of the patients, these entities were uniquely associated with considerable information from long-term memory which may have facilitated their activation and, thus, rendered them more available for a referential link.

The finding that the aphasics tended to dis-prefer referents that were not anchored to the sentential stimuli of the intra-sentential task due to these referents’ low salience in the patients’ discourse model appears to be replicated by a number of relevant studies with both language-unimpaired and language-impaired populations. Most intriguingly, recent approaches suggest that linguistic meaning activates more effectively ‘real-world’ features of objects and events, such that the retrieval of a referent which is non-linguistically expressed is more difficult (Kaschak & Glenberg, 2000; Grodzinsky 1995b).
Zwaan & Taylor, 2006; Clinton & Long, 2009). Dahan, Tanenhaus and Chambers’ (2002) study has also revealed that comprehension is faster for previously mentioned referents compared to things that may be visible but have not been mentioned. Crucially, anterior brain damage in the lesion literature on aphasic deficits (Poirier, Shapiro, Love & Swinney, 2007) has been reported to implicate not only a deficit in the automatic routines underlying syntactic processing, but also a disruption in the function of routines aligned with meaning retrieval operations which are discourse-based (e.g. Verb Phrase Ellipsis structures). Based on these findings, we may assume that the aphasic participants of the present study opted for readings only involving linguistically expressed entities due to their difficulty with activating discourse entities which were not sententially-anchored. Such a performance is consistent with Papadopoulou et al.’s (2007) on-line study with children (among other populations) arguing in favour of a delay in enlarging their discourse model during ambiguous subject pronoun resolution in order to establish reference with entities not mentioned in the verbal stimuli. Papadopoulou et al. (2007) claim that the children’s parsing mechanism initially starts with reliable syntactic cues and gradually adds other sources of information, including discourse over development. In light of the findings of Papadopoulou et al. and the present study, we may claim that one of the differences between the aphasics’ and the children’s performance with respect to their ‘impoverished’ discourse model is that in the former population such an impoverishment stems from pathological factors while in the latter population from maturational limitations.

A second viable explanation for the aphasics’ relatively greater vulnerability at the discourse-syntax interface is an impaired inhibitory mechanism responsible for suppressing inappropriate choices. We claim that the Broca’s aphasics were able to implicitly identify the pronouns’ felicitous referent across all the experimental conditions (i.e. the syntactic subject when the pronoun was null and a non-subject referent when the pronoun was overt to encode disjoint reference), yet, the patients’ infelicitous explicit referential decisions stemmed from an impaired inhibitory mechanism, which, if normally functioning, would reduce/suppress the activation of inappropriate competing entities. Very few studies
have observed language effects on cognitive control and cognitive-control-like effects in the language processing of adults suffering from frontal lobe lesions (Stuss & Benson, 1986; Bialystok, 1999). Cognitive control, i.e. the ability to dismiss a tempting/habitual alternative, was found to be particularly difficult for these brain-damaged patients, who often perseverated, i.e. tended to choose the habitual but wrong option. These studies have postulated an attentional inertia (i.e. sticking to the initial interpretation) or impairment of inhibition at the lexical-semantic level in language processing, thus, explaining the aphasic inability to effectively ignore the automatically evoked, distracting stimulus.

Following the same line of reasoning, we may assume that while the aphasic access to the interface-conditioned properties of the overt subject pronoun was intact, the patients seemed to have difficulty inhibiting or disattending to initial erroneous parses/hypotheses assumed to be identified with the syntactic subject ‘default’ option. Most notably, the aphasic inhibitory mechanism appeared to be most ‘inert’ in the inter-sentential task which was assumingly the most demanding in terms of processing resources. The finding that the patients have opted for the subject antecedent considerably more frequently relative to the controls in the overt pronoun (SVO & OcIVS) trials indicates that the syntactic function of subjecthood completely overwhelmed the aphasics’ inhibitory mechanisms in the relevant task, at least. It would be interesting, thus, to submit the aphasic subjects of the present study to standard cognitive control measures and see whether cognitive control difficulty and processing difficulty at the discourse-syntax interface are positively correlated. Such a finding would give credence to a dissociation between the aphasics’ spared implicit ability to identify the intended referent and their non-target referential co-indexations. The assumption emanating from such a finding would be that ambiguous pronoun resolution in Broca’s aphasia is especially affected by domain-general resources associated with executive control instead of exclusively tapping into the properties of the interface domains or of language exclusively.

The aphasics’ worse performance in the on-line interpretation of pronouns at the discourse-syntax interface (relative to the lexicon-syntax interface) may also partially emanate from the structural
complexity inherent to the linguistic materials employed in the relevant tasks and its cascading consequences on the aphasic processing capacities. The aphasic participants had to compute simultaneously a wide range of linguistic information, including: (i) the type of the pronoun, i.e. whether the subject pronoun was null or overt, (ii) the morphological features encoded on the overt pronoun (i.e. the phi-features of number and gender), (iii) the type of the antecedents, with the definite NPs in the intra-sentential task being assumingly harder to process than the proper names used in the inter-sentential task due to the former lacking a unique connection to real-world knowledge (Clinton & Long, 2009), (iv) the type of event representations, with the temporal events in the intra-sentential task (connectives enoi/while’ & otan/when’) presumably activating more stages or situations over time relative to the causal events in the inter-sentential task (connective epidhi/’because’), thus, suggesting that the former took longer to process (Coll-Florit & Gennari, 2009), (v) the pragmatic plausibility of the event that each participant had to figure out sentence by sentence, and, finally, (vi) shifts in topicality implicated either by the overt pronoun in subject position or the CLLD of the syntactic object bringing it to prominence/Topic position. The simultaneous integration of these disparate informational cues in real-time has assumingly entailed a level of increased complexity that might have overloaded the patients’ processing capacities. On the contrary, the linguistic materials designed for the tasks testing the processing of verbs at the lexicon-syntax interface were structurally simpler, with the arbitrariness of the lexicon being assumingly the only factor confounding the valuation of the ACT non-alternating intransitive verbs as anti-causatives. Each of the sentences in the SPM and the repetition task, for example, was isolated and much shorter (relative to the sentences in the pronoun resolution tasks) consisting just of the critical verb and maximally two arguments. With respect to the CMLP task, the sentences were presented in a self-paced manner in three successive time-windows, such that the participants could spend sufficient time to process verbal information.

Finally, one should also take into account the frequency of occurrence of the experimental stimuli in the subjects’ linguistic input and the way this might have modulated the aphasics’
interpretational choices via experience-based priming of argument-to-role mappings in the resolution of ambiguous structures. An important question in sentence comprehension is the frequency of the representations entertained during on-line processing. Experience-based theories and exemplar-based models of language processing explicitly store every language experience in memory. New linguistic tasks are assumed to be solved on the basis of similarity-based extrapolation from these stored experiences (see Balota et al., 2007 for lexical decision tasks, Griffin & Huitema, 1999 for word-naming tasks, and Bates et al., 2003 for picture-naming tasks). Following this reasoning, the resolution of ambiguous structures may be strongly shaped by the frequency with which interpreters encounter them in everyday linguistic input, creating a trade-off between priming based on previous linguistic experience and on-line grammatically-constrained resolution (Hale, 2001; Reali & Christianson, 2007; Fedorenko, Woodbury & Gibson, 2007; Levy, 2008; Gennari & McDonald, 2008). In principle, structurally complex sentences are likely to be less frequent in the input, thus, harder to recognize and process (Van Durme, Frank & Jaeger, 2009). In this sense, the difficulty with processing referentially ambiguous contexts such as the ones employed in the tasks of the present study could partially be attributed to the specific structures’ relatively lower frequency in natural language, or to put it in more technical terms, to their less conventionalized status in the experimental subjects’ stored schemas in verbal memory61. Richer stored schemas would have probably required that the subjects figured out item by item which referential co-indexations are pragmatically felicitous and why. As such, it is highly unlikely that the comprehenders implicitly learnt strategies of resolving ambiguous pronoun structures and applied them as probabilistic constraints to interpreting new input in the tasks of the present study. On the other hand, anti-causative verbs are relatively more widespread in natural language as well as in the input received within the context of the formal educational system (among other sources), which

61 Though there is no frequency data in Modern Greek validating our assumption about the lower frequency of occurrence of referentially ambiguous two potential antecedent contexts in Greek speakers’ language input, everyday language experience shows that referentially ambiguous structures are harder to find relative to anti-causative structures.
could have probably facilitated residual activation of the anti-causative verbs and their argument-to-role mappings.

Though no frequency counts exist with respect to the distribution of referentially ambiguous structures in Greek, Fotiadou’s (2010) elaborated corpus-based analyses on Greek anti-causatives give strong empirical evidence in favour of the possibility that frequency-based implicit learning may partially account for the differences attested between the two interface-based linguistic phenomena in aphasic comprehension\(^62\). Indeed, Fotiadou’s analyses evince a wide distribution of anti-causative readings in both the corpus developed by the Institute for Language and Speech Processing (ILSP) and the Web corpus in Greek, with anti-causative distributional regularities found to be significantly modulated by [ACT/NACT] voice morphology and the [±animacy] of the subject. Though the verbs examined in Fotiadou’s data-set analyses and the ones used in the present study failed to overlap to a considerable degree, we might as well examine just the frequencies of the verbs occurring in both studies and see whether they provide support for our assumption that anti-causative readings are widely distributed in Greek natural contexts.

