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On the Processing of Thematic Features in Deverbal Nominals

Christina Manouilidou

Thesis submitted to the
Faculty of Graduate and Postdoctoral Studies
in partial fulfillment of the requirements
for the PhD degree in Linguistics

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*στη μαμά,
στο μπαμπά
και στη Μαρία*

*It is difficult to say when you are elsewhere
if you will miss more whatever you left
or what you are again going to leave,
because no matter how you return when leaving,
you will have left when you do return*

(Yiorgos Chouliaras, "Jerusalem, Ithaca")

Abstract

The primary motivation for the research reported in the present dissertation was to investigate the status of thematic features (TFs) in deverbal nominals (DNs) in Modern Greek. The investigation addressed two independent issues with respect to TFs of DN. The first was whether the processing of TFs of DN constitutes a necessary step in accessing their mental representation. The second concerned the status of thematic constraints in deverbal word formation. Three on-line lexical decision tasks and one off-line grammaticality judgment task were carried out. The stimuli for these tasks included deverbal nouns, deverbal adjectives and pseudo-words violating thematic constraints. The findings showed that TFs appear to increase processing load only for those DN with an increased eventive character (e.g. *plysimo* 'washing', *kallymenos* 'covered'), with a decomposition access route possibly playing a facilitatory role. In contrast, TFs do not appear to affect processing in the case of DN with a diminished 'verb-like' character (e.g. *conqueror*). Furthermore, lexical access results for pseudo-words indicated that TFs impose constraints which operate at a later stage of word formation compared to other constraints, such as categorial specifications of the base. This strongly suggests that TFs play a crucial role in the creation of new DN, independently of the type of nominal.

The findings of the present study have implications for both psycholinguistics and theoretical linguistics. The psycholinguistic implications relate to the stage-like nature of lexical access, the existence of a general representational component called *feature representation*, and the role of grammatical class in both lexical access and the organization of the lexicon. The linguistic implications principally inform theories of word formation postulating feature percolation, as well as the role of various constraints operating during derivation. The experimental results support the view that the creation of a new word is subject to constraints specific to the morphological operations involved in it, such as thematic constraints for DN. Furthermore, constraints seem to apply sequentially, with degrees of violability even for those constraints which are considered to be strong. More importantly, there appears to be a relationship between violability and late application, with those constraints that apply at a later stage being more violable.

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μοιά, μπαμπά, Μαρία: όλοι οι παραπάνω άνθρωποι ήταν δίπλα μου όλα αυτά τα χρόνια. Όμως τις στιγμές που ό,τι είχαν να μου δώσουν δεν ήταν αρκετό, εσείς ήσαστε η σκέψη που με κρατούσε. Για όλους βρήκα κάτι να γράψω. Για σας ποτέ και τίποτε, ούτε λόγος, ούτε φωνή, ούτε γραφή θα μπορούσε να περιγράψει το τι μου δώσατε. Ελπίζω να είστε περήφανοι για μένα και να με συγχωρέσετε που ήμουν μακριά σας για τόσο καιρό.

Παππού, τα κατάφερα!

List of Abbreviations

A = Adjective
AS = Argument Structure
Cat. Viol. = Pseudo Word with Categorial Violation
DM = Distributed Morphology
DN = Deverbal Nominal
DNNs = Denominal Nouns
DVAdjs = Deverbal Adjectives
DVNs = Deverbal Nouns
DWF = Deverbal Word Formation
ERPs = event-related brain potentials
GB = Government and Binding theory
GEN = Genitive
IFL = Item Familiar Lexicon
IN = Independent Network Model
LCs = Length Controls
LCS = Lexical Conceptual Structure
LGS = Lexical Generation of Syntax Model
MG = Modern Greek
ML = Mental Lexicon
N = Noun
NOM = nominative
Non-W = Non Word stimulus
NLC = Node Labelling Convention
Novel-Ws = Novel Words
Pseudo-Ws = Pseudo Words
RTs = Reaction Times
SDs = Standard Deviations
SING = Singular
SM = Syntactic Mediation hypothesis
TFs = Thematic Features
TFL = Type Familiar Lexicon
Them Viol. = Pseudo Word with Thematic Violation
TOT = tip of the tongue
V = Verb

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Chapter 1 INTRODUCTION

In recent years, the study of human language performance has been the focus of interdisciplinary research bringing together work on linguistics, cognitive neuroscience, and psychology. Psycholinguistics has been at the center of this research, the primary aim of which is to elucidate the cognitive processes that enable the comprehension and production of grammatical and meaningful sentences from a set of vocabulary and grammatical structures. Various theories and models of language production and comprehension have focused on describing both the form and the content of mental representations and how lexically stored knowledge is brought to bear during on-line language processing. The study of the *Mental Lexicon* is at the center of much of this work, as it is viewed to be central to language processing and a locus of computation, where form is connected to meaning via the mental representations of single words.

Despite considerable progress in our understanding of the Mental Lexicon, there is still much controversy with respect to its organization and the kinds of information contained in it. The goal of the present dissertation is to contribute to our understanding of the Mental Lexicon and, particularly, to our knowledge of how complex words are represented and accessed. More specifically, the present research attempts to identify which linguistic features are encoded in a lexical representation and whether and under what circumstances they are accessed during lexical processing.

Even before the advent of psycholinguistically motivated research, the Mental Lexicon, known simply as the *lexicon*, had already held a place in linguistic theory. The following sections provide a brief overview of various linguistic and psycholinguistic proposals regarding the lexicon. Their presentation in the section below is intended to provide a general framework for the present investigation.

1.1 The lexicon in theoretical linguistics

Almost every linguistic theory, whether its focus is on syntax, semantics, phonology, or word formation, postulates the existence of a component of the grammar called the *lexicon*. However, these theories vary widely in their descriptions of the organization of the lexicon and the type of information it contains. For instance, theories may differ with respect to what

they consider as the minimal representational units within the lexicon, e.g. roots, words, or feature bundles and the type of information encoded with them. They also diverge regarding other properties of the lexicon, e.g. its role in word formation and its interaction with other components of the grammar, such as syntax. For instance, while Lexicalism treats the lexicon as the central component of word formation, including words, roots, affixes and a set of word formation rules, Distributed Morphology (DM) views the lexicon in a very narrow sense. It only includes atomic roots (sound-meaning pairings) and feature bundles. Closer to Lexicalism than to DM, but still with more emphasis on the role of the lexicon in generating not only new words but also syntactic structure, the *generative lexicon* is viewed as a dynamic system which contains both roots and words, as well as various sets of rules; it is considered the locus of computation. The generative lexicon presupposes a robust computational model where not only new forms but also new meanings are derived through computation.

The development of generative approaches to the lexicon can be traced through the work of Noam Chomsky. Over the past 40 years, the Chomskyan perspective has evolved and changed with respect to the status and role of the lexicon. In the very early versions of Chomsky's model (1965) the lexicon was simply not recognized as an autonomous component of the grammar. Also, lexical entries were limited to a minimal form with specification of no more than inherent and selectional features. However, over time, increasing importance has been ascribed both to the lexicon as a component of the grammar and to the nature of lexical entries.

With the formulation of the Government and Binding (GB) theory (Chomsky, 1981), the lexicon began to be seen as one of the four subcomponents of grammar¹ and was considered to exert a crucial influence on syntactic structure. The 'projection principle' of GB postulates that the properties of lexical entries are 'projected onto' syntax. These properties include a representation of the phonological form of each item, a specification of its syntactic category, and its semantic characteristics (the semantic selection and thematic properties of lexical heads). The same properties also specify the argument structure of a head, indicating how many arguments a head licenses and what semantic role each receives. Thus, GB specifies a rich set of information in lexical entries.

¹ The other three are the *syntactic* (categorical and transformational) *phonological* and *logical* components.

In the *Minimalist Program* (Chomsky, 1993, 1995a, 1995b), the four subcomponents of the grammar are substituted by two 'interface levels', Phonological and Logical form. Both D-structure, which, in the previous model, was assumed to be projected from the lexicon, and S-structure have been eliminated. Instead, the status of the lexicon seems to be further enhanced, since the whole process of deriving a syntactic structure is represented as beginning in the lexicon. This means that the lexical entries, after being retrieved from the lexicon and having been transformed into phrases, are transferred into a grammatical derivation. The lexical items, which are selected in any given sentence, are the determinants of both the content and the form of the sentence. This implies that the lexicon has grown in importance to the point that some linguists now claim that acquiring the lexicon is almost all a child has to do, in order to acquire a language. Everything else is generated by a strictly invariant computational system, specific to language, and by the several output conditions at the interfaces of this computational system with other internal mental systems. The Minimalist Program is indicative of the increasing importance that current generative views attribute to the lexicon, which is seen as a dynamic component including lexical entries with rich information. Minimalism paves the way for development of a lexicon-oriented linguistic model.

Similar approaches to the lexicon have been put forward in a variety of generative theories. Head-driven Phrase Structure Grammar, developed by Pollard & Sag (1987, 1994), views words as extremely rich in grammatical information and as playing a key role in determining the syntactic shape of the sentences in which they occur. Lexical Functional Grammar, developed by Bresnan (1982, 2001), also considers the lexicon to be right at the heart of syntax. Every item in the lexicon comes equipped with indicators of how it sounds or how it is signed, and what it means. In the case of a verb, additional indicators determine the roles of the elements that are structured around it in a given sentence (its argument structure) and the grammatical functions assigned to these roles. Lexical choice is the shaper of the syntax of any given sentence. Goldberg's (1995) Construction Grammar attributes to individual lexical items all the information needed for the construction of linguistic structures or utterances. In addition to lexical items, she postulates form-meaning correspondences to exist in the language user's mental lexicon in the form of constructions.

She considers constructions to be necessarily motivated by lexical entries that typically occur in them.

In the present thesis, I adhere to a generative approach to the lexicon. This implies that I assume the existence of rich lexical entries for each lexical item. I assume that a lexical entry is specified for the abstract morpho-phonological structure of each lexical item and its syntactic features, including its categorial and contextual features and generally the combinatorial aspects of its meaning and syntactic characteristics, along the lines of Chomsky (1988: 5) and Schonefeld (2001: 57). More specifically, the lexical entry of an item, in its richest possible representation, includes information about: meaning, syntactic category, grammatical features (number, person, tense, etc.), morphological structure (simple, derived, compound), subcategorization (configurational information), its predicate-argument structure (i.e. thematic information), its cases (of its possible arguments), and register (style) (Lewandowski, 1990: 674). I also assume that the above knowledge is present in the speaker's mind and is accessible as a lexical entry is activated. The following section is a brief introduction to the mental lexicon and the basic assumptions underlying existing research on it.

1.2 From the lexicon to the mental lexicon

In the previous section I briefly presented various theoretical views on the role of the lexicon in grammatical knowledge/competence. As shown earlier, a generative approach presupposes the existence of a rich lexicon, where all pertinent information about the word is stored in the lexical entry. In this section, I will introduce another dimension of the lexicon, often referred to as the *mental lexicon* (ML). Like the lexicon, the ML represents the internalized knowledge of the properties of words. Its 'mental' dimension derives from the fact that it is seen not only as a subcomponent of the language system, but also as part of general human cognition. This is closely associated with the fact the ML is usually studied from the point of view of language use or *performance*. Thus, the term ML is used to describe the dynamic organization of words in the mind, comprising a vast and complex network of mental representations, associations, and cognitive processes.

Research on the ML is predicated on a set of beliefs about central issues in the study of human language. These beliefs assume a rich lexicon, in terms of representation, as well as a close relationship between competence and performance, or rather representation and

processing. Within this framework, the mental lexicon is viewed as the central link in language processing; it relates lexical primitives with the syntactic and semantic interpretation of the message being communicated. This means that an adequate psycholinguistic account of the lexicon and language requires us to combine theories of the form and content of lexical representation with theories of lexical processing. This involves determining how lexically stored knowledge manifests itself during the on-line processes of comprehension and production.

Experimental research on the ML has occupied a central role in cognitive science for over three decades. This research, carried out primarily by psycholinguists and neurolinguists, aims at achieving a comprehensive understanding of how words are represented and accessed in the mind and the brain. Furthermore, it aims at delineating the automatic processes that occur during language use. An understanding of these processes is fundamental to advances in the study of human language, since these are highly suggestive about the relationship between language processing and language representation. As the ultimate goal of psycholinguists and neurolinguists is similar to that of theoretical linguists, the body of research on the ML is of great value to the development and validation of theories of competence. The predictions of linguistic theories are being studied in the light of evidence from psycholinguistic and neurolinguistic investigations. Research on the ML has focused on a number of questions which aim at capturing both the common and variable aspect of lexical representation and processing across languages. Primary among them is the issue pertaining to what is listed in the ML (in terms of minimal units and the information encoded) and how mental representations are accessed and linked to each other.

Experimental research has approached the above questions from various perspectives and through a variety of means, such as investigations of the on-line and off-line performance of non-impaired and brain-damaged populations in a variety of languages, using a wide range of techniques. The central focus is always human performance and its various manifestations, which are often task-dependent. For instance, cross-population research has allowed us to compare non-pathological and pathological language processing and investigate the types of representations that have been lost as a result of brain damage, as well as what representational information within lexical entries is no longer accessible through normal processing channels (see Jarema, 1998). Furthermore, the study of the

bilingual lexicon offers an opportunity to distinguish between universal and language-specific effects, by allowing us to study language-specific processing in the same individual. Finally, cross-linguistic investigations have advanced our knowledge on how linguistic diversity is related to psycholinguistic and neurolinguistic variation. For instance, comparing language processing or language breakdown in fundamentally different linguistic systems has allowed us to investigate hypotheses about how language-specific parameters shape lexical representation, organization and functioning, thus bringing us closer to an understanding of language universals.

Investigations of the on-line performance of non brain-damaged monolingual populations have been the central focus of research on the ML. Although a large number of studies have focused on spoken word recognition, many have also concentrated on visual processing of written words. Work on visual word recognition has used a variety of research methods, the major paradigm being visual lexical decision tasks. In order to understand the nature of lexical representations of monolingual, non brain-damaged populations, one of the great challenges within the lexical decision paradigm has been to tease out the differential effect on lexical processing of a number of lexical properties. These properties refer to the specific phonological, morphological, semantic and syntactic characteristics of the stimuli. Manipulations targeting the relative effects of morphology, phonology, semantics and syntax allow us to probe subtle aspects of lexical representation that would not otherwise be evident. For instance, by comparing individuals' performance in accessing derived versus non-derived words, we can draw conclusions about the effect of complex morphological structure in lexical access and consequently, about the mental representation of these two types of words.

Indeed, experimental evidence leaves no doubt that morphological information is represented in the ML in a quite detailed way (see McQueen & Cutler, 1998). Also, despite some controversy on the time-course of activation of phonology, evidence converges to suggest that phonological information plays a role in word recognition and the organization of the lexicon (e.g. Grainger & Ferrand, 1996). Similarly, a number of reports in the literature indicate that semantic variables, such as concreteness, imageability, and polysemy influence the recognition process (e.g. Zevin & Balota, 2000). The role of syntactic features has been studied to a lesser extent, usually with a focus on grammatical class effects, as well

as on verb argument structure. Grammatical class has been shown to affect lexical access and evidence coming principally from the literature on aphasia suggests that the lexicon is organized based on this type of information (e.g. Bradley, Garrett & Zurif, 1980; Berndt, Mitchum, Haendiges & Sandson, 1997). Verb argument structure and its general thematic information also appear to be accessed immediately upon encountering a verb (e.g. Maurer & Koenig, 1999).

One major concern has been to investigate how these various features interact with each other in visual word recognition. For instance, semantic and phonological transparency have been shown to be necessary for accessing derived forms after decomposing them into their constituents in lexical decision tasks (e.g. Longtin, Segui & Hallé, 2003). Also, non-linguistic features, such as the frequency of occurrence of a particular item, have also been found to affect the speed and the means of its lexical access (e.g. Balota & Chumbley, 1994). The present investigation was conceived against this general background. Focusing on the lexical access of deverbal nominals and deverbal pseudo-words, it attempts to investigate the processing of *thematic features* and to determine their interaction with complex morphological structure and grammatical class. In the following section, I present the main goal and orientation of the present research.

1.3 Goal and orientation of the present research

Within the general framework outlined in the previous sections, the broad goal of the present thesis is to contribute to our understanding of the ML via the study of the lexical access of Deverbal Nominals (DNs) and deverbal pseudo-words (Pseudo-Ws).

The class of DN is fairly rich in terms of linguistic features that have been found to influence lexical access. First, DN demonstrate complex morphological structure, being composed of a verbal base and a suffix. This fact has further implications. There is both linguistic and psycholinguistic evidence to suggest that derived words are specified for features that they inherit from their constituents. For DN, such features are Thematic Features (TFs) inherited from the base verb and the suffix during their derivation. The fact that DN are specified for TFs further adds to their complexity, given that TFs are not typically associated with the grammatical class of nominals. Moreover, increasing evidence on the role of grammatical class in lexical access and the organization of the lexicon, as well

as the role of TFs in lexical access of verbs, raises questions regarding the possible interaction between these two types of properties. The present study approaches these questions from a psycholinguistic perspective through a number of lexical decision tasks involving Modern Greek DNs and Pseudo-Ws. The tasks are designed to probe whether certain TFs inherited from the base verb and suffix during the derivation of DNs are accessed during the retrieval of these items.

The thesis aims at contributing to the current literature on the ML in various ways. First, the effect of TFs in word recognition of Deverbal Nominals will be studied for the first time. Second, it will enhance the cross-linguistic perspective of research on the ML by providing evidence from a less studied language (Modern Greek). Based on the empirical results of the present study we will be able to readdress issues regarding the role of grammatical class in lexical access and its interaction with other semantic/syntactic features. Furthermore, we will also be in a position to provide evidence and make claims regarding the nature of these features, since they are inherited and not inherent. Finally, the experimental evidence will provide us with insight that may inform theories of word formation. In the following section, I outline the content of the remaining chapters.

1.4 Thesis outline

In Chapter 2, I summarize the state of the current research on the ML with respect to the linguistic features of the word and their role in visual word recognition. I outline the empirical evidence relevant to our discussion, i.e. the role of various morphological, phonological, semantic and syntactic features in visual word recognition. I also present the range of theories that have been constructed based on this evidence. Through an examination of previous findings regarding the role of specific features and their interaction, I make a case for the importance of studying the interaction of thematic features, grammatical class and complex morphological structure in the processing of DNs. In Chapter 3, I present in detail the theoretical framework for the present investigation. Two divergent approaches to nominalization (lexicalist and syntactic) are outlined, with a special focus on the lexicalist theories. In addition, I summarize the properties of word formation in Modern Greek (the language under investigation) and provide a thorough description of the type of lexical features studied. In Chapter 4, I present the research questions for the present study. These

questions are founded on a body of previous psycholinguistic evidence and grounded in linguistic theory. Chapter 5 is dedicated to methodological issues, including a description and justification of the experimental paradigms used in the study. Chapter 6 presents in detail the four series of experiments presented in the thesis. A section of the chapter is devoted to each experiment and includes a detailed description of the stimuli and the experimental conditions. Results, statistical analyses and a brief interpretation of each experiment are also presented. In Chapter 7, I discuss the overall results of the present work against the general background outlined in the introductory chapters. Chapter 8 summarizes the thesis and its contribution to our understanding of the mental lexicon, concluding with suggestions for future research.

Chapter 2 PSYCHOLINGUISTIC BACKGROUND

In this chapter I summarize the state of current research on the Mental Lexicon (ML), with a special focus on visual word recognition² I will outline both the empirical evidence relevant to the topic of the thesis and discuss its implications for the experimental component to be introduced in later chapters. Apart from presenting the current trends in psycholinguistic investigations of the ML, an important aim of the chapter is to identify possible gaps in our current knowledge that will provide the rationale for the present investigation.

2.1 The word and its features from a psycholinguistic perspective

As we saw in the introduction, research on the ML seeks to better understand the nature of mental representations, how they are accessed and how they are linked. Although research stemming from each of these three separate directions attempts to delineate different aspects of the ML, all three are closely connected and inter-related. For instance, knowledge on how mental representations are accessed can provide insights into their make-up and, ultimately, information regarding the precise properties of an item listed in the ML. One basic assumption underlying this line of research is that word recognition is achieved through access to a word's lexical entry in the ML. To date, studies on lexical access have sought to answer two main questions. The first one concerns the number of aspects of a lexical representation that are accessed and exploited either for recognition of a word or for constructing a higher-level³ representation. The second seeks to determine the precise time course of activation of the different components of a mental representation.

Previous psycholinguistic research has identified a number of factors that seem to play a role in visual word recognition. These pertain to both pure linguistic⁴ and non-linguistic properties of a word. Although a typical non-linguistic property, such as word length, may play a crucial role in the speed of lexical retrieval, this does not provide us with any information regarding either the nature of the item's lexical entry or the organization of

² The term *visual word recognition* will be used to refer to the system which covers the process of *lexical access* including the point when the *lexical representation* is reached (see McQueen & Cutler, 1998: 425).

³ Higher-level representation refers to sentence level.

⁴ Although there is much controversy regarding the types of properties that can be labelled as *linguistic* and *non-linguistic*, this distinction will be adopted as a working distinction in the present thesis. The term *linguistic* will be used to refer only to those properties of a word that can be described and explained by linguistic theory. All other lexical properties will be referred to as *non linguistic*.

the ML in general.⁵ In contrast, the fact that such linguistic properties as complex morphological structure, phonological transparency, semantic concreteness/abstractness, ambiguity, grammatical class, and various syntactic specifications appear to influence lexical access suggests that these properties may play a prominent role both in the mental representation of particular lexical items and in the organization of the lexicon. For instance, as we will see in the following section, the finding that morphological structure affects lexical access has been repeatedly interpreted as an indication that the lexicon is organized into units with the size and properties of morphemes.

The following section reviews the literature on the word properties or *features* that have been shown to affect lexical access. Rather than providing an exhaustive review of existing research on the features implicated in lexical access, the section seeks to provide the necessary background for the research questions of the current investigation by highlighting the research on lexical access most pertinent to this study and by signalling those areas that have not received adequate attention to date. For instance, relatively few studies have focussed on the role of syntactic features in lexical access outside of sentential context. Furthermore, little attention has been paid to the interaction of the various features displayed by any given lexical item.

2.2. Linguistic features and how they influence lexical access

The word properties that are thought to directly influence lexical access can be broadly divided into those which refer primarily to the structure of the word (morphological/phonological features) and those which are more ‘abstract’ and refer to the semantic and syntactic features of the lexical item. In this section I outline the basic research findings on the role of morphological structure, phonological transparency, semantic concreteness/abstractness and grammatical category.

2.2.1 The role of morphological structure in lexical access

A large number of studies have been carried out to investigate the possible effects of morphological structure on lexical access, as accessing the structure of a lexical item is considered one of the first steps in the entire process of lexical access of complex items. The

⁵ The role of these properties will be addressed in a later chapter, when discussing stimulus design.

most fundamental question with regard to the interaction between the morphological structure of complex words and their storage and access is whether they are accessed through decomposition into their constituents (e.g. *un-deni-able*) or as wholes (e.g. *undeniable*). Researchers tend to fall into three different camps with respect to this question, building their supporting arguments on a foundation of somewhat conflicting research findings. In the first camp, researchers tend to cite studies indicating a decomposed representation (Taft & Forster, 1975 and references thereof), while those in the second camp prefer to cite evidence suggesting that access occurs via a stored representation of the whole word (Butterworth, 1983 and references thereof). Those in the third camp cite a broader range of studies supporting the view that both decomposed and whole word forms are available, with each being accessed under different circumstances (Caramazza, Laudanna & Romani, 1988; Chialant & Caramazza, 1995; Schreuder & Baayen, 1995).

Proponents of the two first proposals agree that accessing the lexicon relies on one mechanism (single route), though they disagree as to the nature of this mechanism; all lexical items are either segmented on-line (morpheme-based hypothesis) or they are all learned and retrieved as wholes from memory (full-listing hypothesis). Proponents of the third proposal postulate that, depending on a variety of factors, both of these two distinct mechanisms can be available for lexical access (dual route/hybrid models). The basic assumptions of these three morphologically-based theories of lexical representation and processing are briefly reviewed in the following subsections. I will begin by presenting the two ‘most extreme hypotheses’ of lexical organization, the strict decomposition and full-listing hypotheses, followed by a discussion of the dual route hypothesis, which reconciles the two.

2.2.1.1 The morpheme-based (decomposition) hypothesis

The morpheme-based (decomposition) hypothesis assumes that lexical access of a complex word takes place after it is decomposed into its constituents. This is based on the premise that lexical representations of complex words comprise units having the nature of some type of morpheme. This view is consonant with the assumption within a number of linguistic theories that the lexicon contains both morphemes and redundancy rules that must apply in order for a lexical item to be accessed (e.g. Selkirk, 1982; DiSciullo, 1996a, 1996b; Ralli, 2002). Depending on one’s perspective, this model is either called the *decompositional*

hypothesis (for those who focus on how lexical access is achieved) or the *morpheme-based hypothesis* (for those who focus on how lexical representations are organized).

In its strict version, the decomposition hypothesis was proposed by Taft & Forster (1975). Their model postulates access procedures in which all affixes of a morphologically complex word are always ‘stripped-off’ prior to lexical access. Taft and Forster (1975; 1976), focusing on the lexical access of prefixed items, view the lexical access process of visually presented prefixed words as a serial process consisting of a number of steps to be taken in a fixed sequence: the prefix is assumed to be stripped off and then a search for the stem is undertaken. If the stem can be located in the lexicon and a prefix can be added to it, then the lexical decision response is ‘yes’. If the stem does not correspond to a lexical entry in the lexicon, then the lexical decision response is ‘no’. These claims were formed on the basis of empirical reaction time data (see Taft & Forster, 1975, 1976). They found that it took readers longer to decide that a non-word containing a real prefix is not a word than to decide on matched, unprefixed controls, e.g. *depertoire* vs. *mowdflišk*⁶. They interpret this reaction time difference as evidence that the affixed words are stored in their base form and that the target of lexical access is the root, not the word as a whole (Taft & Forster, 1975). This view was supported by a series of studies by the same authors, each of which contained substantial modifications of the original hypothesis (e.g. Taft & Forster, 1976; Taft, 1991, 1994).

The rationale behind strict decomposition is economy of storage: it is more economical to store one root, rather than the root plus all its derivatives. However, the principle of economy is no longer valid when it applies blindly to all pseudo-complex words, such as *prefer*, to highly complex words, such as *unremittingly*, or to complex but idiosyncratic words such as *department* (‘depart’ + ‘-ment’ ≠ ‘department’). Taft & Forster (1975: 646) reply to this criticism by claiming that it is more economical to store the stem for a number of different words just once, e.g. *mit*. Also, organization by stems allows for semantically related words to be listed near each other, even if the lexicon is organized orthographically or phonologically. For example *rejuvenate* and *juvenile* could appear as adjacent entries, even in an alphabetical listing, if the prefix is removed (Taft & Forster,

⁶ An important factor that Taft & Forster did not take into consideration and were later criticized about, is that the two types of non-words do not match with respect to ‘wordness’. That is, *pertoire* exists as part of a pseudo-derived word, while *mowdflišk* does not follow the phonotactic rules of English.

1975: 643). Finally, Knuth (1973) has suggested that by stripping off a prefix such as *re-*, one can use an alphabetical storage of words without having to list a very large number of words under the same description.

In fact, research has shown that bound elements such as the root *-fer* in English might be represented in the lexicon only when there is some specific meaning associated with them (Taft & Zhu, 1995). Another problem for the strict decomposition hypothesis has to do with the large number of irregularities and idiosyncrasies in the lexicon. Opaque compounds like *sweetheart* cannot be recognized after decomposition (e.g. Sandra, 1990; Zwitserlood, 1994; Isel, Gunter & Friederici, 2003; Libben, Gibson, Yoon & Sandra 2003), since segmentation of this word will likely lead to a false interpretation. One more weakness of most strict decomposition theories is their failure to consider how complex morphological structure interacts with other lexical features of the whole word and its constituent morphemes, such as frequency and transparency. Furthermore, it is questionable whether decomposition alone is adequate for accessing a complex lexical item.

Since 1975, when Taft and Forster first formulated the strict decomposition model, a great number of models of lexical processing have been proposed. In the light of the new reality, Taft's current position is slightly modified. In his most recent model of 'interactive activation framework', Taft (1994) still postulates that prefixed items are represented in a decomposed way, but without the necessity of an initial prelexical stripping. In this model, prefixes are treated separately from their roots, because morphemes in general, and not just prefixes, constitute independent activation units. In other words, Taft still believes in the role of prefixes in lexical access but seems to have abandoned the idea of obligatory prefix stripping prior to lexical access.