More specifically, in the presence of an inanimate subject the ACT forms of the verbs *tedonii*’stretch’ and *htipai*’hit’ were found by Fotiadou to elicit a higher number of anti-causative readings relative to transitive readings in both the two corpora (57.96% vs. 42.04% for the anti-causative vs. transitive reading for the verb *tedonii* ‘stretch’, and 49.75% vs. 47.69% for the anti-causative vs. transitive reading for the verb *htipai* ‘hit’). For the ACT verbs *tsalakoni*’wrinkle’, *leroni*’spill’, *tripai*’pierce’, and *ljioni*’melt’, the anti-causative readings in the sentential frames having an inanimate subject did not exceed the transitive readings, yet, they were considered to be fairly frequent in both corpora (44.05%, 12.27%, 20.99%, and 37.47%, respectively). Crucially, the ACT non-
alternating verb *ljioni*'melt' was found to be significantly more prone to anti-causative vs. transitive readings once its syntactic subject was animate (55.26% vs. 44.74% for the anti-causative and the transitive readings, respectively). On the other hand, the verbs *tsalakoni*'wrinkle' and *leronii*'splill' were found to be exclusively interpreted as anti-causative when they appeared in NACT form irrespective of the [±animacy] of their syntactic subject (78.96% anti-causative readings for the animate subject contexts and 89.62% for the inanimate subject contexts for the verb *tsalakoni*'wrinkle', and 94.23% anti-causative readings for the animate subject contexts and 100% for the inanimate subject contexts for the verb *leronii*'splill'), while the NACT form of the verb *tedoni*'stretch' was only interpreted as anti-causative (76.67%) in the inanimate subject contexts. With respect to the NACT forms of the verbs *htipai*'hit' and *tripai*'pierce', these tended to receive mainly passive interpretations, yet, the anti-causative readings were relatively frequently encountered across the two corpora (20.12% anti-causative readings for the animate subject contexts and 28.75% for the inanimate subject contexts for the verb *htipai*'hit', and 22.50% for the animate subject contexts and 13.64% for the inanimate subject contexts for the verb *tripai*'pierce'). We strongly believe that the specific evidence offers support in favour of the assumption that anti-causative structures in Greek are frequent enough to be retrieved in an easier and less costly manner relative to referentially ambiguous structures.
8.4 BETWEEN-APHASIC SUBJECT HETEROGENEITY AND NON-LINGUISTIC PROFILES

The purpose of the present section is to investigate the effects of several components of the aphasic subjects' physiological and sociological profiles on their linguistic performance across the various tasks. Although the assessment of the aphasics' impaired processes at the interfaces was crucial for reaching some conclusions on the nature of the linguistic deficit in agrammatism, many other non-linguistic factors may have played a role in guiding their performance, e.g. mood, motivation, health status, age, education, lesion site and socio-economic status (Basso, 2003). The nature of the potentially predictive relations between the patients' ability to complete linguistic tasks and physiological factors like site of brain damage, the patients' age, or the subjects' educational level has been a fundamental question in aphasiological research. Nevertheless, knowledge of the effect of these factors is limited, with the most widely documented predictor of linguistic performance being neurological variables, especially the site of the lesion that determines the initial severity and the type of aphasia (Alexander, 2006; Frattali & Grafman, 2005; Connor et al., 2001; Laska et al., 2001; Pedersen, Vinter & Olsen 2004; Kertesz & McCabe, 1977; Marshall & Phillips, 1983; Lendrem & Lincoln, 1985; Basso, 1992; Blomert, Kean, Koster & Schokker, 1994), whereas non-neurological factors such as age and education have been examined to a less extent. On the other hand, a growing number of studies exists on the potential role of several neuropsychological, psychological and socio-economic factors in predicting the outcome of language unimpaired adult linguistic performance. These studies have used a range of linguistic tasks of varying complexity, like, for instance, the recently examined effects of auditory distraction on older and younger subjects’ speed of grammaticality judgement of visually presented sentences varied by reversibility and short term memory requirements (Jones, 1999; Goff et al., 2006).
The main focus of the present section is to gain insight into the potential role of three non-linguistic variables, including age, lesion site and education, to predict the performance patterns of the eight aphasic individuals of the present study. As will be discussed below, a non-negligible proportion of the aphasics’ performance patterns in the tasks may be accounted for in terms of the impact of these variables, thus, giving credence to the view that the assessment (and subsequently the treatment) of the deficit in aphasia should be conducted in an interdisciplinary manner (Van Mourik & Van de Sandt-Koenderman, 1992; Goldenberg, Dettmers, Grothe & Spatt, 1994; Helm-Estabrooks, 2002; Keil & Kaszniak, 2002; Purdy, Duffy & Coehlo, 1994; Zinn et al., 2004).
8.4.1 The age factor

The few studies investigating the effect of age on aphasic performance are contradictory (Marshall & Phillips, 1983; Lendrem, McGuirk & Lincoln, 1988; Poeck, Huber & Willmes, 1989; Blomert, 1994; Pedersen et al., 1995, 2004), probably because of differences in sampling (Pedersen et al., 1995) and because of the fact that the effect of age may largely depend on unmeasured factors such as motivation, health and mood (Basso, 2003). Generally speaking, everyday functioning is widely documented to become significantly more challenging in the face of cognitive declines associated with aging, such that the relatively poorer performance of older aphasic patients participating in language therapy sessions has been based on advanced age alone (Basso, 1992).

Factors affecting older subjects’ abilities to complete linguistic tasks in the face of various types of distraction have been a subject of ongoing research. This information coming from language-unimpaired populations is considered to be critical in order to separate the real effects of the disorder from those attributed to the natural ageing process. Baum (1989), for example, had older and young subjects monitor words in sentences with extraneous words added to the sentences to increase distraction, while in a more recent study Goff et al. (2006) have investigated older and young subjects’ speed of grammaticality judgement of visually presented sentences varied by reversibility and short term memory requirements. In both studies the younger groups exhibited an increased sensitivity to the distraction conditions relative to the older participants whose performance was not significantly differentiated across conditions. Mathias & Karanth (2009) have also compared the communication performance of an older and a younger experimental group of Indian-English speakers along a number of testing conditions, like the conversational techniques employed to deal with trouble sources or the type token ratio of the subjects’ spoken output. The results of the study revealed a decline in the geriatric group’s linguistic and cognitive resources reflected in their relatively less efficient pragmatic
skills and poorer use of different word classes. Finally, Salis and Edwards (2010) have recently explored the effect of discourse complexity and working memory in healthy older adults, using auditory discourse and digit span tasks. What they found was that the older subjects performed poorer in the complex discourse comprehension condition relative to the younger subjects. Most importantly, what all the aforementioned studies claim is that the declines in linguistic performance observed in older adults are not due to age, but due to declines in either declarative memory or in executive functions mediating most purposeful behaviour including linguistic performance.

According to the memory account proponents, changes in declarative memory are common among older adults with up to half of them complaining about decreased everyday memory function (Jonker, Geerlings & Schmand, 2000). More specifically, healthy adults have been reported to show memory loss with age, especially after the sixth decade (Schaie, 1996). According to the aging brain literature, this decline in memory ability across the lifespan can be parsimoniously attributed to changes in brain structure, and more specifically, to downward changes in cellular, morphologic, and volumetric aspects of the hippocampus and the related medial temporal lobe structures (Oosterman et al., 2008; Raz, 2000; Jernigan et al., 2001). However, some older adults were documented to benefit from

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63 Scientists have tentatively focused their attention on the role that executive function plays in difficulties with auditory processing in populations evincing selective linguistic difficulties, including the elderly (Earles et al., 1997; Hasher & Zacks, 1988), individuals with schizophrenia (Maher, 1983), and those with dementia of the Alzheimer type (Sullivan, Faust & Balota, 1995). Research findings imply the presence of executive dysfunctions in aphasic populations as well predominantly reflected in reduced allocation of attentional resources, costs in attentional switching (engagement/disengagement) and suppression/interference effects. Although the mechanism responsible for the executive malfunction in aphasic individuals and the resultant selective processing impairments is claimed to be an impaired inhibitory mechanism that would serve to limit the generation and maintenance of irrelevant information during automatic (vs. controlled) processing, alternative hypotheses also remain viable such as impaired automatic activation, impaired goal maintenance and impaired attentional shifting (McNeil et al., 2010). To date none of these hypotheses have been tested.
functional reorganization of the brain (Cabeza, 2002), thereby experiencing fewer declines in memory function. Most importantly, apart from the memory limitations hindering the older individuals' cognitive processing, the researchers propose that there is a working memory subsystem responsible for sentence and processing interpretation which is influenced by ageing as well. This language-specific working memory subcomponent is reminiscent of Waters and Caplan's (2005) suggestion that the working memory system for syntax is separate from that used in other aspects of language (e.g. serial recall in digit span tasks). Age-related differences in working memory influencing language processing have been explicitly found in studies comparing ambiguous and unambiguous sentences: elderly adults exhibited greater processing difficulty in ambiguous than unambiguous sentences, as measured by reading times at the critical region (Kemper, Crow & Kemtes, 2004) or comprehension question accuracy (Christianson, Williams, Zacks & Ferreira, 2006). Also, high span WM readers showed less difficulty than low span WM readers in processing ambiguous sentences, particularly among older adults (Christianson, Williams, Zacks & Ferreira, 2006).

On the other hand, proponents of the executive function decline hypothesis claim that age is not the variable responsible for decreases in the linguistic performance of older adults but declines in executive function are responsible instead. Such an assumption was reached after discovering that older adults have scored significantly lower than younger adults on linguistic tasks requiring high-level information processing abilities, such as concept formation and abstract reasoning (characterized as major components of executive function abilities) (Balota, Black & Cheney, 1992; Harris, Rogers & Qualls, 1998; Kemper, 1992; Earles et al., 1997; Hasher & Zacks, 1988). According to the latter hypothesis, age-related declines in executive function may account for age-related deficits in information processing (Raz, 2000).

Deficient self-monitoring including executive functions and deficient WM specialized for syntactic processing are well documented after aphasia. More specifically, it has been assumed that the internal feedback loop contributing to auditory comprehension and monitoring one's comprehension...
is impaired in aphasics (Stuss, 1991). This is consonant with the experimental literature demonstrating that individuals with aphasia have difficulty monitoring their own performance, appropriately evaluating task demands, and, thus, allocating a sufficient amount of resources for the successful completion of tasks (Murray, Holland & Beeson, 1997A; Tseng, McNeil & Milenkovic, 1993). However, very few investigations exist of the executive functions of adults with aphasia because of the language load in many cognitive tasks (Purdy, Duffy & Coelho, 1994). On the other hand, impairments in WM have been characterized as a critical set of non-linguistic deficits in Broca’s aphasia (Murray, Ramage & Hopper, 2001; Wright & Shisler, 2005). Significant differences between the WM capacity of individuals with and without aphasia (Tompkins, Bloise, Timko, & Baumgaertner 1994; Wright, Newhoff, Downey & Austermann, 2003) and significant correlations between WM and general language measures (Caspari, Parkinson, LaPointe & Katz, 1998; Wright et al., 2003; Wright, Downey, Gravier, Love & Shapiro, 2007) have been demonstrated. Nevertheless, no up-to-date study has yet examined the impact of the age factor mediated by executive function and WM correlates on the linguistic performance of aphasic individuals.

Although not the primary intent of the current research, it was important to establish that younger aphasics performed differently than older ones. Though the current study has not delineated and compared patterns of performance of the aphasic participants on the basis of their age by using statistically reliable measures, we hypothesize that age-related cognitive declines may account for part of the aphasics’ linguistic performance at the two interfaces. On the basis of the findings of the aforementioned studies with healthy older adults, we further hypothesize that the age effect would be most pronounced in tasks requiring a high amount of memory resources and the activation of higher-level cognitive processes, such as comprehension tasks involving purposeful and self-guided decisions like the off-line SPM task checking unambiguous pronoun comprehension, the two on-line tasks focusing on ambiguous pronoun resolution, and the CMLP and SPM tasks checking the processing of unaccusativity in an on-line and off-line mode, respectively. Due to the fact that the overwhelming
majority of the aphasic participants in the present study belonged to the geriatric group, i.e. they were above 65 years old (as is the norm with the majority of the studies focusing on adults with acquired language disorders), we will alternatively focus on the performance of the patients GCH and VSK (57 and 47 yrs., respectively) and see whether it was differentiated relative to the rest of the aphasic participants.