Although there is evidence that decomposition does occur, there is no evidence that decomposition always occurs. Thus, given all the problems with the strict decomposition view, a more realistic model would allow for the possibility of the co-existence of both decomposition and its apparent opposite, unitary access. Before describing such a hybrid model, we will first examine another extreme version of a unitary access model, which is the *whole-word* or *full-listing hypothesis*.

2.2.1.2 The full-listing (or whole word) hypothesis

Butterworth (1983) is the foremost proponent of the full-listing hypothesis (FLH), which was originally proposed in response to Taft's (1975) stripping model. The FLH specifies that lexical access is based on the whole word, although fall-back rules may apply when necessary⁷.

After an elaborate discussion pointing to evidence from speech production, speech perception and reading, Butterworth (1983) concludes that the lexicon is most likely not organized in terms of morphemes with attendant morphological rules. Rather, due to the idiosyncrasy of semantic relationships, a full listing model is the only one possible. Such a model postulates that morphological relations are neither represented nor used in lexical access. Consequently, the lexicon is a list of words and each lexical item is recognized as such, without decomposition into its constituents.

This is not in accordance with the majority of linguistic theories, such as those proposed in the framework of Lexicalism,⁸ which assume that regularities in lexical representation can be captured by rules, with only idiosyncratic elements needing a listing as such in the lexicon⁹. For Butterworth, the lexicon contains every possible word, regular or irregular. For instance, the FLH implies the existence of a form *sings* which is associated with a meaning, a major category and a list of suitable syntactic contexts (or subcategorization frames) (Butterworth, 1983: 262). However, critics point out that the FLH seems to ignore the fact that derived words bear meanings that are predictable functions of their components. In reply to this, Butterworth (1983: 264) provides examples from derived words with diverse meanings, not all of which are predictable from the base¹⁰. That is, Butterworth's central argument is that some rules apply to just some lexical items, so the rules must be stated in a lexically sensitive way. Furthermore, derivatives in general have

⁷ The model also touches on other important issues (that I will not review) such as modality and lexicon, the distinction between function and content words in the lexicon and the role of frequency in lexical organization.

⁸ Only Aronoff (1976) denies the existence of morphemes in the lexicon, which he claims to consist of only whole words.

⁹ Butterworth (1983: 261), quoting Bloomfield (1933), Chomsky (1965), and Chomsky & Halle (1968), admits that 'linguists have traditionally rejected the Full Listing Hypothesis (FLH)'.

¹⁰ One such derivation is from the verb *induce*. This verb can have the following meanings: 'persuade', 'cause', 'produce current', 'infer from cases', 'induct'. If we examine its derivatives, we will see that not all of them are associated with all its meanings. Rather, the association between meaning and form is quite arbitrary. Consider, for example, the case of *inducible* which is only associated with the 'infer from cases' and 'cause' meanings of *induce*.

unpredictable semantics and thus constitute a major problem for a model of lexical representation which rejects the FLH. However, the role of morphemes is not altogether rejected by the FLH. For example, it is possible in a full listing model for all forms to have an internal structure marking morpheme boundaries. Thus forms like *sings*, *singing* have separate listings, but with morphemic boundaries, *sing-s*, *sing-ing*.

Another criticism levelled against the FLH is that speakers produce errors that are not real words both orally (e.g. *expection* instead of *expectation*)¹¹ and in writing (*defect* instead of *defection*)¹². These types of errors would not arise if subjects had only listings of full words. For such cases, Butterworth (1983: 282) suggests that rules might be used as fall-back procedures. The input to such rules generally appears to be words. These rules apply when a new word is encountered or when there is a need to coin a word if the full list fails. These rules can be 'substantive rules', which provide a recipe for constructing words. Alternatively, they can be in the form of 'meta-rules', which guide the language user to construct a new word on the basis of already existing similar ones. By assuming the existence of such rules, Butterworth accounts for the productivity problem while still claiming that access procedures do not take place through affixes, but rather through spelling patterns and syllables. If such a proposal is true, then there would be no reaction time differences in lexical decision tasks between affixed and non-affixed words. Indeed, Manelis & Tharp (1977) found no significant difference in reaction times between suffixed (e.g. *dusty*) and non-suffixed words (e.g. *fancy*). However, this lack of a difference between suffixed and non-suffixed words does not necessarily mean that decomposition never occurs. In fact, the relevance of morphological information in lexical access is supported by a variety of studies which show that morphological features do affect word recognition and that their effects can be separated from those of phonology and orthography. Moreover, despite the large number of convincing counterexamples to morphological regularity, the FLH ignores many morpho-semantic relations that appear to be regular and productive.

Both the decomposition model and FLH have important contributions to make to our understanding of lexical access and the organization of the lexicon. The FLH view that decomposition alone cannot account for the many examples of lexical irregularities is

¹¹ Example from Cutler (1980).

¹² Example from a patient with a writing disability (Shallice, 1981). This could be a mis-selection or an example of a derivational process misapplied.

supported by empirical evidence showing that there is no difference in access time between some morphologically complex words and orthographically similar, morphologically simplex polysyllabic words (e.g. Manelis & Tharp, 1977). In addition, the problem of productivity requires full-listing models to accommodate the possibility of morphological decomposition. On the other hand, although the strict decomposition hypothesis accounts for the issue of productivity and associates morphologically related words, it does not account for cases of pseudo-derived words, such as *conceive*, *perceive*, *receive*. Finally, the decomposition model is at odds with the principle of economy in language processing.

Not surprisingly, neither of the extreme positions (whole word access or strict decomposition) has received unequivocal experimental support. In fact, research findings have provided support for both positions, depending, in some cases, on factors such as word frequency. As it appears that neither a pure affix stripping position nor a pure full-listing hypothesis is tenable alone, a position incorporating both seems a most promising compromise. However, positing the existence of these two different modes of lexical access within a 'dual route' model raises a number of questions. For instance, are they applied simultaneously or successively? If simultaneously, what determines the eventual success of one procedure over the other? If successively, what determines which access procedure applies in which situation or with which words? Various proposals regarding these questions are discussed below.

2.2.1.3 The dual access hypothesis

Given the lack of unequivocal experimental support for each of the single route models, a number of hybrid models have emerged in which the lexicon is seen as containing both whole words and individual morphemes. Within such a lexicon, lexical access can take place either after decomposition or through whole word access. Such models are interesting in that they not only provide us with information on processing at the level of the morpheme, but they also allow us to investigate the possible effects of specific lexical features (morphological, morphosyntactic or phonological) during lexical access. In other words, these models take into account possible interactions between a number of factors that may affect lexical access.

There are two types of dual route models. The first type adopts one of the extreme positions ('decomposition' or 'whole word' access) and incorporates parts of the opposite proposal to account for special cases. The second type represents models that use a mixed approach as a starting point and argue that some words or word groups are accessed directly/holistically, whereas others are decomposed. There is also another subset within this second type of model, which assumes a mixed approach of decomposition and whole word access functioning in a parallel manner. Schreuder & Baayen (1995) have proposed one such model, called the meta-model, which incorporates the main points of the earlier dual route models. In order to provide some necessary context for understanding Schreuder & Baayen's meta-model, we will review some of the models upon which it is based.

2.2.1.3.1 Earlier dual route models

An early model combining direct access and decomposition was proposed by Meijs (1975; 1979; 1985). In this model, words are divided into two groups, existing and possible. The finite list of existing words constitutes the Item Familiar Lexicon (IFL), while the indefinitely large set of possible words forms the Type Familiar Lexicon (TFL). In this model, whole word access is the default strategy for items of the IFL, since it is faster. In contrast, the non-existing words of the TFL can be formed or interpreted at any given moment by the application of word formation rules. Although the model provides an explanation for newly formed complex words, there are a number of issues that it does not account for. For instance, although word formation rules seem to play a crucial role, especially in the TFL, the model does not mention whether and where these are stored. Furthermore, the distinction between existing and possible words is not a clear-cut one and this renders such a model applicable only within a strictly synchronic framework and aimed at an idealized language-user's lexical store. To deal with this, Meijs postulates the existence of an activation threshold beyond which it becomes economical to create a new full entry in the permanent lexicon, which is thereby promoted to the status of listed complex word in the IFL (1985: 77). In other words, Meijs believes that there is an individual threshold for each word beyond which it will begin to be stored. Nevertheless, the factors that satisfy such a threshold still need to be determined.

Bybee (1985, 1995) proposes a solution to the problem of when words start being stored by introducing the notions of 'lexical strength' and 'lexical connection'. Lexical strength varies as a function of frequency. The more frequent the lexical item is, the easier it is to activate its lexical representation. On the other hand, lexical connections ensure that information about morphological complexity is taken into consideration by the internal structure of the lexical representations. Thus the issue of when to store and when to analyze depends on the interaction of lexical strength and lexical connection. Frequent, regular, morphologically complex forms develop high lexical strength and thus will activate whole representations, while low frequency forms create stronger lexical connections which will lead to their decomposition. By postulating these two mechanisms, Bybee accounts for frequency, transparency, and regularity without making specific mention of these issues. However, this model does not clearly specify how words, especially new ones, are processed.

In spite of the problems with Meijs' and Bybee's models, the notions of IFL and TFL, as well as those of 'lexical strength' and 'lexical connection', are very useful in that they provide an accurate picture of the role of morphology in the ML. Although Meijs's and Bybee's models were not formulated on the basis of experimental data, their view of the lexicon is in accordance with some of the purely psycholinguistic models of lexical processing that are described below.

Another dual route model was proposed by Stanners, Neiser & Painton (1979), in response to Taft and Forster's (1975) model. Considered a parallel processing model, Stanners et al.'s (1979) model assumes that some words will be accessed after activation of both the unitary representation and the representation of their root, e.g. *unstable* will activate both *stable* and *unstable*. In contrast, words with bound roots will activate both the unitary representation and the words they share the root with, e.g. *conceive* will activate *conceive* and also *receive*, *perceive* etc. Thus we can account for the lack of storage of bound roots (*-ceive*), while maintaining the possibility of affix stripping. Stanners et al.'s work focused exclusively on prefixed words. As prefixation is the least productive morphological operation in English, the language under investigation in Stanners et al. (1979), there is no evidence that the model accounts for the exact function and retrieval of more productive affixes.

All of the models of lexical access examined so far have had to grapple with the issues of productivity, frequency, transparency and regularity, that appear to play a crucial role in determining the way lexical access is achieved and, consequently, the way mental representations are organized. A model such as the Augmented Addressed Morphology (AAM) is a serious attempt to incorporate these factors into its description of the process of lexical access. Inspired by the experimental work of Caramazza and his colleagues (Caramazza et al., 1988; Burani & Caramazza, 1987; Burani, Salmaso & Caramazza 1984; Caramazza, Miceli, Silveri & Laudanna, 1985; Laudanna Badecker & Caramazza, 1989; Chialant & Caramazza, 1995) AAM is a typical hybrid model that combines elements of the previous models. In AAM, processing depends on the orthographic surface form. The lexicon is accessed through 'access units', that are either whole words or morphemes. Activation of access units depends on graphemic similarity. For instance, the stimulus *talked* will activate the whole word *talked*, as well as its constituent morphemes *talk* and *-ed*. Moreover, orthographically similar forms such as *walked*, and *balked* will also be activated.

One basic assumption of the model is that the system functions in a maximally 'transparent' way¹³. Its main tenet is that lexical access of familiar/frequent morphologically complex words is achieved through whole-word access, while less familiar/frequent but morphologically regular words, as well as new words, are recognized through decomposition (Chialant & Caramazza 1995: 63). This model incorporates the analytic precision of the decomposition model and the rapidity of the whole-word access model. This makes it a hybrid model that presupposes the existence of hybrid representations for the same word consisting either of the whole form or its parts.

Various researchers have pointed out that there are a number of problems with the AAM model. First, Taft (1994) indicates that AAM makes wrong predictions regarding pseudo-prefixed words, such as *conceive*. Since the model does not allow for decomposition of such words, their reaction times in lexical access should be the same as for non-prefixed words. However, this is not the case; Taft & Forster (1975) demonstrated increased RTs for pseudo-prefixed words. Another potential problem is that AAM heavily depends on

¹³ That is, it is assumed that processing relies only on information carried explicitly in the surface form of the stimulus. It follows that in the early stages of processing of an orthographic input stimulus, the system can only make use of the surface orthographic information provided by the isolated stimulus (Chialant & Caramazza, 1995: 63).

orthographic similarity and overlooks semantic relations and connections. For instance, the model predicts that an irregular past like *went* will activate *wept* (based on orthographic similarity) rather than *go*, which is semantically related. Finally, Frauenfelder & Schreuder (1992) question the ‘parallel’ character of this model. Since the whole representation is always activated faster than the individual morphemes, the decomposition route should be considered as a back-up mechanism, rather than as a process that takes place in parallel. If this is the case, then the AAM model does not differ essentially from the FLH.

As a result of the shortcomings identified in the AAM, Schreuder & Baayen (1995) put forward the *meta-model*. This model is based on their earlier work, specifically on Frauenfelder & Schreuder’s (1992) Morphological Race Model (MRM) and on Baayen’s (1992, 1993) Race Model (RM). In his Race Model, Baayen (1992) pointed out the crucial role of **productivity** in accounting for lexical representation. He claimed that morphologically productive forms are parsed, whereas unproductive forms are processed through direct access. These two routes start simultaneously as soon as we encounter a word. The route that reaches completion first yields the output. This differs from the AAM model in that it proposes that the two routes may overlap. It is obvious that Baayen links productivity to frequency by assuming that words with productive suffixes are not that frequent, whereas words with unproductive suffixes are usually more frequent. This statement has its own problems, since not all low frequency words can be decomposed to reveal productive affixes.

Frauenfelder & Schreuder (1992) accept most of Baayen’s assumptions, but also give consideration to other factors that influence parsing. More specifically, while Baayen (1992) only considered frequency as a consequence of productivity, Frauenfelder & Schreuder deal with frequency as an independent factor. They determine the time that is necessary for a word to be recognized for both routes: For the direct route, which applies to simple or opaque words, recognition time depends on the token frequency of the word¹⁴. Words that are frequent will thus be recognized faster. For instance, both *table* and *swamp* will be accessed via the direct route, but *table* will be accessed faster since it is more frequent than *swamp*. In contrast, the recognition time for the parsing route depends on the phonological

¹⁴ Baayen only considered frequency as a consequence of productivity. Frauenfelder & Schreuder deal with frequency as an independent factor.

transparency, the semantic coherence and the resting activation level of the root and the affix.