The data from the specific tasks have, indeed, revealed that the two younger aphasic participants exhibited subtler sensitivity to the dynamics of the interface-conditioned encoding processes relative to the rest of the aphasic patients belonging to the geriatric group. More specifically, both patients have demonstrated target-like performance in identifying the number and person features of the pronouns in the unambiguous pronoun-identification SPM task, with ceiling performance being registered across both testing conditions (95.83% accuracy rate for both the number and the gender condition for the patient GCH, and 95.83% and 100% accuracy rates for the number and the gender condition, respectively, for the patient VSK). Furthermore, both patients preferred to interpret the null pronoun as referring to the main clause subject in the intra-sentential ambiguous pronoun paradigm, like controls did, while their RTs on the subordinate verb matched the controls’ parsing preferences\textsuperscript{64}. With respect to the inter-sentential pronoun resolution task, GCH was the only patient that has demonstrated robust evidence in favour of increased sensitivity to the word-order variable reflected in his significantly higher RTs in the OclVS relative to the SVO trials in the overt pronoun condition. VSK, on the other hand, was one of the two patients (the other patient being THR) that has exhibited a between-pronoun type dissociation in the SVO trials of the inter-sentential ambiguous pronoun paradigm, with the overt pronoun being linked to the subject considerably fewer times than the null pronoun. This finding implies that the specific patient was sensitive to discourse-based information forcing a ‘disjoint reference’ reading of the contexts with an overt pronoun in subject position. VSK’s

\textsuperscript{64} Nevertheless, none of the two patients has exhibited a clear preference towards either the subject or the object in the overt pronoun trials, unlike controls.
spared sensitivity to discourse cues during pronoun disambiguation is also reflected in his spontaneous speech sample cited in the ‘Subjects and Methodology’ chapter, where one may observe his frequent use of pre-fabricated idiomatic expressions (e.g. *na pumel* ‘sort of saying’, *varese kanoni* ‘it was sold’, *megalo lavraki* ‘a big catch’). The pragmatically appropriate interpretation of those idioms in VSK’s non-fluent speech evinces that the specific patient could take into account contextual information and local coherence factors while planning his speech.

Furthermore, both patients provided evidence of retained sensitivity to the unaccusativity features of some intransitive verbs in Greek. More specifically, GCH was one of the two patients (the other patient being PAPAL) whose RTs in the CMLP task provided robust evidence in favour of the distinct processing of voice, with the ACT unergative and anti-causative predicates being processed significantly faster than the NACT anti-causatives, and the ACT anti-causatives, in turn, being processed significantly faster than the NACT anti-causatives. The same patient’s RT data has also evinced post-verbal antecedent re-activation in the ACT anti-causative verb class at probe position 3. VSK, on the other hand, was one of the two patients that have provided RT evidence in favour of antecedent re-activation across both the ACT the NACT anti-causative verbs at both post-verbal probe positions 2 (in the inanimate subject condition) and 3. The same patient was also found to have intact access to the animacy features of the syntactic subject, with his antecedent re-activation patterns of performance at position 2 reflecting the same heuristic-based constraints that have also regulated the control subjects’ interpretation preferences in (ACT, at least) anti-causatives. Both patients’ registered RTs on the unrelated probes provided evidence in favour of a gap-filling procedure in the anti-causatives only, with their RTs on the post-verbal unrelated probes increasing dramatically in both ACT and NACT anti-causatives. Most importantly, the two aphasic subjects have also responded similarly across the various conditions of the SPM task, such that both patients’ performance dropped only in the interpretation of the ACT anti-causative and the transitive verb class.
In sum, the two patients responded with comparable, relatively target-like patterns of performance to the various experimental conditions of the tasks in question. The older aphasics, on the other hand, performed more poorly, thus, supporting previous studies with language-unimpaired populations documenting a decrease in linguistic performance with age. Patient THR, for example, (aged 74 at the time of the study) was found to score significantly lower (87.50%) than the controls in identifying the number feature of the clitic pronouns in the unambiguous referent identification SPM task, while he systematically misinterpreted prototypically reflexive actions as passives and transitives in the SMPT testing the interpretation of verbs of alternating transitivity. Patient SP (aged 68 at the time of the study) did not exhibit the performance predicted by the redundancy avoidance strategy favouring subject-drop in NSLs, with the main clause subject and object competing for reference in the null pronoun trials (60% preference rate for the ‘null pronoun-main clause subject’ co-indexation, and 70% preference rate for the ‘null pronoun-main clause object’ co-indexation). Furthermore, THEX (aged 76) exhibited a rather asymmetric RT pattern in the CMLP task with antecedent re-activation being registered for the unergatives rather than the anti-causatives contra linguistically-principled expectations. Finally, patient PAPAL (aged 69 at the time of the study) appeared to assign reference to both null and overt pronouns in the OclVS trials of the inter-sentential task in a rather random fashion, while the overall scores of the patients THP and DENT (aged 87 and 79, respectively, at the time of the study) in the unambiguous referent identification SPM task were found to be significantly lower relative to the controls.

In sum, partial insights into the older aphasic participants’ performance across the various linguistic tasks of the study reveal that age-related working memory and/or cognitive decline may be one of the factors driving performance heterogeneity in the specific aphasic population. As such, it may well be that there is a working memory and executive function subsystem responsible for linguistic interpretation which is influenced by ageing. Though further analyses are needed to compare error
rates in the different age ranges in greater depth, the current findings point towards a new avenue of research on agrammatic linguistic performance, with ageing as an important variable.
8.4.2 The lesion site factor

Evidence for contemporary theories on the organization and structure of linguistic knowledge in the brain has been primarily based on findings with aphasic patients (Hillis & Caramazza, 1995; Shelton & Caramazza, 1999; Bird, Howard & Franklin, 2000; Shapiro & Caramazza, 2001). Most individuals studied have been Broca’s aphasic adults following stroke with defined lesions. Lesion location has assisted in developing theories predominantly related to the representation of syntactic knowledge and lexical access. As already mentioned, Broca’s aphasia is variably associated with large superficial and deep lesions, often including, but certainly not confined to the classically delimited Broca’s area—Brodmann Area (BA) 44 and BA 45 (Alexander, Naeser & Palumbo, 1990; Benson, 1985; Mohr, 1976; Vignolo, 1988). However imprecisely bounded the specific region is\(^{65}\), specific linguistic limitations stateable in the abstract terms of linguistic theories of agrammatic aphasia are reasonably certain to be connected with lesions in cortically localizable processing resources ‘wired in’ the specific areas. One of the most widely documented brain-language-mapping correlation in agrammatism has been the one between the clinical symptom of delayed automatic syntactic reflexes and lesions at the left anterior frontal cortex (Love, Swinney, Walensky & Zurif, 2008, a.o.), whereas damage to posterior regions has been mainly associated with semantic impairments (Poirier, Shapiro, Love & Swinney, 2007).

Neuroimaging analyses of impaired sentence processing (e.g. the functional Magnetic Resonance Imaging (fMRI) method) have sought to provide greater precision on language localization in the brain, i.e. the neuro-anatomical substrates that are crucially involved or play participatory roles in language operations reported to be disrupted in Broca’s aphasia. Besides the generally acknowledged

\(^{65}\) Amunts, Zilles, and their colleagues, for example, have shown that the sulcal contours defining BA 44 and 45 are not reliable landmarks of the borders of the Broca’s area (Amunts & Zilles, 2006; Amunts et al., 1999).
Non-Linguistic Factors – Lesion Site

suggestion that the frontal cortical region for syntactic processing incorporates only the inferofrontal gyrus—BA44 and BA45 (Ben-Shachar, Hendler, Kahn, Ben-Bashat & Grodzinsky, 2003; Caplan, Alpert & Waters, 1998; Dapretto & Bookheimer, 1999; Stromswold, Caplan, Alpert & Rauch, 1996, yet, see Caplan, 2000, for a discussion of inconsistencies), some more fine-grained localizations of language functions have been suggested. Recently, disruption of complex syntax that occurs during open-ended sentence formulation, such as spontaneous discourse, has been associated with the mid-dorsolateral prefrontal cortex which serves as a major locus for the organization and the integration of sensory and mnemonic information, as well as for cognitive regulation (Eshel, Frattali & Faroqi-Shah, 2009; Chen, Johnston, Frey, Petrides, Worsley & Ptito, 2004; Petrides, 1991; 2000). Furthermore, poor comprehension in agrammatism has been related to lesions at the primary auditory cortex of the temporal lobe, while good comprehension has been related to lesions that spared the temporal lobe (Auther, Wertz, Miller & Kirshner, 2000). Furthermore, recent behavioural and neuro-anatomical studies provided support for the hypothesis that a relationship exists between the anterior lesion extension and the severity of concomitant anomia in aphasics with left inferior temporal lobe damage. In fact, the data suggests that such lesions may disconnect relatively preserved semantic knowledge from regions critical for accessing phonological word forms (Antonucci, Beeson & Rapcsak 2004). Finally, Martin, Mortensen, Burton and Hofwegen (2007) have recently highlighted the close relationship between the WM maintenance capacity and the left middle and left inferior frontal gyrus centered in Brodmann’s area 46.

Certainly, it is not clear that efforts to achieve such fine-grained brain localization on the basis of neuroimaging techniques are warranted even in principle. Inter-individual variation in the language regions as well as in functional neuroanatomy is great no matter what anatomical mapping method is used (Amunts & Zilles, 2006; Petrides, 2006; Chen, Johnston, Frey, Petrides, Worsley & Ptito, 2004). However, detailed neuroimaging data of some of the aphasics of the current study suggests that their performance levels and error types may correlate with neuro-anatomical regions of ‘compromised’
subcomponents of the linguistic module. More specifically, the disturbed repetition capacity of the patients THP and PAPAL, reflected in their relatively high rates of semantically inappropriate responses in the repetition task at the lexicon-syntax interface, may be associated with a lesion in the left arcuate fasciculus observed in both patients. Damage to the posterior portion of the arcuate fasciculus is a strong predictor of impaired repetition in stroke patients with left hemisphere damage, whereby the connections between the posterior comprehension areas in the temporal lobe are disconnected from the anterior speech production region in the posterior-inferior frontal lobe (Geldmacher, Quigg & Elias, 2007). Furthermore, the complete lack of syntactic arguments in SP’s spontaneous and elicited speech in the picture-naming task at the lexicon-syntax interface may be attributed to the specific patient’s extended brain damage; SP was the only patient of the aphasic group presenting with a large left basal ganglia haemorrhage involving the posterior putamen. A CT scan performed on the patient just before surgery demonstrated increased perfusion in the left temporal cortex, frontal cortex and white matter, as well as to the left basal ganglia due to the extended haemorrhage after the stroke. Finally, GCH’s reported anterior extension of the lesion towards the left inferior temporal lobe, which has been traditionally associated with the storage site of semantic knowledge and conceptual representations, may account for the patient’s lexical access deficit registered in the CMLP task at probe position 1. The reader is reminded that GCH has not exhibited a statistically significant priming effect either in the CMLP task (at probe position 1) or in the follow-up study checking semantic priming for de-contextualized words. However, we have to be cautious in drawing firm conclusions, as the associations between critical lesion locations and the linguistic symptoms in aphasia are not always clear-cut.
8.4.3 The educational background factor

Previous studies on both spoken production (Ertan, Unal, Sat & Sakar, 2009) and language comprehension (Mishra & Pandey, 2007) have shown that semantic fluency and speed, as well as accuracy of grammaticality judgements, respectively, are partially a function of the experimental subjects’ literacy level. More specifically, Ertan et al.’s (2009) results indicated a graded effect of literacy on the immediate launching of semantic category naming over others, with literate and semi-literate participants listing significantly more names for each semantic category. Likewise, Mishra and Pandey’s (2007) visual eye-tracking experiment has revealed that illiterate subjects’ eye movements to visually presented objects carrying critical for the interpretation of the sentence gender features were considerably delayed relative to highly literates and semi-liters, thus, suggesting a slowing-down of lexical access in the illiterates. Such fine-grained details of the temporality of language processing give credence to the view that illiterates are slow relative to literates in anticipating upcoming words in spoken sentences.

Following previous research on the effects of literacy on language processing in general, we believe that literacy may have had a measurable influence on the speed of lexical access and other language processing operations in the patients of the present study. More specifically, we hypothesize that the patients’ performance in the tasks focusing on interface-conditioned materials, and particularly on anti-causatives, may show the potential of the RTs in the CMLP task and of the performance rates in the off-line tasks at the lexicon-syntax interface to reveal fine-grained details of the role of literacy in the performance of the aphasics of the present study. The reason that we have focused on anti-causatives and not on pronoun interpretation within the literacy-effect framework is the assumption that the subcategorization restrictions of the verbs belonging to the anti-causative class may be more frequently primed within the context of everyday language or formal education. Following constrained-based
models of comprehension (e.g. Pickering & Garrod, 2007) we assume that comprehenders may implicitly learn (S-V) lexical-structural pairings encoding unaccusativity and apply them as probabilistic constraints to interpreting novel input. On this view, the patients’ RTs and their interpretation preferences for the anti-causative verbs may partially reflect learning over patterns in the received linguistic input. On the contrary, the lower frequency of ambiguous subject pronouns in natural language makes their resolution on the basis of stored linguistic experience highly unlikely. As such, comprehenders are rather required to figure out item by item which antecedent is the most felicitous for an ambiguous pronoun, also bearing in mind a number of informational cues contributing to anaphora resolution (i.e. the pragmatic plausibility of the event, the syntactic frame of the sentence, the antecedent-type, a.o.).

More specifically, the present study assumes that unaccusativity is not exclusively inherently encoded on the verb stem as traditionally being assumed by several theoretical analyses (e.g., Alexiadou & Anagnostopoulou, 1999; Van Valin, 1990) but it is also the outcome of linguistic experience. As already mentioned in the ‘Results’ chapter, a high proportion of the experimental participants’ RT patterns in the CMLP task stemmed from the integration of information other than that encoded on the verb, like the [±animacy] feature of the syntactic subject and the heuristic-based constraints imposed by world knowledge on interpretation; for instance, the animacy of the syntactic subject in the NACT anti-causatives has increased the availability of the reflexive readings in the aphasic group, while a priming effect for half of the aphasics and the controls in the ACT anti-causatives was only registered for the verbs having an inanimate subject. On this view, the highly literate aphasic patients being supposedly more exposed to lexical-structural (S-V) pairings encoding unaccusativity through the formal educational system (among other sources) were probably more likely than the semi-literate aphasics to be influenced by the relative plausibility of the candidate analyses when processing ambiguous sentences, applying effective probabilistic constraints to interpreting the verbal input. As such, the highly literate aphasics were predicted to track lexical and morpho-syntactic
regularities critical for the identification of the anti-causative verbs faster than the semi-literate aphasics in the CMLP task. Moreover, the same patients were expected to be more successful in interpreting verbs of identical morphology but distinct meanings (e.g. NACT verbs being prone to an anti-causative, a passive, or a reflexive interpretation) in the SPMT (testing verbs at the lexicon-syntax interface) in accordance to distributional frequencies in their linguistic experience. Indeed, as will be analysed below, the aphasic patients with a greater range of years in the formal education (primary school to high school and college) tended to have a wider array of probabilistic constraints which has increased their sensitivity to the unaccusativity features over the rest of the aphasic participants.

The majority of the aphasic participants in the present study were semi-literate, with five of the patients (namely, patients SP, THP, THR, THEX, and PAPAL) dropping school after finishing primary education, and two of them (namely, VSK, and DENT) entering University, and more particularly, the medical and the dental school, respectively. Our expectation that the two highly-literate patients would exhibit a higher sensitivity to the sub-categorization information of the anti-causative verbs relative to the rest of the aphasic subjects was only fulfilled by VSK’s interpretation preferences in the SPM task testing verbs of alternating transitivity; VSK’s accuracy score (60%) for the anti-causatives was the highest among the aphasics. On the other hand, DENT’s performance in the same task was slightly below chance level (40%) as the majority of the aphasic individuals.

The two patients’ RT patterns, on the other hand, may be used as a more reliable index of their linguistic information processing capacities. Indeed, the two patients’ RT performance in the CMLP task gives robust evidence in favour of relatively spared tracking of unaccusativity during real-time processing. First, the strongest cue in favour of both patients’ superior performance relative to the rest of the aphasic subjects was the speed of their responses to the fast-acting automatic routine that underlies antecedent reconstruction at a post-verbal position in the anti-causatives: VSK’s and DENT’s

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66 The patient GCH has dropped school just after finishing the second grade of High School, such that he could not be classified to either the highly literate or the illiterate group of the patients.
mean RTs indicate immediate priming of the antecedent post-verbally (at probe position 2), with the related probes yielding the shortest response latencies for these two patients relative to the rest of the aphasics for the (ACT & NACT) anti-causative verb conditions67 (Mean RTs for the ACT anti-causatives: 2130.6 msecs (position 2) - 2377.8 msecs (position 3) for VSK, and 2820.7 msecs (position 3) for DENT, & Mean RTs for the NACT anti-causatives: 2327.7 msecs (position 2) - 2698.7 msecs (position 3) for VSK, and 2723.8 (position 2) for DENT). In fact, the two patients’ RTs were the closest to those registered for the control group relative to the rest of the patients (Mean RTs for the controls for the ACT anti-causatives: 1452.7 msecs (position 2/voice-alternating condition) – 1509.7 msecs (position 3/inanimate/non-voice alternating condition), & Mean RTs for the NACT anti-causatives: 1352.4 msecs (position 2/voice-alternating condition) – 1469.6 msecs (position 3/non-voice-alternating condition). Data of this type indicates that the two highly-literate patients were able to refer rapidly to the anti-causatives’ derived syntactic subject in contrast to the rest of the patients whose syntactic reflexes appeared to be more delayed, thus, impeding the syntactic routine of co-indexation to take place automatically. This finding seems to be highly consistent with Mishra & Pandey’s (2007) visual world eye-tracking results with Hindi speakers showing that literate subjects were considerably faster than the semi-literate in lexical access.

At a secondary level, VSK’s and DENT’s increased RTs in the unrelated probe condition were registered for all the anti-causative verbs irrespective of their (ACT/NACT) morphological marking, thus, verifying the implicated gap-filling procedure in the anti-causatives (vs. the unergatives). Furthermore, DENT has offered significant RT evidence in favour of increased awareness of the ACT/NACT voice distinction at position 3, as well as of the [+voice-alternation] properties of certain ACT anti-causative

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67 The RTs mentioned only refer to the testing conditions whereby the two patients have exhibited a statistically significant post-verbal priming effect. The reader is reminded that VSK has exhibited a priming effect for both ACT and NACT anti-causative verbs at both post-verbal probe positions 2 (in the inanimate subject condition) and 3, while DENT has shown evidence of a priming effect only for the NACT anti-causative verbs at probe position 2, and for the ACT voice-alternating anti-causative verbs at probe position 3.
verbs at position 3 again, thus, suggesting that the specific patient was highly sensitive to the verbs’ morphological distinctions as well as to the property of the NACT suffix as a cue to transitivity change. Finally, the systematic integration of animacy cues immediately after the critical verb during the online interpretation of both ACT and NACT anti-causative verbs on behalf of the patient VSK gives credence to the influence of heuristic-based constraints on the aphasic individual’s interpretive preferences in real-time. Overall, the analysis suggests that the educational background of the aphasic patients may have been important for enabling them to adjudicate between candidate structures at the lexicon-syntax interface. This correlation was mainly evident in the on-line CMLP task whereby the two highly literate aphasics were more able to apply automatically thematic plausibility constraints relative to the rest of the patients.

Our study was tailored to explore the aphasic performance in interface-conditioned linguistic structures, such as a more elaborate analysis of the influence of non-linguistic factors on the aphasic linguistic performance is beyond the scope of the present research. Though the demographic (age & education) and neurological (lesion site) factors in the current research were not used in statistical analyses along with the rest of the linguistic variables, specific results from the tasks show a clear direction, and can carefully be interpreted as implicating a predictive relationship between the aphasic linguistic behaviour and the patients’ literacy level, age and site of lesion after the stroke. We strongly believe that non-linguistic variables should be addressed in future research in a larger population with more interdisciplinary teams rating the aphasics’ sociological and clinical profiles.
8.5 CONCLUSIONS

This dissertation has provided evidence that an approach to language ability that distinguishes between interfaces and the computational system can account for the Broca's aphasics' reduced ability to perform well at interface-conditioned phenomena. A redefinition of the much-maligned diagnostic term 'agrammatism' from an interface-based perspective may not only broaden its scope, but also capture the qualitatively heterogeneous performances of aphasic individuals. More specifically, since the seminal paper by Zurif & Caramazza (1976), a great amount of work has been dedicated to reach a better understanding of the linguistic difficulties of agrammatic Broca's aphasics. Different approaches have been proposed to deal with this phenomenon and, more generally, with the correct characterization of agrammatism. Simplifying to a high degree, and leaving aside the many differences between individual approaches, the whole spectrum of analyses has been divided into competence accounts arguing for a permanent grammatical knowledge deficit (e.g. Friedmann & Grodzinsky's (1997) Tree-Pruning Hypothesis, Varlokosta et al.'s (2006), and Nanousi, Masterson., Druks & Atkinson's (2006) Impaired Interpretable Features Hypothesis, Grodzinsky's Trace Deletion Hypothesis (1986a, 1986b, 1990, 1995a, 1995b, 2000), and performance accounts (e.g. Burkhardt et al.'s (2003) Slow Syntax Hypothesis, Haarmann & Kolk's (1991) Slow-Activation Hypothesis), postulating a processing difficulty compromising the possibility of utilizing grammatical knowledge on-line.