For morphologically complex words, the fastest route will depend on the activation levels of the root and affixes relative to the activation level of the whole word. If the word is frequent but phonologically opaque, then the resting activation of the whole word will be greater than the resting activation of its morphemes and, therefore, the direct route will win the race. For instance, for accessing the word *conclusion*, both the direct access and the parsing route will be activated. However, since it is a frequent word without clear phonological boundaries¹⁵, the activation of the whole representation will be greater than the activation of its morphemes, resulting in the direct route for its lexical access. In the case of a low frequency word, depending on its transparency, the resting activation of its morphemes should be higher than the resting activation of the whole word, giving precedence to the parsing route for its recognition. This is the case for a word such as *unfamiliar*, for which both the whole word representation and the morphemes will be activated. However, given that the word *unfamiliar* is of low frequency, the resting activation of its morphemes will be higher than the resting activation of the whole word and lexical access will take place via parsing. In this way, variables such as transparency, frequency, and productivity are incorporated in the model and their interaction appears as a crucial condition for the access route and ultimately word recognition. Based on this background argumentation, Schreuder & Baayen (1995) formulated the *meta-model* which accounts for all these and other factors in considerable detail.

2.2.1.3.2 Schreuder & Baayen (1995)

As we have seen so far, the dual route models try to accommodate factors such as frequency, transparency and productivity in their accounts of morphological processing. The model proposed by Schreuder & Baayen (1995) takes into account an even greater variety of factors, including linguistic ones, and considers how they might interact with each other. The authors' aim is to demonstrate the role of meaning during morphological computation. The model tries to incorporate word features ignored by the previous models, which is why it is

¹⁵ This is because the morpheme boundary affix *-ion* mutilates the stem.

called a *meta-model*. Apart from the central role of meaning, the meta-model is applicable to all language modalities and can explain morphological processes in a variety of languages.

According to Schreuder & Baayen (1995: 133), morphological processing, whether in production or comprehension, includes three stages. The first one is *segmentation*, which includes the mapping of the stimulus onto form-based access representations of full, as well as bound forms. The second stage is called *licensing* and involves checking whether representations that have become active can be integrated on the basis of their subcategorization properties. The third stage, *combination*, deals with the computation of the lexical representation of the complex word from the lexical (syntactic and semantic) representations of its constituents, given that this integration is licensed. A considerable advantage of this model is a mechanism called *activation feedback*, which allows for activation at all levels of the processing mechanism to be affected by all other levels.

Let us examine how this system works when it comes to the recognition of complex words. Schreuder & Baayen (1995: 133) consider that each language has its own ‘complex’ words, the meaning of which cannot always be inferred from their constituents. For such words, they postulate separate representations at various levels without excluding the fact that fully regular and transparent forms may have their own representations depending on their frequency. The recognition process proceeds in the following way. At an initial stage, the stimulus is transformed into an **intermediate access representation** which usually contains more than one alternative. For instance, a word like *distraction* might be represented as *distraction* or *distract + ion*. These representations must be mapped onto the **access representation proper**. Such ‘lexical’ access representations may be present for full complex forms, as well as for stems and affixes. Activation speed depends not only on the existing level of activation, but also on the complexity of the mapping process from the intermediate stages to the access representation proper. For instance, when the processor encounters phonological mutations that cause the surface form to differ from the base, a longer processing time will be needed as compared to the time needed for transparent forms. Thus *destruction* will take longer than *distraction*, due to the change of *destroy* to *destruct-*.

Every access representation is linked to one or more lexical representations. A lexical representation consists of a *concept node*, which in turn is connected to syntactic and semantic representations. For instance, the lexical representation for an inflected form such

as *books* should be connected to three conceptual nodes. One node represents the meaning of BOOK, one represents the meaning of Plural and one stands for information associated with the grammatical class of Noun. Both the concept nodes and the access representations can receive activation feedback from higher levels. The activation level of a concept node does not depend solely on the access representation, but also on the feedback received from the syntactic and semantic representations, which are very often also activated from other words that have the same syntactic and semantic features.

Once the concept node is activated, the processor has to determine whether or not the syntactic and semantic representations allow the combination. As soon as the syntactic node gives licensing, the meaning of the complex word has to be computed. At the final stage, the processor has to reach the *lexical representation*; this consists of a concept node and its associated syntactic and semantic representations. In the case of newly formed words, procedural lexical knowledge is required, since no lexical representation is available. The role of licensing and combination is to create the new representation, which will be linked to syntax through the subcategorization features of the lexical item.

Schreuder & Baayen's (1995) model is the first to take into account linguistic notions such as syntactic subcategorization and it is the only model that states that linguistic features are being computed in lexical access. Furthermore, it can account for effects such as root-frequency, whole-word frequency, pseudo-affixation and productivity. More importantly, it gives special attention to the interaction of all of the above-mentioned variables. Despite its strengths, various aspects of the model need further development. For instance, the model positions both the syntactic and semantic representations under the concept nodes, rather than clearly differentiating between the two. Also, although it takes into account syntax and semantics when it comes to representation, it does not mention how the syntactic and semantic features of each word would influence lexical access and how they would interact with the other lexical features. In the present research this question is explored by focussing on the role of thematic features in the lexical access of nominals derived from verbs (deverbal nominals).

2.2.1.4 Interim summary and further implications

In reviewing the literature on the role of morphological structure in lexical access, we have seen how complex morphology can play a crucial role in lexical access and lexical representation. It has also become clear that neither of the extreme positions, strict decomposition or whole word access, can account for the experimental facts. Rather, a variety of factors interact to determine whether words can be accessed as wholes or through decomposition. More specifically, morphological productivity, frequency and transparency are interrelated concepts that have played a major role in modelling the role of morphology in the lexicon. In fact, most of the dual route models reviewed here take these factors into account. Schreuder & Baayen's (1995) model stands out in this respect, as it not only incorporates aspects of several other models, but also takes into account linguistic theory by trying to accommodate the role of pure linguistic features such as syntactic subcategorization frames. Such a model will be adopted and argued for in the present dissertation.

In the following section I will describe other linguistic factors that appear to influence lexical access and, consequently, the organization of the lexicon.

2.2.2 The role of phonological features in lexical access

In visual word recognition, the nature of the reading task does not demand that phonology be used at all; in principle, words could be directly recognized on a strictly visual basis. However, some researchers have observed that reading is accompanied by inner speech¹⁶ (Rubinstein H., Lewis & Rubinstein M.A., 1971; Gough, 1972; Smith & Spoehr, 1974), leading indirectly to a renewal of experimental interest in the role of phonology in word recognition. The results of these experiments led some researchers to the claim that phonological information is rapidly activated in silent reading under a broad range of conditions (e.g. Grainger & Ferrand, 1996; Ferrand & Grainger, 1992, 1993).

The debate in the current literature focuses on whether word recognition is 'direct' or 'phonologically mediated'. As with the processing of morphology, we find dual route models regarding phonological computation as well. A dual route model postulates that both direct and phonologically mediated routes are thought to prevail for different types of words. The

¹⁶ Certain influential linguists, such as Bloomfield (1942), have pronounced writing and reading to be a derivation of speech, lacking any independent linguistic identity. For more details on the relationship between linguistics and written language see Gendreau-Héту (1995).

direct route provides the only means for recognizing words containing irregular spelling-sound correspondences. Regular words could be recognized by either route, but skilled readers are thought to recognize them directly (Castles & Coltheart, 1993). Further evidence for a direct route comes from patients with phonological dyslexia, a disorder where the patient can read despite severe damage to the phonological route (Shallice & Warrington, 1980; Patterson, 1982; Funnell, 1983).

However, there is also sound evidence for ‘phonological mediation’. This is apparent through a number of reading tasks and priming studies. For instance, Meyer, Schvaneveld & Ruddy (1974) found facilitatory effects for visually presented rhyming pairs such as *stone-flown*. Moreover, robust effects of phonological priming were observed in lexical decision experiments by Grainger & Ferrand (1996) and Ferrand & Grainger (1992; 1993). Also, Van Orden (1987) and Van Orden, Johnston & Hale (1988)¹⁷ provide evidence for phonological mediation in a silent reading task, with semantic categorization. Finally, a number of studies have shown that poor reading is often associated with impairments in the use of phonological information and that an efficient route of grapheme – phoneme correspondence facilitates word recognition (Bradley & Bryant, 1985; Liberman & Shankweiler, 1979; Lesch & Pollatsek, 1993; Lukatela & Turvey, 1994a 1994b; Pollatsek, Lesch, Morris & Rayner, 1992). It is also clear from a number of studies that phonological information generated from the printed word influences early, automatic processes in visual word recognition (e.g. Berent & Perfetti, 1995; Ferrand & Grainger, 1994; Lukatela & Turvey, 1994; Van Orden, Pennington & Stone, 1990). Moreover, in full support of phonological mediation, Seidenberg & McClelland (1989) suggest that a single process (phonological mediation in this case) can generate correct phonological codes for both regular and irregular words. In Seidenberg & McClelland’s view, all words might be read through phonological mediation, not merely those that are ‘rule governed’. Phonological consistency and regularity also appear to play a role. In other words, if a word follows the usual rules of pronunciation with respect to the rules for mapping print to sound, then its access is achieved more easily.

¹⁷ The same authors also suggest that evidence for a direct route based on the reading abilities of acquired phonological dyslexics might reflect adaptation to severe brain injury rather than a component of the normal system.

If we accept that phonological mediation indeed takes place, there are further issues to address. For instance, a long-standing question concerns the time course of phonological activation with respect to meaning and its further relationship to other processes taking place in lexical access, such as orthographic and semantic activation. It has been claimed that activation of orthography and semantics alone is less efficient than activation of orthography, semantics, and phonology, because it is more difficult to map orthographic with semantic codes which are uncorrelated with each other without the mediation of phonology (Seidenberg, 1995: 154).

To address the issue of the time course of activation, Ferrand & Grainger (1992; 1993) used a masked priming procedure with a lexical decision task with a variety of priming durations. Their goal was to determine the course of phonological activation and whether this can be differentiated from the effects of orthography. A phonological priming effect appeared over and above the orthographic effect. For instance, Ferrand & Grainger (1992; 1993), using a range of SOAs¹⁸ from 17ms to 100ms, found that phonological facilitation started to emerge only at exposures of 45ms to 50ms and not earlier. Orthographic priming, however, was observed with shorter SOAs.

If phonological information is indeed activated after orthographic information, then we should postulate a pattern for visual word recognition which proceeds from spelling to sound and then to meaning. In such a model, phonology would constitute an intermediate level in the process of word recognition. However, this may be an overstatement. While there is clear evidence of phonological mediation, phonological activation may only occur under specific conditions and concurrently with other processes. Low word frequency may be one such condition. As high frequency words are recognized with little or no input from phonology (Seidenberg, 1985), the use of phonological information in word recognition may be inversely dependent on word frequency. Thus, while the irregular pronunciation of an extremely high frequency word such as *have* does not delay its lexical access, the same would not be true for irregularly pronounced low frequency words.

In fact, the studies cited in this section (e.g. Meyer et al., 1974; Van Orden, 1987; Van Orden et al., 1988; Lukatela & Turvey, 1994), by investigating performance in reading tasks and lexical decision experiments, provide unequivocal evidence for phonologically

¹⁸ Stimulus Onset Asynchrony. Term used to describe the prime duration.

mediated access to lexical representations, especially for less frequent words. The priming studies (Ferrand & Grainger, 1992, 1993) suggest that briefly presented letter strings, after activating orthographic information, proceed to activate sublexical phonological units which in turn affect the activation level of whole-word orthographic units. Of course, as with morphological features, there was a significant interaction of these results with frequency and transparency. This suggests that phonological features are computed in visual word recognition and, depending on phonological transparency and regularity, they can facilitate lexical access and accelerate the mapping from orthography to meaning, which is discussed in the following section.

2.2.3 The role of semantic features in lexical access

Although most theories of lexical access indicate that the word must be recognized before its meaning is determined, a number of reports in the literature indicate that semantic variables influence the recognition process. Evidence that semantics plays a role in the early stages of processing comes even from masked primes (Carr & Dagenbach, 1990; Hirshman & Durante, 1992; Diependaele, Sandra & Grainger, 2005), where, traditionally, no semantic priming effect is observed. Although, the role of semantic transparency in the lexical access of complex words (both derived and compounds) has been taken into account in models of lexical access (e.g. Schreuder & Baayen, 1995), the research findings have been equivocal. For instance, Diependaele et al. (2005) found early effects of semantic transparency, while both Pollatsek & Hyönä (2005) and Boudelaa & Marslen-Wilson (2005) failed to find any effects of semantic transparency in the recognition of transparent and opaque compounds in Finnish and in priming word recognition studies in Arabic, respectively. Additional evidence for the role of semantics is also provided by the word superiority effect. This last effect refers to the well-documented fact that actual words are accessed faster than well-formed non-words or individual letters (Reicher, 1969; Johnson, 1977) and suggests that the processing of meaning facilitates recognition.

Apart from the general effect of ‘meaningfulness’, more specific factors such as concreteness, ambiguity, and imageability appear to play a role (either inhibitory or facilitatory)¹⁹ in lexical access. For instance, a number of studies have found that words

¹⁹ A discussion of the specific effects of these factors is beyond the scope of this section.

representing concrete nouns are processed more quickly and efficiently than words representing abstract nouns (e.g. Eviatar, Menn & Zaidel, 1990; Bleasdale, 1987). This has been termed a ‘concreteness effect’ by Eviatar et al. (1990) and Jessen, Heun, Erb, Granath, Klose, Papassotiropoulos & Grodd (2000), among others. Concreteness effects have also been observed in studies using event-related brain potentials (ERPs) (West & Holcomb, 2000).

Imageability is closely tied to concreteness. Effects of concreteness and/or imageability have been examined in previous research, with results tending to show faster responses for concrete or imageable words than for abstract words in both lexical decision tasks and naming (e.g., Cortese, Simpson & Woolsey, 1997; de Groot, 1989; James, 1975; Strain & Herdman, 1999; Strain, Patterson & Seidenberg, 1995; Zevin & Balota, 2000). In fact, it has been argued that highly imageable or concrete words have richer semantic representations because they activate more semantic features than abstract words (Jones, 1985; Plaut & Shallice, 1993).