Despite the progress in research, both accounts lack in important respects. First, by interpreting aphasics' problematic linguistic behaviour as owing to representational deficiencies, the competence accounts leave open the question of how agrammatic patients manage occasionally to perform successfully in tasks testing the production/comprehension of grammatically-constrained structures. Second, the performance account does not itself advance any explanation for the patients' qualitatively heterogeneous patterns of performance but merely pursues the (quantitatively-centred) cross-patient variability debate, whereby differences in the severity of the deficit can easily be
translated into quantitative differences in the availability of processing resources. For what is more, both accounts have spoken in favour of broad linguistic deficits claimed to be characteristic of the whole population of the patients with Broca's aphasia, with the group averaging most probably obscuring the existence of subgroups of aphasic subjects with limited and distinct cognitive abnormalities.

We address these concerns with new work on the role of the interfaces in agrammatic comprehension (mainly) and production. We assume that language problems in aphasia go beyond simply a grammatically-impaired or a non-fully active system and involve a complex mixture of linguistic and cognitive deficits, including limited access to interfaces of the grammar and a number of domain-general, executive processing impairments, while perhaps individual components of the grammar (syntax, morphology, lexicon/semantics) continue to function near normally. We believe that such an approach has many advantages like, avoidance of stipulating any independent mechanism differentiating the knowledge of agrammatic subjects from that of controls, and unification of task effects and disorders like schizophrenia, dementia, and ageing characterized by cognitive limitations similar to the ones in Broca's aphasia. Most importantly though such an account allows us to deal with the lack of commonality in agrammatic performance in terms of the patients' distinct more global cognitive deficiencies thus disconfounding deficit-specificity as in the previous studies.

Crucially for the present approach, we observed an unstable performance at the interfaces on behalf of the majority of the agrammatic aphasic patients participating in the experiments of the study. The aphasic subjects faced difficulty with the integration of discourse information regulating the interpretation of the overt subject pronoun (especially in contexts entailing the establishment of long-distance co-indexation links) and displayed limited processing efficiency in the utilization of lexicon-filtered information regulating the interpretation of some intransitive ACT verbs. The aphasic weakness at co-ordinating information at the interfaces was compensated for by the extensive application of a number of strategies and heuristics, including the universally default parsing option of the subject antecedent, the NACT morpheme as a cue to transitivity changes in verbs, the animacy of the subject
as a cue to argument-to-role mappings, and the ‘good enough’ strategy entailing over-reliance on
pragmatic plausibility factors (over syntax) during syntactic argument interpretation. Further findings in
favour of an impaired inhibitory mechanism and misallocation of attentional resources due to WM
deficits in the aphasic participants constitute important pieces of evidence towards the growing
realization that aphasia symptomatology can not be explained on a purely linguistic bias. For what is
more, predictive relations observed between the patients’ performance and a number of non-linguistic
factors, like the individuals' literacy level, age and site of lesion, point towards the close relationship
between aphasia and non-linguistic dimensions.

This is an area ripe for investigation as we rightfully move away from the conceptualization of
language, and language use in particular, as being separate from cognition and accept that language is
one aspect of cognition. In the last decades, the position within the cognitive science and linguistics
communities regarding “big” modularity - the view that the mind is comprised of discrete, encapsulated
cognitive domains, each of which rests on its own organizing principles and constraints - and “little
modularity” - the view that language, itself, is modular and comprised of distinct levels of representation
and processing -- has shifted away from both big and little modularity views. The present thesis offers
evidence which can carefully be interpreted as supporting a non-modular view of the mind and the
language as a more viable model. On this view, aphasia may be a part of a larger phenomenon
affecting a wide range of cognitive processing abilities. As such, a linguistic-cognitive approach that will
assess and monitor aphasic symptoms in addition to/separately from language represents perhaps a
more accurate and useful model that may also account for qualitative variations observed in aphasic
individuals. We particularly believe that further specification of the proposed underlying executive
dysfunction in Broca’s aphasia will considerably strengthen its power both as an explanatory factor of
the highly heterogeneous linguistic symptomatology in the Broca’s aphasics and as a principled guide
for future treatment techniques. It is clear that the analysis presented here as well as many issues that
were left open for further investigation (and most importantly the status of the executive (dys)functions
in Broca’s aphasia) require longer and careful research, and we do hope that there will be abundant data from the breakdown of language in the future that will be brought to bear on the topic.
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APPENDICES
APPENDIX I: EXPERIMENTAL ITEMS - Syntactic Comprehension Task (Peristeri, 2005)

Sample Test Items

- **Clitic Left Dislocated Object Condition**

  Picture A  Picture B  Picture C

  **Stimulus Sentence**: Τη γυναίκα τη στρώξιε ο άντρας.

  = The woman-CLLded-ACC her-CL-ACC pushes the man-NOM ('The man pushes the woman')

- **Focused Object Condition**

  Picture A  Picture B  Picture C

  **Stimulus Sentence**: Τον άντρα κλωτσάει η γυναίκα.

  = The man-FOC-ACC kicks the woman-NOM ('The woman pushes the man')
Sample Test Items

- 1st condition, Gender

**Stimulus Sentence:** Ο άντρας τη χαίδεψε

= The man her-CL-ACC caresses

**Stimulus Sentence:** Η γυναίκα τον κουρεύει

= The woman him-CL-ACC cuts (his hair)
- 2nd condition, Number

**Stimulus Sentence**: Η γυναίκα την κυνηγάει

= The woman her-CL-ACC hunts

**Stimulus Sentence**: Ο άντρας τον σπρώχνει

= The man him-CL-ACC pushes
APPENDIX III: EXPERIMENTAL ITEMS- Self-Paced Listening Sentence-Picture Matching Task

Instructions (translated here into English): “In this task you are going to listen to successive phrases making up sentences and you will be viewing an image appearing on the screen at the same time. Once you listen to the first segment, press the space bar to listen to the next one. Once you listen to the whole sentence, the image on the screen will disappear and a question mark ‘?’ will appear on the centre of the screen. Then, you will have to decide whether the sentence you have heard matched in meaning the image you have just seen. Press the ‘1’ button in case it did, or the ‘0’ button in case it didn’t. Press the space bar whenever you feel ready to begin the trial. Good luck!”

- 1st condition, Overt Subject Pronoun
  1. I gramateas/voithuse/ ti nosokoma/ otan/ afiti/ egrafe/ ena grama
  ‘The secretary/ was helping/ the nurse/ when/ she/ was writing/ a letter’
  ‘The man/ was paying/ the cashier/ when/ he/ was closing/ his bag’
  ‘The client/ was paying/ the waiter/ when/ he/ has pouring wine/ in the glass’
  4. I mitera/filise/ tin kori tis/ kathos/ afiti/ evaze/ to palto tis.
  ‘The mother/ was kissing/ her daughter/ while/ she was putting on/ her coat’
  5. O pateras/heretise/ to gio tu/ otan/ afitos/ ekane podilato/ sto dromo.
  ‘The father/ waived at/ his son/ when/ he/ was biking/ on the road’
  ‘The grandmother/ waived at/ the lady/ when/ she/ was crossing/ the street’
  ‘The teacher-FEM/ was pointing to/ the student-FEM/ while/ she/ was yelling/ in the classroom’
8. I giagia/ plisiaze/ tin katharistria/ eno/ afti/ kituse/ to roloi tis.
   ‘The grandmother/ was getting close to/ the cleaning lady/ while/ she/ was looking at/ her watch’

   ‘The policeman/ whistled to/ the thief/ when/ he/ was running/ on the road’

10. I nosokoma/ esprokse/ tin katharistria/ kathos/ afti/ evgene/ apo to asanser.
   ‘The nurse/ pushed/ the cleaning lady/ while/ she/ was exiting/ the elevator’

Picture Triplet Examples

No. (2) O kirios/ plirone/ ton tamia/ otan/ aftos/ ekline/ tin tsanta tu.
   ‘The man/ was paying/ the cashier/ when/ he/ was closing/ his bag’

   a. ‘Match’ reading
   b. ‘Mismatch’ reading i
   c. ‘Mismatch’ reading ii

No. (7) I daskala/ edihne/ ti mathitria/ eno/ afti/ fonaze/ stin taksi.
   ‘The teacher-FEM/ was pointing to/ the student-FEM/ while/ she/ was yelling/ in the classroom’

   a. ‘Match’ reading
   b. ‘Mismatch’ reading i
   c. ‘Mismatch’ reading ii
• 2nd condition, Null Subject Pronoun

1. I ksanthia kopela/ edine/ to harti/ stin kiria/ otan/ ebene/ sto grafio.

‘The blonde lady/ was giving/ the paper/ to the lady/ when/ Ō was entering/ the office’

2. O pateras/ elege hronia pola/ sto gio tu/ kathos/ anige/ tin porta.

‘The father/ was saying happy birthday/ to his son/ while/ Ō was opening/ the door’


‘The doorman/ waived/ hastily/ at the postman/ while/ Ō was opening/ the door’


‘The trainer/ was talking/ loud/ to the athlete/ while/ Ō was holding/ the bottle’

5. O papus/ miluse/ grigora/ ston egono tu/ otan/ diavaze/ ena vivlio.

‘The grandfather/ was talking/ fast/ to his grandson/ when/ Ō was reading/ a book’


‘The checker/ asked/ the ticket/ from the man/ while/ Ō was yawning/ intensely’


‘The guard/ saw/ suddenly/ the beggar/ when/ Ō was walking/ at the park’

8. I giagia/ edikse/ ti fotografia/ stin egoni tis/ otan/ etroge/ proino.

‘The grandmother/ pointed at/ the photograph/ to her granddaughter/ when/ Ō was having/ breakfast’


‘The policeman/ saw/ instantly/ the thief/ when/ Ō was turning/ on the corner’

10. O papas/ miluse/ sinehia/ ston turista/ kathos/ perimene/ to leoforio.

‘The priest/ was talking/ continuously/ to the tourist/ while/ Ō was waiting for/ the bus’
Picture Triplet Examples

No. (3) O thiroros/ heretise/ viastika/ ton tahidromo/ eno/ anige/ tin porta.

‘The doorman/ waived/ hastily/ at the postman/ while/ Ø was opening/ the door’

a. ‘Match’ reading  
b. ‘Mismatch’ reading i  
c. ‘Mismatch’ reading ii

No. (10) O papas/ miluse/ sinehia/ ston turista/ kathos/ perimene/ to leoforio.

‘The priest/ was talking/ continuously/ to the tourist/ while/ Ø was waiting for/ the bus’

a. ‘Match’ reading  
b. ‘Mismatch’ reading i  
c. ‘Mismatch’ reading ii
APPENDIX IV: EXPERIMENTAL ITEMS – Self-Paced Listening

Antecedent Identification Task

**Instructions** (translated here into English): “In this task you are going to listen to sentences segment by segment and you will be viewing the sentence segments on the screen at the same time. In order to be able to listen each time to the next sentence segment, you must press the space bar on the computer. Once you listen to the whole sentences, a question mark ‘?’ will appear on the centre of the screen. Then I will ask you a question on what you have just heard and you have to reply as quickly as possible. Press the space bar whenever you feel ready to begin the trial. Good luck!”

Sample Test Items

- **SVO condition**

1. Γιατί/ ο Νικός/ φιλάει/ το Γιάννη/ τόσο/ χαρούμενα; Γιατί/ Ό(αυτός)/ πέρασε/ στο πανεπιστήμιο; στην νομική.
   ‘Why does Nikos kiss John so happily? Because he enetered the university, the law school’

2. Γιατί/ η Μαρία/ χαιρετάει/ την Άννα/ τόσο/ λυπημένα; Γιατί/ Ό(αυτή)/ φεύγει/ για την Αμερική/ σήμερα.
   ‘Why does Mary waive at Anne so sadly? Because she is leaving for America today’

3. Γιατί/ ο Κώστας/ συναντάει/ τον Πέτρο/ στην ίδια καφετέρια/ κάθε μέρα; Γιατί/ Ό(αυτός)/ έχει/ αυτή την καφετέρια/ για στέκι.
   ‘Why does Kostas meet Peter at the same café every day? Because he has this café as a hang-out post’

4. Γιατί/ η Άννα/ βλέπει/ τη Μαρία/ στο ίδιο βιβλιοπωλείο; κάθε πρωί; Γιατί/ Ό(αυτή)/ δουλεύει/ σ’ αυτό/ το μαγαζί.”
‘Why does Anne see Mary at the same bookshop every morning? Because she works at the same store’

5. Γιατί/ η Μαρία/ επισκέπτεται/ την Κατερίνα/ τόσο συχνά/ τον τελευταίο καιρό; Γιατί/ Ὄ(αυτή)/ είναι/ μόνη της/ και βαριέται πολύ.

‘Why does Mary visit Katherine so often lately? Because she is lonely and she is very bored’

- OcIVS condition

1. Γιατί/ τη Μαρία/ τη βρίσκει/ η Βούλα/ στην κλινική/ κάθε Τρίτη; Γιατί/ Ὄ(αυτή)/ πάει/ εκεί για να δει/ τον ἀρριστό πατέρα της.

‘Why does Voula find Mary at the clinic every Tuesday? Because she goes there to visit her sick father’

2. Γιατί/ τον Ηλία/ τον τράκαρε/ ο Κώστας/ χτες; στην εκκλησία; Γιατί/ Ὄ(αυτός)/ δεν είχε φώτα/ και δεν τον είδε/ στο σκοτάδι.

‘Why did Kostas crash Ilias’ car yesterday at the national road? Because he didn’t have the lights on and he didn’t see him in the dark’

3. Γιατί/ τον Νίκο/ το συμπάθει/ ο Γιώργος/ ο ηλεκτρολόγος/ τόσο πολύ; Γιατί/ Ὄ(αυτός)/ κατάγεται/ από το ίδιο νησί/ την Νάξο.

‘Why does George, the electrician, like George so much? Because he comes from the same island, Naksos’

4. Γιατί/ την Άννα/ την πετυχαίνει/ η Μαρία/ στα ίδια φαναρία/ κάθε πρωί; Γιατί/ Ὄ(αυτή)/ περνάει/ απ’ αυτό το σημείο/ για τη δουλειά της.

‘Why does Mary run into Ann at the same traffic lights every morning? Because she passes from the same point on her way to work’

5. Γιατί/ την Νίκη/ την αποφεύγει/ η Μαρία/ τόσο πολύ/ τελευταία; Γιατί/ Ὄ(αυτή)/ ἔχει γρύπη/ και δε θέλει/ να την κολλήσει.
‘Why does Mary avoid Niki so much lately? Because she has flew and she does not want to catch it/ to transmit it’
APPENDIX V: EXPERIMENTAL ITEMS-CMLP TASK

Instructions (translated here into English): “In this task you are going to listen to successive phrases making up sentences and you will be able to view these phrases written on the screen at the same time you listen to them. After each phrase, a single word will appear on the centre of the screen and you have to make a quick decision whether this word is a Greek word or not. If it is, press the ‘1’ button; in case this word does not exist in Greek, press the ‘0’ button. Once you press the button you will be able to listen to the next segment of the sentence. Try to listen carefully to the meaning of the sentences you are going to hear. Press the space bar whenever you feel ready to begin the trial. Good luck!”

Experimental verbs used in the cross-modal lexical priming task with literal translations.

<table>
<thead>
<tr>
<th>Verb Class</th>
<th>ACT Unergatives</th>
<th>ACT Anti-causatives</th>
<th>NACT Anti-causatives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[-Voice-</td>
<td>[Voice-</td>
<td>[-Voice-</td>
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<tr>
<td></td>
<td>alternating]</td>
<td>alternating]</td>
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</tr>
<tr>
<td>hamogela/‘smile’</td>
<td>ligizi/‘bend’</td>
<td>diploni/‘fold’</td>
<td>vithizetel/‘sink’</td>
</tr>
<tr>
<td>dipsa/‘get thirsty’</td>
<td>lionii/‘melt’</td>
<td>htipaili/‘hit’</td>
<td>komatiazetel/‘chop’</td>
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<td></td>
<td></td>
<td></td>
<td>kegetel/‘burn’</td>
</tr>
<tr>
<td>fevgol/‘leave’</td>
<td>spaili/‘break’</td>
<td>leronil/‘spill’</td>
<td>giatrevetel/‘heat’</td>
</tr>
<tr>
<td>rohalizi/‘snor’</td>
<td></td>
<td></td>
<td>diplonetei/‘fold’</td>
</tr>
<tr>
<td>lipothimal/‘faint’</td>
<td>krionii/‘get cold’</td>
<td>tedoni/‘stretch’</td>
<td>sigedronetel/‘gather’</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>tsalakonetei/‘crinkle’</td>
</tr>
<tr>
<td>griniazii/‘murmur’</td>
<td>vuliazi/‘sink’</td>
<td>zesteni/‘heat’</td>
<td>krivetei/‘hide’</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>htipiete/‘hit’</td>
</tr>
<tr>
<td>apergi/‘strike’</td>
<td>pefti/‘fall’</td>
<td>zaroni/‘blench’</td>
<td>mionetei/‘decrease’</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>zestenetei/‘heat’</td>
</tr>
<tr>
<td>vihi/‘cough’</td>
<td>plateni/‘widen’</td>
<td>tripai/‘prick’</td>
<td></td>
</tr>
<tr>
<td>dakrizi/‘tear’</td>
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</tr>
<tr>
<td>Type</td>
<td>Sentence</td>
<td>Related probe</td>
<td>Control probe</td>
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<td>---------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Unergatives</td>
<td>1. <strong>O dolofonos</strong> me to ageliko prosopo ksafnika <strong>drapetefse</strong> otan o astinomikos kimithike stin karekla tu tmimatos ekso apo to keli. ‘The murderer with the angelical face suddenly escaped when the policeman fell asleep on the chair of the police station right out of the cell.’</td>
<td>eglima/’crime’</td>
<td>fakelos/’envelope’</td>
</tr>
<tr>
<td></td>
<td>2. <strong>O giatros</strong> me to kodo padeloni ksafnika <strong>hamogelase</strong> otan i omorfi despinis perase apo to diadromo tu nosokmiu. ‘The doctor with the short trousers suddenly smiled when the beautiful lady walked through the corridor.’</td>
<td>nisteri/’scalpel’</td>
<td>ahladi/’pear’</td>
</tr>
<tr>
<td></td>
<td>3. <strong>To moro</strong> apo tin proti mu ksaderfi ksafnika <strong>dipsase</strong> otan ide ti thia mu na pini nero.</td>
<td>pana/’diaper’</td>
<td>ota/’lights’</td>
</tr>
<tr>
<td>Number</td>
<td>Greek Text</td>
<td>Translation</td>
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<tr>
<td>4.</td>
<td>Ο θιος τι μεγάλη κιλά σινεία ροχαλίζε οταν πιγενε στο κρεβάτι κε τον επερνε ο ιπνος.</td>
<td>The uncle with the big belly was always snoring when he was going to bed and he was falling asleep.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Ο ιδρανλικός το μαύρο παδελωνί κασαντίκα λιποθιμίσε οταν η ζητήσεις στο δωμάτιο ιτάνν φοβερή και κανένα παράθυρο δεν ήταν άνοιγμα.</td>
<td>The plumper with the black trousers suddenly fainted when the heat in the room was great and no window was open.</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Ο πισάρις το μαγαζί στη γωνία κασαντίκα ετέρκε στον ιδιοκτήτη και είδε έναν ουρένιο άνθρωπο να τρώει μια τυρόπιτα.</td>
<td>The fisherman with the shop at the corner suddenly ran when he saw a tall man eating a cheese-pie.</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Η δασκάλα τα μαύρα μαλλιά σινεία απεργίσε οταν η κυβέρνηση δεν κρατήσει τις προμήθειες και δεν δίδει τις αύξησεις.</td>
<td>The teacher with the black hair was continuously on strike when the government didn't keep its promises and didn't grant the raises.</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Ο αρχαιολόγος το μεγάλο καπέλο κασαντίκα εφιώκε οταν η σκόνη από τον αέρα ήταν πολύ μπράκτε στο στόμα του.</td>
<td>The archaeologist with the big hat wore a hat when the dust from the air was very strong in his mouth.</td>
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</tr>
<tr>
<td>No.</td>
<td>Name</td>
<td>Action</td>
<td>Location</td>
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<tr>
<td>9.</td>
<td>Ο μαστόρας</td>
<td>έκρυβεν τα εργαλεία</td>
<td>καθώς ο οπλίτης του σπάνει το πόδι</td>
</tr>
<tr>
<td></td>
<td></td>
<td>και ο γιατρός του απαγόρευε να εργάσει</td>
<td>θυμώνει την ασφαλή χειροκίνηση</td>
</tr>
<tr>
<td>10.</td>
<td>Ο αθλητής</td>
<td>γκρίνισε ένα χαμηλό γεράκι</td>
<td>καθώς ο αθλητής του πόσιμεν μια καρέκλα στο γυμναστήριο</td>
</tr>
<tr>
<td></td>
<td></td>
<td>μαύρες γυάλινες φωτιζόταν από χάσμα</td>
<td>θυμώνει την επικίνδυνη συμπεριφορά στην αθλητική αγωγή</td>
</tr>
<tr>
<td>11.</td>
<td>Ο δικαστής</td>
<td>έκρυβε τα γαλάκτωμα</td>
<td>καθώς ο δικαστής του περπατούσε προς την καρδιά των κατοίκων του οικισμού.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>μαύρα γυαλιά από την καρδιά που ανοίγει χειροπέδες</td>
<td>θυμώνει την απειλητική συμπεριφορά του δικαστή.</td>
</tr>
<tr>
<td>12.</td>
<td>Η νικοκίρα</td>
<td>έπεσε στο σπίτι</td>
<td>καθώς οιλοκόκκοι με τον μαύρο καπέ ήρθε στην αγορά</td>
</tr>
<tr>
<td></td>
<td></td>
<td>μαύρος όμηρος από την καρδιά που μελλοντικά</td>
<td>θυμώνει την έντονη επικίνδυνη συμπεριφορά του οπλίτη.</td>
</tr>
<tr>
<td>13.</td>
<td>Η νιφί</td>
<td>επικόμια ένας ημερήσιος γαμήλιος συνθέσες στο σπίτι</td>
<td>καθώς ο ιππότης του έπεσε στο σπίτι με το καπέ και το καπέλο του</td>
</tr>
<tr>
<td></td>
<td></td>
<td>μαύρα μαντίνες από την καρδιά που αρπάζετε</td>
<td>θυμώνει την επικίνδυνη συμπεριφορά του οπλίτη.</td>
</tr>
</tbody>
</table>
### 14. Ο enikiastis me ti makria miti ke ta megala gialia ksafnika efige otan pire metathesi stin Athina ke anagastike na metakomisi.