Finally, Lexical Ambiguity can also affect word recognition. Ambiguous words can be divided into two types: polysemous and homonymous. Lexical items which ‘accidentally’ carry two distinct and unrelated meanings are termed *homonymous*, e.g. *bank* means ‘financial institution’ but also ‘river side’. Lexical items having multiple related meanings are called *polysemous*. For instance, the word *mouth* refers both to a body part and to the point where a river meets the sea. There is evidence that these two types of ambiguous words are processed differently from one another. For example, polysemous words required shorter fixations than homonymous ones in reading tasks (Frazier & Rayner, 1990). In other studies, ambiguous words with related meanings (polysemous) were processed faster than those with unrelated meanings (homonymous) (Azuma & van Orden, 1997; Klepousniotou, 2002). These findings point towards differential representations of ambiguous words, depending on whether they are semantically polysemous or homonymous and underline the crucial role of semantic features in visual word recognition. In the following section, I describe some representative studies that highlight the role of syntactic features in word recognition.

2.2.4 The role of syntactic features in lexical access

Among syntactic features²⁰, grammatical class has been shown to play a role in lexical retrieval, suggesting that lexical items should be organized in the lexicon, at least to some extent, with respect to their lexical category. However, greater attention has been paid to the study of the syntactic features of verbs than of other parts of speech. For instance, the number and type of arguments associated with various verbs, as well as their possible argument structure, have been extensively discussed in the literature. In the following sections, I review the research on grammatical class and verb argument structure properties²¹.

2.2.4.1 Grammatical class

Grammatical class is one of the syntactic features that the processor is thought to make use of in retrieving a lexical item²² (e.g. Jenkins, 1970; Bradley, 1983). This implies that lexical items are organized in the lexicon based on whether they are nouns, verbs, adjectives, etc. In support of this notion, numerous studies have also shown that knowledge about different grammatical categories is represented in the brain (e.g. Thompson, Lange, Schneider & Shapiro, 1997; Kim & Thompson, 2000; Kellenbach, Wijers, Hovius, Mulder & Mulder, 2002).

The first type of evidence for the role of grammatical category in lexical retrieval comes from speech errors and tip-of-the-tongue states. In these types of errors, nouns tend to be substituted with nouns, verbs with verbs and adjectives with adjectives. Also, in word association tests, subjects most commonly respond to the stimulus word with a word of the same grammatical category (Ervin, 1957 as cited in Reeves, Hirsh-Pasek & Golinkoff, 1998; Jenkins, 1970). However, the largest body of evidence supporting a grammatical category-based organization of the lexicon comes from patients with grammatical category-specific deficits. The vast majority of these reports describe dissociations between function and content words (Bradley, 1983; Bradley, Garrett & Zurif, 1980), although there are also

²⁰ I use the term *syntactic features* to denote more general combinatorial and thematic properties of a lexical item. Such properties can lead to potential syntactic structures. For instance, the fact that the verb *to kill* requires two participants which are realized as subject and direct object derives from its specific syntactic properties.

²¹ Grammatical gender, i.e. feminine, masculine, neuter, is another syntactic property which has been found to affect lexical access although mostly in language production (see Mirković, McDonald & Seidenberg, 2005).

²² Although this is not explicitly mentioned by Schreuder & Baayen (1995), it is insinuated by them.

reported dissociations among content words. The most often reported dissociations among content words are between verbs and nouns. The dissociation between verbs and nouns has been demonstrated in both language production and comprehension, as well as in a variety of behavioural tasks, such as visual word recognition, sentence priming, and cross-modal priming experiments.

The most striking evidence of a dissociation between verbs and nouns and, consequently, of the role of grammatical categories in the organization of the lexicon, comes from the literature on agrammatic aphasia. Agrammatic aphasic patients demonstrate differential performance in retrieving verbs and nouns, especially in *language production* (e.g. Berndt, Mitchum, Haendiges & Sandson, 1997; Miceli, Silveri, Nocentini & Caramazza, 1988; Miceli, Silveri, Villa & Caramazza, 1984; Zingeser & Berndt, 1990; Marshal, Chiat & Pring, 1997; Thompson et al., 1997), in *naming* (Luzzatti, Raggi, Zonca, Pistarini, Contardi & Pinna, 2002; Miceli et al., 1984; Kim & Thompson, 2000; Marshal et al., 1997), and in *sentence comprehension* (Shapiro, Gordon, Hack & Killackey, 1993). For instance, Marshall et al. (1997) report on patient P.B., whose verb retrieval was impaired in both spontaneous speech and naming. While P.B.'s subcategorization was intact, his assignment of the thematic roles of verbs was poor²³. His verb comprehension was also impaired, particularly when the task demanded an appreciation of thematic information. The same patient showed a significant advantage for nouns. In another study, Webster et al. (2001) report on the performance of agrammatic aphasics who had to narrate the story of Cinderella. While normal controls produced a variety of argument structures, especially when a verb allowed for alternations, Webster et al.'s agrammatic patients produced only a limited set of argument structures. However, the phrasal realization of arguments in those with agrammatism was not qualitatively different from that of the non-impaired individuals. Further support for the differential processing of nouns and verbs comes from several studies which report selective difficulties in the performance of brain-damaged populations in producing words of one grammatical class in only one modality (Caramazza & Hillis, 1991; Damasio & Tranel, 1993; Hillis & Caramazza, 1995; Rapp & Caramazza, 1997; Rapp, Benzing & Caramazza, 1995). For instance, Rapp & Caramazza (1997) report on a patient

²³ For instance, P.B. respected the syntactic structure of verbs, although in some cases there were semantic anomalies e.g. *buy*_ NP, PP (*I buy the money for the milkman*). However, he had trouble assigning thematic roles to the NP associated with a particular verb, e.g. *the woman put the shelf to the book*.

whose oral production of both verbs and nouns was normal, but when he was asked to perform the same tasks in writing, his performance deteriorated with verbs but not with nouns. There is also evidence of the difference between nouns and verbs from an on-line study of an individual with aphasia. Using a cross-modal lexical decision task in sentence processing, Russo, Peach & Shapiro (1998) recorded RTs for transitive and intransitive verbs in preferred and non-preferred argument structures. Individuals with aphasia were insensitive to the preference information associated with the processing of verbs in sentences.

Recent studies on the representation of words with different grammatical classes using electrophysiological (ERPs) and neuroimaging techniques (PET and fMRI) in both healthy and brain damaged populations complement the findings based on behavioural techniques. For example, ERP recordings indicate that nouns and verbs can be distinguished relatively early in processing. Kellenbach et al. (2002) demonstrated processing differences between nouns and verbs which can be separately explained by either categorical distinctions per se or semantic attributes (abstract, visual, motor). These results suggest ERP effects for each of these two dimensions (grammatical class and attribute type). Similarly, Koenig & Lehmann (1996), using stimuli from German in another ERP study, report different patterns of spatio-temporal organization of neural activity after the presentation of words belonging to different grammatical classes. Taken together, these results support distinct neural substrates for grammatical word classes. Furthermore, controversies concerning the spatial validity of ERPs notwithstanding, results from a variety of ERP studies seem to confirm the anterior-posterior distinction regarding the localization of verbs and nouns that emerges from the aggregate of lesion studies (Dehaene, 1995; Koenig & Lehmann, 1996; Federmeier, Segal, Lombrozo & Kutas 2000; Kellenbach et al., 2002).

Despite the converging evidence of lesion and ERP studies, the few neuroimaging studies that have directly compared verbs and nouns do not provide unequivocal support for the notion that these two classes are represented in different cortical networks. For instance, neuroimaging data (PET) support only a partial separation of sites that become active for nouns versus verbs in tasks such as word generation (Warburton, Wise, Price, Weiller, Hadar, Ramsay & Frankowiak, 1996) and lexical decision (Perani, Cappa, Schnur, Tettamanti, Collina, Rosa & Fazio 1999; Fujimaki, Miyauchi, Pütz, Sasaki, Takino, Sakai & Tamada 1999). These results add strength to the claim that grammatical class alone is not

sufficient for distinguishing between nouns and verbs. For example, semantic differences within the same category can be sufficient for changing the topography of cortical processes induced by word stimuli (Pulvermuller, Lutzenberger & Preissl, 1999). Indeed, as Shapiro & Caramazza (2003: 204) observe, “semantic information about words can be represented in a distributed network, in which the organization of features patterns along some dimension(s) related to meaning and not along the lines of grammatical category in the formal sense.” Thus, although damage to this network might produce deficits that resemble grammatical category specific deficits, the difference might in fact originate from dissimilarities in their semantics. The same authors further point out that the contrast between nouns and verbs might originate from differences in their inflectional morphology (Shapiro & Caramazza, 2003: 204). Verbal morphology seems to depend on the left midfrontal gyrus superior to Broca’s area, whereas nominal morphology appears to be located in more inferior neural systems. Hence, it could be the case that observed differences between nouns and verbs originate from a split in the morphological processing system. Although this last argument is not as strong, given that there is a priori reason to believe that the morphological processing system is divided in two along categorical lines, it certainly adds weight to previous concerns about the validity of the hypothesis that the organization of the lexicon is based on the lexical status of words. In any event, the role of grammatical category as such in the organization of the lexicon and lexical retrieval remains an open issue.

From a purely linguistic perspective, the differences in processing patterns between nouns and verbs has been attributed to the internal complexity of verbs, i.e. their argument structure features (e.g. Saffran, Schwartz & Marin, 1980). Indeed, current research has shown that *verb argument structure* is accessed immediately upon encountering a verb and that it constitutes part of a verb’s mental representation. Evidence for these claims comes from various sources, including on-line and off-line comprehension experiments, classification tests, Event-Related Potentials (ERPs) and eye movement studies (Maurer & Koenig, 1999; Bencini & Goldberg, 2000; Friederici & Frisch, 2000). For example, Maurer & Koenig (1999) carried out an on-line experiment followed by an eye movement study in order to investigate whether unexpressed agent information²⁴ is introduced via argument

²⁴ For instance in a short passive like *The ship was sunk*, the typical understanding is that it was sunk by someone. There are two ways in which unexpressed event participant information might become part of our understanding of a sentence. The first possibility is that event participant information comes from situational

information and, if so, when argument information is used. The results of their study showed that verb argument structures are accessed immediately and are not reducible to generic conceptual knowledge representations.

Another major question about verb processing is whether native speakers are sensitive to the various verb classes on the basis of their argument structure. As these classes are usually seen as the result of shared semantic and syntactic properties,²⁵ this question is crucial to supporting the existence of a stored representation of verb-specific information. Bencini & Goldberg (2000) demonstrated that types of complement configurations are directly associated with sentence meaning, confirming that adults respect both syntactic information and verb classes. Finally, Friederici & Frisch (2000), in an ERP study targeting brain activation in different types of violations of AS, demonstrated the special status of thematic information carried by the verb by showing that structural and thematic aspects encoded in the verb are processed differently and are possibly supported by different brain systems.

All of the above studies strongly suggest that verb argument structure properties and thematic features have a prominent role in lexical access and, consequently, in their mental representation. In the following section I outline some theoretical assumptions about the mental representation of verbs.

2.2.4.1.1 Verb representation

The aim of the previous section was to highlight the differences between verbs and nouns in terms of processing in normal and aphasic populations. Many researchers consider these differences to originate from a certain ‘complexity’ attributed to verbs. Indeed, verbs are characterized by a complex of semantic and syntactic information which is integrally related to the semantics and syntax of the structures in which they occur. A verb’s representation can

knowledge stored in memory in the form of conceptual schemata (Rumelhart & Ortony, 1977), scripts or frames (Minsky, 1975). The second possibility (which is supported by the results of Mauner & Koenig, 1999) is that participant information is derived from linguistic sources (such as verb argument structure).

²⁵ For example, the phrase *Beth got Liz an invitation*, in terms of verb meaning, is related to the phrase *Michelle got the book*. However, in terms of verb AS, it is more related to the phrase *Paula took Sue a message*, both being ditransitive constructions. Similarly, the AS of *Laura got the ball into the net* is related to that of *Pat threw the keys onto the roof* (both caused motion constructions). However, we do not know the extent to which native speakers rely on the AS configuration in determining sentence meaning.

roughly be divided into three different components comprising its *core meaning*, *thematic information*, and *subcategorization information* (Jackendoff, 1990; Pinker, 1989).

Semantically, verbs encode events by describing different types of action. This is supposed to be their *core meaning*. For example, the core meaning of 'drink' is 'imbibe liquid'. The core event may impose restrictions on the participants in the event. For instance, 'drink' requires a liquid substance as an object, which is why the phrase 'I drank the bed' is unacceptable. Furthermore, the core meaning is responsible for explaining the differences between synonyms. For instance, both *kill* and *assassinate* call for an animate object. However, *assassinate* implies the involvement of a political figure, making the phrase 'I assassinated the neighbour' anomalous.

In addition to its core meaning, a verb's representation also includes a component which describes the *thematic information* associated with the verb. A fundamental assumption is that thematic information is still part of the conceptual structure of the verb and not of the syntax (Jackendoff, 1990: 46, Pinker, 1989: 4). This component determines the number of the participants (or *arguments*) in the event and their specific role. For instance, an event implying causation, such as the one implied by *kill*, requires an animate agent, whereas a non-causative event such as the one implied by *die* does not. Similarly, verbs which encode change of possession require a source (which is the sender), a theme (the item sent), and a recipient (the person to whom the item was sent).

Finally, there is the *subcategorization component* that is the part of the conceptual level that is visible in syntax. Different subcategories of verbs make different demands regarding which of their arguments must be expressed, which can be optionally expressed, and how the expressed arguments are encoded grammatically- that is as subjects, objects, or oblique objects. More specifically, the subcategorization component specifies the syntactic frames in which the verb may occur. For instance, *kill* would fit in a frame of the type [_{NP}], while *die* would fit in [_∅], which means that it cannot receive a complement. Subcategorization frames may specify several options for a particular verb. The case of the verb *send* provides a good example of such a case. The possibilities for *send* range from a single NP [_{NP}], such as in *send the parcel*, to a NP and a prepositional phrase [_{NP PP}], as in *send the parcel to John*, to [_{NP NP}], as in *send John a parcel*. The properties of verbs with different subcategories are specified by their entries in the ML, in data structures called

argument structures (also called predicate argument structures, subcategorization frames, subcategorizations, case frames, lexical forms, and theta grids) (Pinker, 1989: 4).

Core meaning, thematic information and subcategorization all contribute equally to a verb's integration in a syntactic frame and its successful use in discourse or in a sentence which further requires correct *mapping information*. In other words, the speaker must decide where to place the verb roles in the sentence. While some cases are quite straightforward, others are not. For instance, with a verb like *kill*, mapping its thematic roles onto subject-verb-object structure requires only the knowledge that agents occupy the subject position. The case of *receive*, however, is not that simple. Here the general knowledge that agents occupy the subject position can actually be misleading. If Tom is the sender of the parcel and Jen the recipient, then only Jen, who is not the agent, can be the subject of a sentence containing the verb *receive*, e.g. *Jen received the parcel from Tom*. Thus additional lexical information is needed about the specific verb *receive* in order for the correct mappings to take place.