‘The tenant with the long nose and the big glasses suddenly left when he got a transfer to Athens and he was forced to move.’

### 15. I mathitria me to skismeno padeloni ksafnika griniakse otan o diplanos tis ipe ena anekdoto ke I daskala tine avgale apo tin taksì.

‘The student with the torn jeans suddenly murmured when the boy next to her cracked a joke and the teacher dispelled her.’

### 16. O ksaderfos me tis megales ikonomikes diskolies sinehia taksìdevi apo tote pu vrike defteri dulia ke egine politis tsigaron.

‘The cousin with the great financial difficulties travels all the time since he got a new job and he became a cigarette salesman.’

### ACT Anti-causatives

<table>
<thead>
<tr>
<th>ACT Anti-causatives</th>
<th>diamerisma/’apartment’</th>
<th>karamela/’caramel’</th>
</tr>
</thead>
<tbody>
<tr>
<td>otan teliose to kiros piato ke ti salata ke ta klarina arishan</td>
<td></td>
<td></td>
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<tr>
<td>‘The bride with the big nose was dancing all the time when she has finished the main course and the salad and the clarinets began to play music.’</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>enikiastis</th>
<th>diamerisma/’apartment’</th>
<th>karamela/’caramel’</th>
</tr>
</thead>
<tbody>
<tr>
<td>me ti makria miti ke ta megala gialia ksafnika efige otan pire metathesi stin Athina ke anagastike na metakomisi.</td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>mathitria</th>
<th>daskala/’teacher’</th>
<th>kutali/’spoon’</th>
</tr>
</thead>
<tbody>
<tr>
<td>me to skismeno padeloni ksafnika griniakse otan o diplanos tis ipe ena anekdoto ke I daskala tine avgale apo tin taksì.</td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ksaderfos</th>
<th>thia/’aunt’</th>
<th>likos/’wolf’</th>
</tr>
</thead>
<tbody>
<tr>
<td>me tis megales ikonomikes diskolies sinehia taksìdevi apo tote pu vrike defteri dulia ke egine politis tsigaron.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘The cousin with the great financial difficulties travels all the time since he got a new job and he became a cigarette salesman.’</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>tragudistis</th>
<th>stihurgos/’lyrist’</th>
<th>vasilias/’king’</th>
</tr>
</thead>
<tbody>
<tr>
<td>me ta poli perierga ruha ksafnika kriose otan vgike horis palto sto dromo pu hionize.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘The singer with the very weird clothes suddenly caught a cold when he went</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
out at the street without a coat while it was snowing.'

2. Ο **epihirimatias** me ta tesera spilia ksafnika **ligise** otan i den mporese na pari to danio pu ithele ke hreokopise.

   ‘The businessman with the four houses suddenly bent when he didn't manage to get the loan that he wanted and he went bankrupt.’

3. Ι **mitera** me tis megales ikonomikes diskolies sinehia **elione** kathos etrehe sinehia sta nosokomia xoris to pedi tis na ginete kala.

   ‘The mother with the great financial difficulties was melting since she kept going to hospitals without her child being healed.’

4. Ο **hrimatistis** me tis pola spilia ksafnika **espase** otan meta apo mia periodo apusias tu sto eksotero emathe oti ehase ola ta kerdi tu.

   ‘The broker with the many houses suddenly broke when after a period of absence abroad he learnt that he has lost all his profits.’

5. Το **agori** me ta mavra mala ksafnika **diplose** sto edafos apo aforitus ponus ke fonaze ti mama tu.

   ‘The boy with the black hair suddenly folded on the ground with unbearable pains and he was screaming for his mother.’
6. To **koritsi** me ta megala matia ksafrnika **xtipise** otan epeze kinigito sti mesi tu dromu ke glistrise.

   ‘The girl with the big eyes suddenly hit when she was playing tag in the middle of the road and she slipped.’

7. To **moro** me ta ble matia ksafrnika **lerose** mia ora meta to fagito otan ekane emeto.

   ‘The baby with the blue eyes suddenly spilled one hour after lunch when he vomited.’

8. To **prosopo** tis ilikiomenis kiri ksafrnika **tentose** meta tin triti plastiki epemvasi pu ekane to kalokeri.

   ‘The face of the old lady suddenly stretched after the fifth plastic surgery that she had in the summer.’

9. To **dentro** sto kentro tis platias ksafrnika **anthise** otan o keros egine kaliteros ke an eveke i thermokrasia

   ‘The tree at the centre of the square suddenly blossomed when the weather became better and the temperature rose.’

10. I **varka** me ti megali tripa ksafrnika **vuliakse** apo mia megali ekriksi sti mihani ke pigi katefthian ston pato.

   ‘The boat with the big hole suddenly sank by a big explosion in the engine and it went straight to the bottom.’

11. Ta **malia** mu mesa to mina ksafrnika **sampuan**/’shampoo’

   ‘The girl with the big eyes suddenly hit when she was playing tag in the middle of the road and she slipped.’

   ‘The baby with the blue eyes suddenly spilled one hour after lunch when he vomited.’

   ‘The face of the old lady suddenly stretched after the fifth plastic surgery that she had in the summer.’

   ‘The tree at the centre of the square suddenly blossomed when the weather became better and the temperature rose.’

   ‘The boat with the big hole suddenly sank by a big explosion in the engine and it went straight to the bottom.’

   ‘The girl with the big eyes suddenly hit when she was playing tag in the middle of the road and she slipped.’

   ‘The baby with the blue eyes suddenly spilled one hour after lunch when he vomited.’

   ‘The face of the old lady suddenly stretched after the fifth plastic surgery that she had in the summer.’

   ‘The tree at the centre of the square suddenly blossomed when the weather became better and the temperature rose.’

   ‘The boat with the big hole suddenly sank by a big explosion in the engine and it went straight to the bottom.’
epesan otan hrisimoplisa to kenurio proion pu ihaferi apo Ameriki

‘My hair in the present month suddenly fell when I used the new product that I had brought from the United States.’

12. Ο δρόμος στο κέδρο του ήριου κςαφνικά πλατίνα otan mihanimata ekopsan ta dedra ke eriksan asfalto.

‘The road in the centre of the village suddenly widened when earthmovers cut the trees and threw asphalt.’

13. Το φορέμα με το μεγάλο χισίμο σινέια tsalakoni me to paramikro logo tis piotitas tu opou ki an kathiso.

‘The dress with the big cut crinkles all the time due to its quality wherever I may sit.’

14. Το δωμάτιο στο ντομίνι ευθύς zestane otan o keros egine kaliteros ke anevike h theromokrasia.

‘The room at the northern part fortunately heated when the weather became better and the temperature rose.’

15. Το λαστιχό στο πίσινο μερός κςαφνίκα tripise otan o Kostas perase apo ena simio me spasmena gialia.

‘The tyre at the rear suddenly pricked when Kostas passed by a spot with broken glasses.’

16. Το φορέμα apo to eksteriko σινέια tsalakoni logo tis poli kakis piotitas tu opou ki an kathiso

metaksi‘silk’

uranos‘sky’
<table>
<thead>
<tr>
<th>NACT Anti-causatives</th>
<th>'The dress from abroad crinkles all the time due to its very bad quality wherever I may sit.'</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To <strong>ptoma</strong> apo tin ka'antia gineka ksafnika <strong>vithistike</strong> otan to erikse sti thalasa o satanikos dolofonos.</td>
<td>nekros/'dead' kota/'hen'</td>
</tr>
<tr>
<td>2. I <strong>nosokoma</strong> apo tin Kalamata ksafnika <strong>lerothike</strong> otan patise se laspes se mia lakuva</td>
<td>giatros/'doctor' manavis/'greengrocer'</td>
</tr>
<tr>
<td>3. Ta <strong>luludia</strong> stin akri tu dromu disthōs marathikan otan o k. Giorgos aroistise poli varia ke de dulepse deka mines.</td>
<td>kipos/'garden' plio/'ship'</td>
</tr>
<tr>
<td>4. To <strong>harti</strong> me ta politima sthia ksafnika tsalakothike otan epese kata lathos kato ke to patisame me ta podia</td>
<td>tetradio/'notebook' okeanos/'ocean'</td>
</tr>
<tr>
<td>5. I <strong>gineka</strong> me ta makria malia ksafnika zestathike otan kathise se ena pagaki tou parku ke den ihe katholu skia.</td>
<td>adras/'man' maimu/'monkey'</td>
</tr>
</tbody>
</table>

The corpse of the blonde woman suddenly went down when the evil murderer threw it into the sea.'

'The nurse from Kalamata suddenly spilled when she stepped in mud in a pit.'

'The flowers at the corner of the road unfortunately withered when Mr. George fell heavily sick and missed work for ten months.'

'The paper with the invaluable data suddenly crumpled when it fell down by mistake and we stepped on it.'

'The woman with the long hair suddenly heated when she sat on a bench at the
park and there was no shadow.’

6. To **provato** sti mesi tu dromu **ksafnika** komatiastike otan kapia stigma htes to apogevma perase ena fortigo apo pano tu.

‘The sheep in the middle of the road suddenly got torn into pieces when sometime in the afternoon yesterday a truck ran over it.’

7. O **arostos** me tis liges meres zois **ksafnika** giatreftike otan episkeftike ena monastiri prin liges meres ke ekane tama.

‘The ill man with the few days of life suddenly healed when he visited a monastery a few days ago and he made an offering.’

8. O **podosferistis** me to akrivo simvoleo **ksafnika** diplothike sto tetarto lepto me aforitus ponus otan o astragalos tu girise.

‘The football player with the well-paid contract suddenly folded during the fourth minute with unbearable pains when his ankle twisted.’

9. O **illos** giro sto apogevma **ksafnika** kriftike otan pigename me ti Maria gia kafe ke epiase vrohi.

‘The sun around the afternoon suddenly hid when we went with Maria for a coffee and it started to rain.

10. To ** nisi** sta notia tis Eladas **ksafnika** htipithike apo ena megalo sismo giro sta
The island at the south of Greece was suddenly stricken by a huge earthquake around midnight and the houses collapsed.'

11. I ηθολόντες για τον ερανό έφθασαν μεγάλης σίγκρουσης όταν τα δημοσια και τα ιδιωτικά κανάλια τον διαφημίσαν με σίγκροτα μονάδες.

The volunteers for the fund fortunately gathered when both the public and the private TV channels promoted it with frequent spots.'

12. Η ζητήσαν από την Αφρική εφέσα ειρήνη στην Ελλάδα μετά από δύο μήνες με ιδιαίτερα υψηλές θερμοκρασίες.

The heat from Africa fortunately faded in Greece after two whole months with very high temperatures.'

13. Το δάσος στην νότια περιοχή έκαψε και τα κανάλια μετέφρασε το νέα μας λέγοντας ότι ήταν στρατιωτική.

The forest at the south part suddenly burnt and the TV channels transmitted the news saying that it was arson.'

14. Η βάλα του μικρού κοριτσιού καταστράφηκε όταν ένα αγόρι τον πέτισε από το φρουρά και έπεσε σε ακαθαρσία.

The ball of the little girl suddenly pricked when a boy kicked it mightily and it fell on thorns.'
APPENDIX VI: EXPERIMENTAL ITEMS-SPMT

Sample Test Item

- Reflexive Verb Condition

Stimulus Sentence: Ο άντρας πλένεται
= The man washes.

- ACT Anti-causative Verb Condition

Stimulus Sentence: Το λάστιχο τρύπησε
= The tyre pricked.
- **NACT Anti-causative Verb Condition-Animate Subject**

  ![Picture A](image1)
  ![Picture B](image2)
  ![Picture C](image3)

  **Stimulus Sentence:** Ο άντρας λερώθηκε

  = The man spilled.

- **NACT Anti-causative Verb Condition-Inanimate Subject**

  ![Picture A](image4)
  ![Picture B](image5)
  ![Picture C](image6)

  **Stimulus Sentence:** το τραπεζομάντηλο λερώθηκε

  = The tablecloth spilled.
- ACT Transitive Verb Condition

**Stimulus Sentence:** Η γυναίκα ογκαλάζει τον άντρα

= The woman hugs the man.
APPENDIX VII: EXPERIMENTAL ITEMS-Picture Naming Task

- Reflexive Verb Condition

  ![Image of a woman pricking herself]

  **Question:** Τι κάνει η γυναίκα στη φωτογραφία;
  
  = What does the woman do in the picture?

  **Target:** Τρυπείται.
  
  = She pricks-NACT-PRS-3sg. (herself)

- ACT Anti-causative Verb Condition

  ![Image of a branch falling from a tree]

  **Question:** Τι έπαζε η θαλάσσια στη φωτογραφία;
  
  = What has happened to the branch in the picture?

  **Target:** Έσπασε.
  
  = It broke-ACT-PRS-3sg.
- **NACT Anti-causative Verb Condition-Animate Subject**

  ![Man spilling liquid](image)

  **Question:** Τι έπαιθε ο άντρας στη φωτογραφία;

  =What has happened to the man in the picture?

  **Target:** Λεξώθηκε.

  =He spilled-NACT-PERF-3sg.

- **NACT Anti-causative Verb Condition-Inanimate Subject**

  ![Boat sinking](image)

  **Question:** Τι έπαιθε η βάρκα στη φωτογραφία;

  =What has happened to the boat in the picture?

  **Target:** Βυθίστηκε.

  =It sink-NACT-PERF-3sg.
Question: Τι κάνει ο άντρας στη φωτογραφία;

=What does the man do in the picture?

Target: Φιλάει τη γυναίκα.

=He kisses-ACT-IMPERF-3sg the woman-ACC.
APPENDIX VIII: EXPERIMENTAL ITEMS-Sentence Repetition Task

I. Reflexive verb condition:

1. o adras plenete-NACT ‘The man washes himself’
2. i gineka htenizete-NACT ‘The woman combs her hair’
3. i gineka vafete-NACT ‘The woman puts make-up’
4. to koritsi dinete-NACT ‘The girl puts on her clothes’
5. to agori fortonete-NACT vivlia ‘The boy carries books’

II. ACT Anti-causative verb condition:

1. i varka vuliazi-ACT ‘The boat sinks’
2. to lastiho tripise-ACT ‘The tyre pricked’
3. ta malia stegnosan-ACT ‘The hair dried’
4. o dromos platine-ACT ‘The road widened’
5. to kaldi espase-ACT ‘The branch broke’
6. to dentro anthise-ACT ‘The tree blossomed’
7. to fagito kei-ACT ‘The meal burns’
8. i limni pagose-ACT ‘The lake froze’
9. to forema zarose-ACT ‘The dress crinkled’
10. i porta eklise-ACT ‘The door closed’
11. to domatio zestane-ACT ‘The room heated’
12. i supa kriose-ACT ‘The soup got cold’
13. ta magazia aniksan-ACT ‘The shops opened’
14. ta malia epesan-ACT ‘The hair fell’
15. to dentro ligise-ACT ‘The tree bent’
16. to pagoto eliose-ACT ‘The ice-cream melted’
17. to panteloni tsalakose-ACT ‘The trousers crinkled’
18. to lastiho tedose-ACT ‘The slingshot stretched’
19. to baloni eskase-ACT ‘The balloon blew’

III. NACT Anti-causative verb condition with an Animate Subject:

1. i gineka tripithike-NACT ‘The woman pricked’
2. o adras lerothike-NACT ‘The man spilled’
3. to agori kriftike-NACT ‘The boy hid’
4. o adras zestathike-NACT ‘The man heated’
5. i gineka vithistike-NACT ‘The woman sank’
6. o arostos giatreftike-NACT ‘The ill man healed’
7. o kosmos sigentrothike-NACT ‘The people gathered’
8. o pirosvestis kaike-NACT ‘The fireman got burnt’
9. o pektis diplothike-NACT ‘The player folded’
10. to provato komatiastike-NACT ‘The sheep was torn into pieces’
11. to koritsi tentothike-NACT ‘The girl stretched’
12. ta pedhia berdeftikan-NACT ‘The children mingled’
IV. NACT Anti-causative verb condition with an Inanimate Subject:

1. to lastiho tripithike-NACT ‘The tyre pricked’
2. to forema lerothike-NACT ‘The dress spilled’
3. o ilios kriftike-NACT ‘The sun hid’
4. I kuzina zestathike-NACT ‘The kitchen heated’
5. to karavi vithistike-NACT ‘The ship sank’
6. ta luludia marathikan-NACT ‘The flowers withered’
7. i zesti miothike-NACT ‘The heat decreased’
8. to dasos kaike-NACT ‘The forest burnt’
9. to harti tsalakothike-NACT ‘The paper crinkled’

V. ACT Transitive verb condition:

1. o adras filai-ACT ti gineka ‘The man kisses the woman’
2. to agori vrehi-ACT to koritsi ‘The boy wets the girl’
3. to koritsi deni-ACT to agori ‘The girl ties the boy’
4. o adras agaliazi-ACT ti gineka ‘The man hugs the woman’
5. I gineka klotsai-ACT ton adra ‘The woman kicks the man’
APPENDIX IX: EXPERIMENTAL ITEMS - The Working Memory Task

*Instructions* (translated here into English): “In this task you are going to view and listen to one sentence at a time accompanied by three images. Once you listen to each sentence you have to pick the image that best depicts the meaning of the sentence you have just heard. At the same time, you have to recall each word that pops up between two successive sentences. After a four-sentence set you will view eight images and you have to pick the four images that depict the four words you have previously seen on the screen between the sentences. Press the space bar to proceed to the next sentence/word. Good luck!”

Sample Test Items-Trial 2

### VERBAL STIMULI

<table>
<thead>
<tr>
<th>I motosikleta akoluthi to leoforio</th>
<th>I mitera kspniete apo to agoiri</th>
<th>Ine o adras me ta koda malia pu vrehi ti gineka me to kodomaniko</th>
</tr>
</thead>
<tbody>
<tr>
<td>I motosikleta akoluthi to leoforio</td>
<td>Ine o adras me ta koda malia pu vrehi ti gineka me to kodomaniko</td>
<td></td>
</tr>
</tbody>
</table>

### VISUAL STIMULI

- kialia
- zigaria
- roloi
- prioni

### RECOGNITION DISPLAY

- 6:45
## APPENDIX X: The Eight Patients’ Clinical Profiles

<table>
<thead>
<tr>
<th>Patient</th>
<th>Lesion site</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCH</td>
<td>Left-hemisphere ischemic stroke: lesion in Broca’s area with deep extension involving cortical and subcortical gyrus of the left inferior temporal-parietal lobe and left basal ganglia</td>
</tr>
<tr>
<td>VSK</td>
<td>Left-hemisphere ischemic stroke: large lesion in Broca’s area, with deep extension involving subcallosal fasciculus, lesion in insular structure across temporal isthmus, and some super extension to supermarginal gyrus and angular gyrus</td>
</tr>
<tr>
<td>SP</td>
<td>Extensive haemorrhage of the left basal ganglia: most of Broca’s area, with deep extension to border of frontal horn, including subcallosal fasciculus, temporal isthmus, superior temporal gyrus, insular structure, posterior putamen, anterior limb internal capsule, obus pallidus, head of caudate, lowest 2/5 sensory and motor cortex, left temporal and frontal cortex, anterior supermarginal gyrus, periventricular white matter</td>
</tr>
<tr>
<td>THP</td>
<td>Left-hemisphere ischemic stroke (occlusion of left middle cerebral artery): most of Broca’s area, left arcuate fasciculus, anterior and post supermarginal gyrus and part of angular gyrus</td>
</tr>
<tr>
<td>DENT</td>
<td>Left-hemisphere ischemic stroke: all Broca’s area, with deep extension to white matter, some involvement of subcallosal fasciculus, insular structure, putamen, anterior limb of internal capsule; superior extension involving lower 2/3 of motor and sensory cortex, anterior and post supermarginal gyrus and part of angular gyrus</td>
</tr>
<tr>
<td>THR</td>
<td>Left-hemisphere ischemic stroke: patchy left hemisphere lesion involving temporal isthmus and posterior portion of putamen and insular area; posterior supermarginal and angular gyrus areas, with deep extension to border of body of left lateral ventricle</td>
</tr>
<tr>
<td>THEX</td>
<td>Left-hemisphere ischemic stroke: left frontal Broca’s</td>
</tr>
<tr>
<td>PAPAL</td>
<td>Left-hemisphere ischemic stroke: all Broca’s area, ½ left arcuate fasciculus, ½ temporal isthmus, ½ Wernicke’s area; periventricular white matter, insular structure, putamen, global pallidus, anterior limb of internal capsule, super lesion involving premotor, motor and sensory cortex, anterior supramarginal gyrus; supplementary motor area, cingulated gyrus area 24</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>area, with deep extension to left frontal horn and lower motor cortex</td>
</tr>
</tbody>
</table>