To summarize, we have seen that verb representation contains three major components. These are the *core meaning* that expresses the basic characteristics of the event, the *thematic information* component that determines the number and the role of the participants in an event, and the *subcategorization* information that is responsible for the expression of the participants in the syntactic structure. We have also seen how the components of thematic information and subcategorization that is present in verbs, but not generally in nouns, can cause verbs to demonstrate a greater processing load than nouns and this in a variety of psycholinguistic tasks.

2.2.4.2 Interim summary and implications

The previous sections summarized a number of basic findings on word recognition. The goal of the summaries was to highlight the linguistic features that appear to influence lexical access and that provide insights into the nature of the mental representation of words and the organization of the lexicon. The role of complex morphology was the most studied linguistic feature in the experimental literature. The question underlying the bulk of this research was whether the lexicon consists of words or morphemes. It is clear from these studies that complex morphological structure plays a crucial role in lexical access, in conjunction with

frequency and phonological and semantic transparency. These findings have given rise to a number of models attempting to describe the organization of the lexicon, such as those by Meijs (1975, 1979, 1985), Caramazza et al. (1998), Frauenfelder & Schreuder (1992), and Baayen & Schreuder (1995).

Assuming a rich mental representation, other linguistic properties such as semantic and phonological features also play a role in word recognition. However, relatively little is known about the role of the syntactic properties of a word in lexical access. For instance, we know that grammatical class affects lexical access and is implicated in the organization of the lexicon. We also reviewed on-line studies indicating that verb AS properties are accessed early on and that they constitute part of a verb's mental representation. However, we do not know the effect of syntactic information which is associated with lexical items of other grammatical categories, such as nouns and adjectives.

Although it might seem reasonable to overlook syntactic features in studies dealing with isolated words, it leaves open the question of whether or not the parser uses syntactic features 'out of context' and how such features interact with other lexical properties. If these features play a defining role in the recognition of specific lexical items, then they should surface even in isolation. The aim of the present dissertation is to address the role of specific syntactic features in relation to other lexical properties (such as complex morphological structure), thereby attributing a role to syntactic features in lexical access. In order to set the stage for our investigation, we will need to examine the existing literature on the role of syntactic features at the lexical level. Given the dearth of information on the out-of-context accessing side, we will begin by examining models of language production, where syntax has been shown to play a significant role in lexical retrieval at the level of speech. We will contrast these models with models of language comprehension, focusing on the role of lexical syntactic features in building higher-level representations within a sentential context.

2.2.4.3 Lexical access in speech production

The amount and type of information that needs to be computed in order to retrieve a lexical item has been addressed fairly extensively in the literature on language production. The various theories of speech production agree that there are independent levels of mental

representation and that these levels are accessed sequentially. In other words, semantic, syntactic, and lexical information is stored and accessed separately.

Despite a general consensus regarding independent levels of lexical representation, there has been a lot of controversy with respect to the processing of syntactic information. There are two opposing views on this issue. The first approach postulates the centrality of syntactic information in defining the structure of words and their subcomponents. This is known as the Syntactic Mediation Hypothesis (henceforth, SM). According to SM, syntactic information is required to activate a lexeme. Proponents of the opposing view, referred to as the Independent Network Model (IN), claim that the retrieval of a lexical item is independent of any syntactic feature characterizing the specific item. In the following section I briefly review the main arguments and evidence for each approach.

2.2.4.3.1 The Syntactic Mediation (SM) hypothesis

This hypothesis is the outcome of a proposal initially put forward by Roelofs (1992) and subsequently adopted by Bock & Levelt (1994) and Jescheniak & Levelt (1994). According to their model of language production, there are three levels of representation: conceptual, lemma, and lexeme. The *conceptual* level represents lexical semantic concepts, the *lemma* level is connected to a set of syntactic nodes specifying properties such as grammatical class, while the *lexeme* level includes the phonological and orthographic form of a word. Lexical access in this model is represented by the sequential selection of lemma (and hence the syntactic features that define a word) and lexeme nodes through spreading activation emanating from the lexical concept node. The selection of a word's lemma is equal to the selection of the syntactic nodes/features that define the word. Thus it appears that the selection of the lexeme is mediated by the selection of the word's grammatical features. This has recently been termed the Syntactic Mediation Hypothesis²⁶. Indeed, there is abundant evidence in the neuropsychological literature supporting the crucial role of syntactic information in the organization of lexical knowledge. For instance, we saw earlier that the multiple dissociations between both open and closed class elements (e.g. Bradley et al., 1980) and between verbs and nouns (e.g. Marshall et al., 1997; Webster et al., 2001) are

²⁶ Dell has also proposed that the retrieval of syntactic information is necessary for the successful retrieval of lexemes (Dell, 1986, 1990; Dell & O' Seaghdha, 1991).

manifestations of the fact that the lexical system is organized in terms of grammatical information.

The experimental evidence presented in section 2.4.1 suggests that syntactic information may be independently represented. However, this does not mean that its retrieval is necessary for lexical access. More specifically, none of the studies reviewed deals with where the syntactic information is represented, how the syntactic features are activated and how they are related to semantic and phonological information. Furthermore, there is evidence from tip of the tongue (TOT) research that various types of features may be independent of one another in word retrieval. Miozzo & Caramazza (1997a) showed that Italian speakers in TOT states could retrieve grammatical gender information and partial phonological information (initial phonemes) for words that they were unable to produce at that moment. In both cases, performance was above chance. However, statistical analyses failed to show a correlation between the two types of information. This result demonstrates that, contrary to the SM hypothesis, access of a word's phonological features does not strictly depend on the prior access of its syntactic features.

Further evidence from the spontaneous speech of brain-damaged subjects suggests that lexemes can be accessed without correct access to their gender features. For instance, Semenza, Mondini & Cappelletti (1997) and Miceli & Caramazza (1988), providing evidence from article/noun and agreement errors, have shown that the phonological representation of a word can be accessed despite erroneous accessing of syntactic features. This type of evidence suggests that access to a word's syntactic features is not required in order to activate its lexeme. In the light of such evidence suggesting that syntactic information is not necessarily retrieved in lexical access, it is reasonable to question why one would postulate its presence in lexical representation. An alternative account is presented in the following section.

2.2.4.3.2 The Independent Network (IN) model of lexical access

Taking into account the weaknesses of the SM model of lexical access in word production, Caramazza (1997) put forward the Independent Network Model of lexical access (IN). This model assumes that lexical knowledge is organized in sets of independent networks connected to each other by a modality-specific lexical node. Lexical semantic networks are

separate from lexical syntactic ones. The latter incorporate syntactic features, such as category node, gender node and auxiliary node²⁷. IN differs from previous models in that lexical representations are modality specific (phonological and orthographic). During lexical access in production, the selected lexical-semantic representation spreads activation towards the lexical syntactic and phonological/orthographic lexemes. With respect to the retrieval of syntactic information, Caramazza (1997) claims that although grammatical category and tense features receive some activation from the semantic network, the activation of syntactic nodes from the semantic network is *not* sufficient for a grammatical feature to reach threshold. "Selection of the full set of the grammatical features of a word requires the prior activation and selection of the modality-specific lexical node" Caramazza (1997: 195). Thus, Caramazza (1997) considers syntactic features as secondary in lexical access during production²⁸. He actually claims that processing of syntactic features is 'part of a metalinguistic task, which may be difficult and slow' (Caramazza, 1997: 195). In other words, according to his model, syntactic features are part of the representation, but are not necessarily activated in lexical retrieval. Caramazza (1997) further postulates that lexical access occurs in two stages. In the first one, modality specific syntactically and semantically specified representations are activated. In the second stage, the selection of the lexeme's phonological (or orthographic) content takes place. In the course of this process, syntactic information receives 'weak activation', which means that, in lexical production, the selection of a lexeme does not guarantee the selection of the full set of its associated syntactic features (Caramazza, 1997: 197). In support of the independence of phonological information from the prior retrieval of syntactic features, Caramazza cites evidence collected by Miozzo and his colleagues (Badecker, Miozzo & Zanuttini, 1995; Miozzo & Caramazza, 1997b). In these studies, while the retrieval of auxiliary and gender information was available in anomic patients, information about the phonological features of inaccessible noun and verb lexemes was not. There is also indirect evidence for the independence of phonological and syntactic features from the spontaneous speech of brain-damaged subjects who made syntactic

²⁷ This is strongly related to the kind of representation Schreuder & Baayen (1995) postulate.

²⁸ Earlier in the same paper, Caramazza (1997: 186f) proposed a distinction between 'intrinsic' and 'extrinsic' grammatical features. The first type describes features inherently associated with the word, such as grammatical class and gender. They can be further divided into arbitrary and less arbitrary ones. The second type refers to features which are contextually determined (such as number and tense). It may turn out that the accessibility of the different types of grammatical features for a specific word is not uniform.

agreement errors despite the ability to retrieve the phonological form of the word (Miceli & Caramazza, 1988).

To summarize, there are two opposing views on the role of syntactic information in language production. The first one claims that accessing syntactic information is an independent and essential step in the production of a lexical item. While the second view still maintains the independence of syntactic from phonological representations, it does not consider the accessing of a word's syntactic information to be a necessary prerequisite to its production. Similar proposals have been put forward with respect to lexical access in sentence comprehension. These are discussed briefly in the following section.

2.2.4.4 Lexical access in sentence comprehension

There are two basic approaches to the study of lexical access in sentence comprehension and syntax plays a crucial role in both. The first line of research considers the lexicon as the driving force in the parsing process, whereas for the second one, which gives priority to syntax, the parsing process is initiated on the basis of word-category information before any other type of information (pragmatic, semantic, thematic) has been actually activated. These two approaches gave rise to the development of two distinct theories/models. They are the Lexical Generation of Syntax Model (e.g., Marslen-Wilson & Tyler, 1987; Tanenhaus & Carlson, 1989) and the Phrase-Structure Driven Model (Amherst group – Frazier, 1989; Clifton, Speer & Abney, 1991). A third approach, put forward by Tanenhaus, McDonald and colleagues (e.g., McDonald, 1994; Tanenhaus, Carlson & Trueswell, 1989), is known as the 'Constraint-based' or 'evidential approach'. This approach claims that sentence processing depends on discourse information.

As the Lexical Generation of Syntax Model (LGS) is most pertinent to the present research, it will be described here in more detail. LGS argues in favour of a lexical approach, which allows us to extract some interesting facts about the role of syntax in lexical access during sentence processing. We know from the introductory paragraph of this chapter that the lexical entry of a word is specified for certain characteristics related to its phonological/graphemic properties and its meaning, as well as its morphological and grammatical features, its syntactic category etc. Also, more combinatorial aspects of the meaning and of the syntactic characteristics of the lexical item are contained in its lexical

entry. The proponents of LGS claim that the semantic and syntactic contents of lexical representations become available simultaneously and at a very early stage in the word recognition process (Marslen-Wilson & Tyler, 1987; Tanenhaus & Carlson, 1989). As a result, given a verb such as *build*, which always takes a direct object, the parser would never even consider constructing an intransitive phrase headed by this verb. In contrast, given a typically intransitive verb like *sleep*, the parser would never interpret the phrase following it as its direct object. This is because, according to Tyler (1989: 443), “the entire lexical representation of a word is momentarily activated against the demands of the utterance-and-discourse context in which it occurs”. Thus it is the lexical item that constrains the type of structure that can be built (Tyler, 1989: 444). Evidence for the above claims come from numerous studies, including Marslen-Wilson & Tyler (1987), Tyler (1985) and Marslen-Wilson, Brown & Tyler (1988). For example, Marslen-Wilson et al. (1988) focused on verb argument relations, investigating whether both the syntactic and the semantic specifications of a verb function to immediately constrain the properties of its argument. They used a word-monitoring task that contained semantic and syntactic violations in sentential context. Typical violations included *the young man drank the guitar* (semantic violation) vs. *the young man slept the guitar* (syntactic violation)²⁹. Subjects had to press the response key as soon as they heard a target word, such as GUITAR. The slowest RTs were observed for the syntactic violations. Marslen-Wilson et al. interpreted this result as evidence that the lexical representation of a verb imposes immediate structural constraints on the processing of the subsequent input.

2.2.5 Summary and implications

The studies we reviewed in the preceding sections focused on the activation of the syntactic features of words during comprehension in sentential context. The research presented later in this dissertation also addresses the activation of word features that can lead to potential syntax, but it does so during the recognition of isolated words, rather than in sentential context. As we noted earlier, by isolating stimuli, we can tease out the inherent syntactic

²⁹ Although this particular example from Marslen-Wilson et al. (1988) cannot be viewed only as syntactic violation, this necessarily does not mean that all syntactic violations are semantic as well. For instance, a sentence like *the boy died the dog* can only be considered syntactic violation, since the meanings of *die* and *kill*, which would be syntactically appropriate in this case, are very close.

properties of a lexical item without the confounding variables introduced by the elements of the sentence. My research focuses specifically on the interaction of two features that could be equally considered syntactic, and are thought to influence lexical access. These are grammatical class and thematic features. I have chosen to approach the study of these interactions by investigating the lexical access of *deverbal nominals*. It is not clear whether the nominal or verbal properties of a deverbal nominal take precedence in lexical access. Nor is it clear what implications this might have for the organization of the lexicon. We saw that evidence from several experimental techniques converges to suggest that the grammatical category of a word may determine how it is stored and how it is related to other words. We also saw that the argument structure of verbs affects performance as measured by reaction times and brain waves (in ERP studies). This naturally leads us to wonder whether argument structure features or *thematic features* have a similar effect on accessing deverbal nominals, or whether the status of argument structure features is overshadowed by the nominal properties and complex morphological structure of these lexical items. The answers to these questions hold potentially important implications for our understanding of lexical access and representation of this class of lexical items, as well as for our understanding of the structure of the lexicon in general.

Before proceeding to a detailed description of our research questions and the reasoning behind them (to be presented in Chapter 4), we pursue an in depth look at various theoretical descriptions of deverbal word formations and of their thematic features.

In the previous chapter we argued that Deverbal Nominals³⁰ (DNs) might be good candidates for studying the interaction of the role of grammatical class with other lexical (semantic, syntactic and morphological) features in lexical access. In this chapter I will demonstrate why, by describing the basic thematic, syntactic and semantic properties of these formations. The fact that these nominals have complex structure is indisputable. Thus, we will not elaborate on this issue. However, we will look very closely at the process of their derivation, since this process is directly related to the fact that DN demonstrate thematic properties or *thematic features*.

The chapter is divided into three main sections. Section 1 provides a brief introduction to the complement-taking properties of nominals and outlines the different approaches (lexical vs. syntactic) towards this phenomenon. Section 2 focuses exclusively on the lexical approaches that basically talk about inheritance of thematic properties from the verbal base to the deverbal formation. Three models of word formation are reviewed, each of which assumes a different mechanism for the inheritance of thematic features (TFs) through deverbal formation. Finally, the last section presents a detailed description of Modern Greek (MG) deverbal nouns and adjectives, which will compose the experimental stimulus set.

3.1 The complement-taking properties of deverbal nominals

Chomsky (1970) established the idea that in some fundamental respects verbs and nouns seem to share complement-taking properties, as illustrated in example (1).

- (1) a. the enemy destroyed the city
 b. the enemy's destruction of the city

Examples like (2) and (3) suggest that, regarding argument realization, nouns may be governed by the same properties as verbs (e.g. CP complement, locative PP complement).

³⁰ With the term *deverbal nominals* I refer to both *deverbal nouns* and *deverbal adjectives*, following Aronoff's (1976) assumption that nouns and adjectives are considered a 'natural class' bearing the feature [+N].

- (2) a. the physicists claimed that the earth is round
b. the physicists' claim that the earth is round
- (3) a. the train arrived at the station
b. the train's arrival at the station (Grimshaw, 1990: 47)

The fact that DNs can have argument structure has been further observed by a number of researchers and is now considered indisputable (e.g. Williams, 1981; Alexiadou, 2001, etc.).

However, a lot of the discussion in the most recent literature concentrates on whether the origin of argument structure properties of nominals is situated in the lexicon (see Williams, 1981), or whether it is a syntactic one, making reference to word formation in the syntax (see Alexiadou, 2001; Borer, 1993). In other words, there are two basic approaches to nominalization, *lexical* (or *lexicalist*) and *syntactic*.

Before proceeding with a description of the most prominent views within each category, it is important to state that the categorization of these approaches is based on the fundamental distinction between *semantic participants* and *grammatical arguments*. Each verb and each noun has a lexico-semantic representation (a Lexical Conceptual Structure - LCS) that includes, among other things, the *participants* in the activities or states described by the verb/noun. Some of these participants are part of the verb/noun argument structure and are projected as *grammatical arguments*. What distinguishes lexical from syntactic approaches to nominalization is whether they focus on the level of *semantic participants* and their relationship to the noun/adjective (lexical approaches) or whether they seek to determine what triggers the realization of semantic participants as *grammatical arguments* (syntactic approaches). For the lexicalist approaches, thematic properties are part of the lexical entry of the noun (N), represented by semantic participants. For the syntactic approaches, the presence of TFs in Ns is only syntactically represented.

As the aim of the present thesis is to contribute to our understanding of how the lexicon is organized, priority will be given to the description of the lexical analyses. This is also necessary in the sense that the properties of words in single word presentation should be examined before considering them in sentential context. However, since grammatical arguments also express additional information about semantic participants, any facts regarding their realization in sentential context could be suggestive about the lexico-semantic

representation. Therefore, various syntactic phenomena related to DNs will be taken into account.

Those who opt for a lexical analysis often refer to either inheritance or percolation of the verb Argument Structure (AS) properties to the nominal. Hoekstra (1986) argues that the verb has a thematic grid, incorporating a set of semantic arguments. In nominalization, it is the suffix that transmits the AS properties of the base to the deverbal nominal. Lieber (1980) also assumes a percolation mechanism that is responsible for the transmission of the thematic grid from the verb to the noun. In a similar vein, Williams (1981) focuses on the way the morphological rule involved in the derivation of a deverbal formation affects the argument structure properties of the new item. According to his proposal, argument structure is a labeled listing of the arguments of a lexical item.

However, the subsequent observation that nouns take arguments only optionally (Anderson, 1983-1984; Higginbotham, 1983; Dowty, 1989) gave rise to interesting developments in the study of nominals. With respect to this issue, Grimshaw (1990: 45) states that many nouns are ambiguous between an interpretation in which they take arguments obligatorily and other interpretations in which they do not. Based on this observation, she further proposed a division among nouns that roughly corresponds to *result* versus *process* nominals. Result nominals describe the output of a process or an element associated with the process; process nominals, as their name implies, name the process or an event (Grimshaw, 1990: 49). For instance, example (4a) refers to a concrete entity (a result nominal) while example (4b) refers to an event.

- (4) a. The examination was long/on the table.
- b. The examination of the patient took a long time.

Grimshaw (1990: 49) further suggests that even this distinction is not enough to isolate the argument-taking nominals. Instead, she proposes that only a subclass of process nominals, the one associated with event structure, appears to take complements. She calls this type of nominals *complex event nominals*. If an event nominal has an event structure (which is further associated with aspectual and thematic analyses), then it will also have an argument structure and it will license grammatical arguments. This interesting claim was a

starting point for considering the contribution of the syntactic component of the grammar to the argument structure realization of a deverbal noun. Most of the syntactic approaches (e.g. Borer, 1993; van Hout & Roeper, 1998; Alexiadou, 2001) assume that the nominal contains a VP node which is syntactically active, or that the presence of AS is regulated by various functional projections, such as vP and AspectP, of the extended projection of VP (cf. Grimshaw, 1990).

A syntactic approach, one which assumes that AS properties are available only in a syntactic context, would exclusively focus on syntactically realized arguments and not on semantic participants in the broader sense. To pursue this issue further within an experimental paradigm would require presenting stimuli within syntactic contexts that provide the appropriate conditions for the generation of the arguments. As the goal of the present thesis is to ascertain whether these TFs form part of the mental representation of DNs by measuring how these features affect the accessing of them as single lexical items, our focus for the remainder of this chapter will be on understanding lexical approaches. In the following section I elaborate on four alternative, but closely related, theories which describe how the creation of a deverbal nominal is accompanied by the inheritance of thematic properties from the base verb and the suffix.

3.2 The lexicalist approach

In this section I present four lexicalist approaches which adopt a percolation mechanism for the inheritance of TFs to the new derivative. The basic assumption behind each theory is that immediately upon its creation, every deverbal nominal is equipped with the appropriate TFs. Williams (1981) believes that this is a product of the *morphological rule*. For Lieber (1980; 1990), Selkirk (1982), and DiSciullo & Williams (1987), various *percolation mechanisms* are responsible for transmitting from the verbal base to the deverbal nominal. Finally, Hoekstra (1986) is more concerned with the type of arguments transmitted than with the mechanisms of percolation *per se*. For each approach I will provide some basic information about the general system of word formation before focusing on how the percolation mechanisms work to derive a deverbal nominal from a verbal root.

3.2.1 The morphological rule account

3.2.1.1 Williams (1981)

Williams (1981) builds his account on the assumption that argument structure is a labeled listing of the arguments that a lexical item can have. For instance, the argument structure of *hit* can be represented as in (5).

(5) *hit*: (Actor, Theme)

The basic claim is that morphological rules can alter argument structure in two ways: either by externalizing an internal argument or by internalizing an external one. These two processes are called *argument externalization*, symbolized as E(X) and *argument internalization*, symbolized as I(X). These types of operations basically refer to how the morphological rule operates on the AS of the input (the verb in this case) to produce the AS of the output (the deverbal nominal).

Williams' account of nominalization is based on the assumption that nouns have one and only one external argument, which he labels with *R*. This label is meant to suggest 'referential', since it is this argument position that is involved in referential uses of NPs as well. *R* is distinguished from the more familiar kind of arguments by the fact that it is not the realization of a participant in the Lexical Conceptual Structure of the word - there is no sense in which *R* is a Theme, a Goal, or an Agent of a predicate.

The rule that is relevant to nominalizations is I(X), 'internalize the external argument'. This rule acts as follows:

1. Set the external argument of the input word equal to X in the output word
2. Add a new external argument, R for nouns.

More specifically, when it comes to nominalizations, Williams actually proposes that the normal case is I(0) or 'internalize zero', which can be interpreted as 'add a new external argument, R, for nouns'. In this case the external argument of the verb will become internal by an automatic conversion. Therefore, a noun like *destruction* would have the argument structure \underline{R} <Ag<Th>>. The <Ag<Th>> component would come from the base verb and the

R external argument would be the contribution of the morphological rule of nominalization. Consider the case of *shooting* in (6a) and (6b).

- (6) a. the hunters shot the lions <Ag<Th>>
- b. the shooting of the lions by the hunters <R<Ag<Th>>
- c. the shooting of the hunters

However, the alternative in (6c) is also possible by applying I(Th) or by considering that the PP *of* is a special realization of Actor in NP. According to Williams (1981), the example in (6b) can be accounted for by assuming that the Ag in English nominalizations is assigned to a *by*-phrase only if there is an active Theme; otherwise it is assigned to an *of* phrase. This is also shown in the ungrammaticality of (7). The example is ungrammatical because there is no active theme.

- (7) *the expression by the patients.

To summarize, in this section we saw that Williams is concerned with the specific rules that alter AS. He describes nominalization as introducing an external *R* argument which automatically internalizes the external argument of the base verb for the resulting deverbal nominal. In the following sections we will examine another alternative to nominalization, which suggests that the TFs of the verb are transmitted to the deverbal nominal via various percolation mechanisms.

3.2.2 The percolation accounts

3.2.2.1 Selkirk (1982)

Selkirk (1982) proposes her account of word formation based on English word structure. According to this model, word structure has the same general formal properties as syntactic structure and it is generated by the same sort of rule system. For Selkirk, the morphological component consists of three subcomponents:

1. *the word structure rules*, that are a set of context free rewriting rules. This component generates labeled trees with terminal strings consisting of dummy elements.

2. *the extended dictionary*, which contains, apart from unaffixed lexical items, affixes and other bound forms, like clitics.
3. *the (morpho) lexical insertion transformation*, which completes the structures generated by the rewriting rules by inserting items from the dictionary, subject to the (lexically specified) conditions that the particular items may impose (e.g. category of the item and subcategorization frame).

The last two components constitute the *word structure component* or *the morphological base*. According to Selkirk, the lexical entry of an affix contains all pertinent information about its properties, which include:

- a. subcategorization frame
- b. category (referring to the syntactic category which dominates the affix and its sister)
- c. semantic functions
- d. phonological representation

The subcategorization frame and the category information are particularly relevant to the study of word formation and argument structure. The *subcategorization frame* provides information on the affix's *name* (whether it is a prefix or a suffix) and on the *type* of the affix's sister category (whether it attaches to nouns, verbs etc.). For instance, the subcategorization frame for *-less* indicates that it is a suffix attaching only to nominal category items. This can be represented as [Noun, _]. The second property, or *category*, involves the categorial makeup of the affix itself (Williams, 1981); that is, whether it is +Noun or +Adjective. The category dominating *-less* is always +Adjective.

Percolation, the convention regarding the distribution of category features in a syntactic representation, plays a crucial role in systems such as the one proposed by Selkirk, where the suffixes are fully specified for features. Within this model, an affix strictly subcategorizes for a sister with a particular category name. Thus, depending on its position in the word structure (W-structure), either its features or those of its sister will be in a percolation relation to the mother node. In the light of this process, it is entirely plausible to consider that the W-structures generated by the affixation rules contain no category names, but that they acquire them through lexical insertion and percolation.

Selkirk (1982) demonstrates how such a mechanism works in DWF through a set of examples that permit us to isolate the roles of the verb, the head and the nonhead. By providing examples of deverbal compounds, Selkirk (1982: 33) argues that the derivatives of a verb inherit any specifications related to the AS of the verb. For instance, the derivation of the deverbal noun *eater* involves the following steps: The suffix *-er* has the categorial makeup for +Noun and the subcategorization frame [V_]. In other words, it can attach to verbs and it creates nouns. The verb *to eat* is associated with an agent and a theme argument. These specifications are inherited by its derivatives, such as *eating*, *eater*. Therefore, the new derivative *eater* is a well-formed noun that takes an agent and a theme argument, as shown in example (7), where *Bob* is the agent and *pasta* is the theme argument.

(7) *Bob is an eater of pasta.*

However, while some deverbal forms, like those in *-ing*, fully inherit the thematic properties of the base verb, some others (like *-able*) do not. Let us consider the derivation of *trainable* as an illustration of this. This deverbal adjective is based on the verb *train* (Ag, Th) and the affix *-able*. Example (8) shows that inheritance of the verb argument structure is not enough to account for the argument structure of the derived word.

- (8) a. *The teachers train the children*
b. *The children are trainable (by the teachers)* (Selkirk, 1982: 41)

The verb *train* is predicated of an agent and a theme argument. The Agent occupies the subject position and the Theme the object position. However, in *trainable*, the Theme is in the subject position and the Agent in the optional *by*-phrase. Thus there is a mismatch with respect to the syntactic realization, if we consider argument structure inheritance as such. Hence, the only interpretation that can be given to the new derived word is ultimately based on the lexical rules related to the affix and its lexical representation. Consequently, we have to assume that the affix *-able* also comes with the information that the object of the base verb surfaces as subject of the deverbal word and that the subject of the base verb surfaces as *by*-object or \emptyset . This is illustrated in a 'training' event in (9) and (10). There is an event *e* and the

event is a training and x is the Agent of the event and y is the Theme of the event. The suffix *-able* introduces a variable r , such that it externalizes the internal argument as in (10).

(9) $\exists e(\text{TRAIN}(e)\&\text{AGENT}(x,e)\&\text{THEME}(y,e)$

(10) $[\text{train}(e, \underline{x}, y,)] r > [\text{trainable}(e, \underline{y}, (x))]$

Although this is suggestive of the crucial role of the head in a percolation model of derivation, Selkirk's system also accepts interference from the features of the nonhead in feature percolation (1982:20). This is known as the 'Revised Percolation Principle'. According to this, the features of the new word are inherited from the features of the head constituent. In the case where the new word is underspecified for certain features, then these are inherited from the non-head constituent. Thus in the derivation of *helpless*, percolation of the grammatical category is from *-less*, while percolation of the semantic features is from *help*.

Selkirk (1982: 76) defines the percolation convention as follows:

- a. If a head has a feature specification $[aFi]$, a $\neq u$, its mother node must be specified $[aFi]$, and vice versa.
- b. If a nonhead has a feature specification $[bFj]$, and the head has the feature specification $[uFj]$, then the mother node must have the feature specification $[bFj]$.

With this convention, Selkirk (1982) gives priority to the role of head in transmitting features to the new word. However, her account also requires that other specifications from the nonhead contribute to the final specifications of the new derivative.

3.2.2.2 DiSciullo and Williams (1987)

The work by Selkirk (1982) has heavily influenced the system of word formation adopted by DiSciullo & Williams (1987). Both approaches consider word formation rules to be phrase structure rules, with words having heads analogous to the heads of syntactic phrases. The properties of the head are those of the whole; in other words, there is complete agreement of features between the head and the whole.

Based on Selkirk's observation that features can also percolate from the non-head constituent and the Revised Percolation Principle, DiSciullo & Williams (1987: 26-28) modify the notion of the head by introducing the term *Relativized Head*. They accept that the head is responsible for attributing features of lexical category, but acknowledge that sometimes the same constituent may behave as a non-head with respect to other features (usually morphosyntactic, semantic etc.). In such cases, a non-head (with respect to the lexical category) takes over the role of head (with respect to another feature). This is called the *Relativized Head Percolation Principle*. The notion *Relativized Head* implies that a constituent can be a head with respect to one particular feature, but a non-head with respect to another.

If the rightmost constituent has the feature [+F] and [uG] (where [uG] means 'not marked for feature G'), and its lefthand sister constituent has the feature [+G], the righthand constituent is the relativized head with respect to the feature [F], whereas the lefthand constituent is the relativized head with respect to the feature [G]. As a consequence the Feature Percolation Conventions percolate up the feature [+F] from the righthand constituent and [+G] from the lefthand one. This is illustrated in Figure 1a.

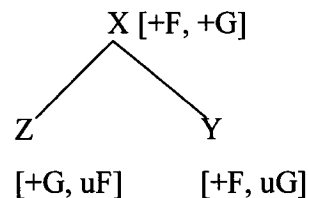


Figure 1a: *Relativized head Percolation Principle*

Figure 1b illustrates how the *Relativized Head Percolation Principle* applies in the derivation of a deverbal nominal such as *correction*. The rightmost constituent (the suffix) is specified for the feature [+N] although it lacks the features [Telic] and [Accomplishment]. Its lefthand sister constituent has the features [+V], [+Telic], [+Accomplishment]. As the rightmost constituent is the relativized head with respect to the feature [+N], the derived word belongs to the grammatical class of nouns. The lefthand constituent is the relativized head for the features [+Telic] and [+Accomplishment]. Thus the Feature Percolation Conventions percolate up the features [+Telic] and [+Accomplishment] from the righthand constituent.

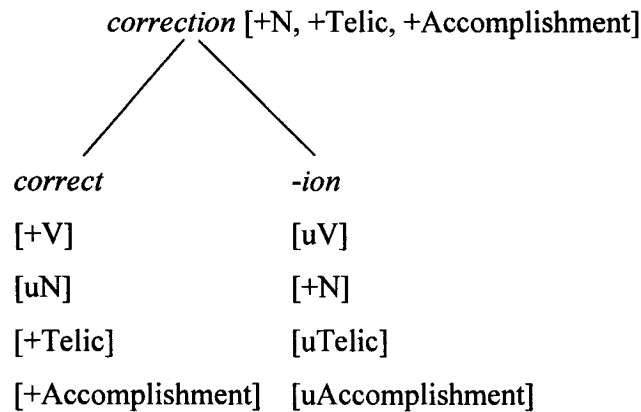


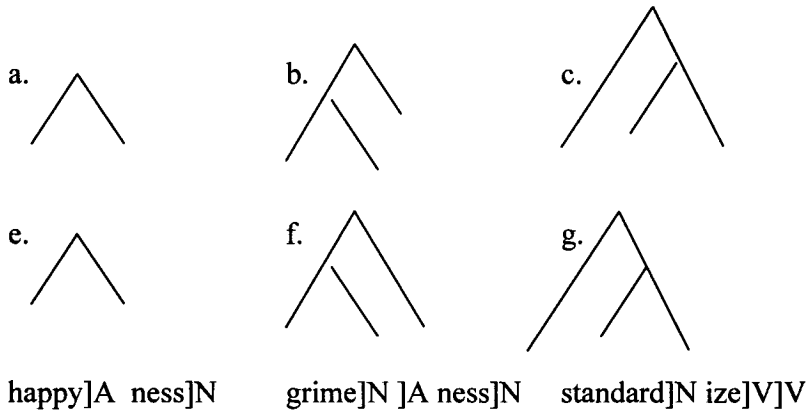
Figure 1b: *Example of Relativized Head Percolation Principle*

3.2.2.3 Lieber (1980/1990)

Lieber also incorporates percolation into her model of word formation. According to Lieber, the lexicon consists of three components. The first component, the *permanent lexicon*, contains lexical entries of all unanalyzable morphemes. Each entry, in turn, contains idiosyncratic information about morphemes, including their category, subcategorization features, diacritic specification, semantic representation, syntactic argument structures, etc. The second component, the *lexical structure*, consists of a rule generating binary unlabeled trees into which morphemes from the permanent lexicon are inserted subject to their subcategorization restrictions. Finally, the third component contains *rules of word formation* which must refer to properties of the segmental string on which they operate. Among these rules are reduplication, infixing, vowel ablaut and umlaut processes.

Of particular interest for the present thesis is Lieber's claim that lexical trees generated by the lexical structure are labeled according to a small number of highly constrained Feature Percolation Conventions. This functions as follows: In Lieber's component of lexical structure, a single context-free rewrite rule can generate unlabeled binary branching tree structures like those illustrated in (11a-d) (Lieber 1980: 85-93). In such a morphological binary construction X, which is constituted from Y and Z, the grammatical category and the rest of the morphosyntactic features of X come from the particular features of Y and Z. If Y and Z are the terminal nodes of a tree structure, then they receive their features from the lemmas of the lexicon that are inserted into these nodes (examples 11e-g).

(11)



It is at this point that the Feature Percolation Conventions apply (Lieber, 1990: 83).

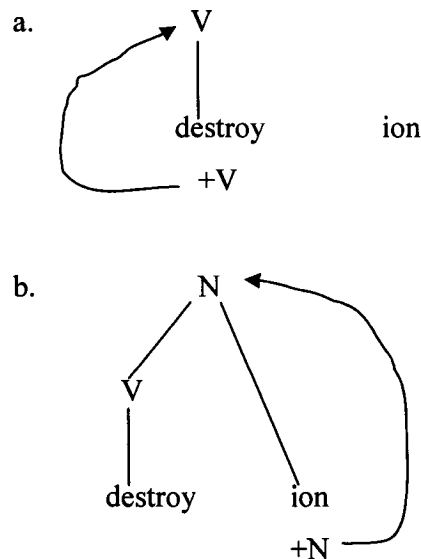
There are two feature percolation conventions pertinent to our examples.

Convention I: all features of a stem morpheme, including category features, percolate to the first non-branching node dominating that morpheme.

Convention II: all features of an affix morpheme, including category features, percolate to the first branching node dominating that morpheme.

Applying the above conventions to the deverbal noun *destruction* results in the structures shown in (12a) and (12b).

(12)



The structures in (12a) and (12b) can be interpreted as follows: The V *destroy* passes its lexical category feature (V) onto the first non-branching node. In (12b), we label the branching node N, after the category membership of the morpheme *-ion*. Lieber's percolation conventions clearly state that 'all features' of both the stem and the affix percolate to the nodes that they label. However, when the new word is derived from a stem and an affix, it is the features of the affix that have priority. If the features of the affix are insufficient to provide a full description of the new word, then some features of the stem must percolate to the new word. For instance, in the creation of the word *helpless*, the suffix *-less* is responsible for the grammatical category and the morphosyntactic features of the new word, while the stem *help* contributes its semantic features.

Lieber's account of feature percolation is very similar to Selkirk's in that they both give priority to the role of the head without ignoring the contribution of the nonhead. However, neither Lieber nor Selkirk talk specifically and in detail about features of argument structure that both the stem and suffix carry. Nor do they show how these two components interact with each other with respect to their subcategorization features. Although both Lieber and Selkirk clearly view the verbal stem as a determining contributor to the inherited argument structure of a derived word such as *destruction*, their conventions do not predict how this might happen. Hoekstra (1986), whose account is discussed below, deals with this issue. As Hoekstra (1986) relies on previous descriptions of percolation we will briefly summarize them before proceeding with an examination of his proposal regarding the inheritance of argument structure.

3.2.2.4 Interim summary of percolation accounts

All of the above-presented models have striking similarities when it comes to how percolation works. In every model, the head is the main source of features. However, when its features are inadequate to fully characterize the new word formation, then the nonhead constituent can intervene and provide the new word with its own features. This operation has received various names, such as *relativized-head percolation principle*, or *revised percolation principle*. Both names refer to the increased role of the non-head constituent in transmitting features to the new word. Hoekstra (1986) assumes these same percolation

mechanisms, but with the crucial addition of restrictions and modifications on argument structure inheritance that clearly show the contribution of both the stem and the affix.

3.2.3 Hoekstra (1986)

Rather than describing the percolation mechanism itself, Hoekstra's (1986) *complement inheritance* account defines the properties of the features that are percolated. The *complement inheritance* takes elements from two opposing views. The first one, the *categorial view*, supports the idea that subcategorization requirements are inherited. However, in the light of the great number of discrepancies between verb and noun complements in a number of construction types, it is obvious that the *categorial view* makes wrong predictions. For example, although the sentence in (13a) is perfectly grammatical, its nominal counterpart in (13b) is not.

- (13) a. *I turned down the proposal*
b. **the turning down of the proposal*

In an attempt to account for all cases of percolation, Hoekstra (1986) proposes the *thematic view*. According to this view, it is not the subcategorization requirements that are inherited, but only the thematic grid of the verb. This process is further followed by the important restriction that 'each complement to a noun indicates its thematic status with respect to the noun'. This restriction reflects a basic difference between Ns and Vs with respect to case marking.

While a V can case mark an NP that does not bear a thematic relation to it, as in example (14a), the ungrammaticality of (14b) shows that its nominalization is not possible. Hoekstra (1986) argues that this is because the NP *John* does not bear any thematic relation to the noun.

- (14) a. *We believe John to have done it.*
b. **The believing of John to have done it*

Yet, the most significant contribution of Hoekstra's account is the generalization stated in (15).

- (15) In nominal constructions the formal realization of arguments is determined by their thematic role with respect to the head (not the case).

The generalization in (15) is based on the distinction between *structural complements* and *semantic participants*. Only semantic participants of the V and not just case marked NPs can be inherited by the nominal. In other words, the realization of arguments reflects the participant status or thematic role. We can see this applied to the original example (14), repeated here as (16). In (16) *John* is marked by the V, but has no thematic relation with respect to V. Thus the nominalization is not possible.

- (16) a. *We believe **John** to have done it.*
b. **the believing of J. to have done it.*

The above hypothesis explains the lack of nominalizations in a number of constructions, such as raising construction, small clauses, themes of goal, double object constructions, predicate complement constructions, particle constructions etc. Some examples of predicate complement constructions are given in (17) and examples from particle constructions in (18).

- (17) a. *We found him guilty > *the finding of him guilty*
b. *They proved the theorem wrong > *the proving of the theorem wrong*

- (18) a. *John looked the info up > *the looking of the info up*
b. *They turned the lights on > *the turning of the lights on.*

In an important sense, Hoekstra's (1986) account adds a qualitative dimension to feature percolation. In his account, the new derivative must inherit a real argument (in the sense of semantic participant as described earlier) and not just a syntactic complement. If an item is only case assigned but not an argument of the verb, it cannot appear in

nominalizations. For this reason he explicitly talks about *inheritance* of thematic grids. Thus, a number of discrepancies between verbal and nominal constructions can be explained by Hoekstra's claim that only arguments of the head of the construction that are marked for the specific thematic role they bear can appear in nominal constructions. Otherwise, Hoekstra adopts Lieber's percolation mechanism to account for the process of percolation.

The word formation models reviewed above show that, one way or another, the thematic properties of a deverbal formation result from some percolation mechanism that manipulates both the features of the head as well as the nonhead. However, these models leave a number of details to be worked out. In the following section, I present the descriptive rules of Baker & Bobaljik (2002) that clearly show how the thematic properties of the verb percolate to the derived word.

3.3 Baker and Bobaljik (2002)

In the previous sections we saw that there are sound theoretical arguments for assuming that verbal TFs are passed on to nominals derived from them. In this section, I will use Baker and Bobaljik's (henceforth B&B 2002) representational tools of Node Labelling Convention (NLC), Argument Binding, and Substitution Linking to demonstrate explicitly how this percolation takes place both for deverbal nouns and deverbal adjectives.

Before proceeding with a description of specific deverbal derivations, it is important to state some basic assumptions. As many others before them, B&B (2002) recognize that nouns and adjectives have argument structure and that the majority of them have external and internal arguments associated with verbs. This is illustrated in (19) and (20).

- (19) a. They consider me [(to be) a fool].
b. They consider this [(to be) good luck].
c. They made me president.
- (20) a. They made the metal flat.
b. They consider Chris smart.
c. That makes me hungry.

In both (19) and (20) the underlined words serve as the external argument of the nouns and adjectives respectively. However, as B&B (2002: AS11-12) point out, this is certainly not the case for every adjective and possibly not for every noun. For instance, the cases in (21) clearly demonstrate that *it* might be in the external argument position, but as in these uses it neither refers to anything nor replaces a more meaningful NP, it is just a place-holder and not a real argument. The fact that some nouns and adjectives can take external arguments while others cannot confirms that this is a lexical property worthy of putting in the lexical entry in the form of an argument structure (B&B, 2002: AS-12).

- (21) a. This makes it unlikely that Chris will win.
b. They consider it mild today.
c. They consider it a cinch that Chris will win.

Although some nouns and adjectives have external arguments, these external arguments are not of the same type. For instance, the external argument of adjectives is commonly assumed to be a Theme. This is mainly because the external argument of adjectives often corresponds semantically to the Theme argument of related verbs, as shown in (22).

- (22) a. The wind cleared the sky.
b. The sky cleared.
c. The sky is clear.

For the external argument of nouns, Williams (1981), and later Higginbotham (1985), DiSciullo & Williams (1987), Grimshaw (1990), posit the existence of a non-thematic argument *R* which is distinguished from the more familiar kind of argument by the fact that it does not appear as either a complement to the head or as the realization of a participant in the LCS of the word. There is no sense in which *R* is a Theme, a Goal, or an Agent of a predicate.

Although there is some confluence with respect to the external arguments of nouns and adjectives, the situation is not that clear for internal arguments. First of all, not all nouns

or adjectives have internal arguments. In some instance, another phrase can appear inside the NP or the AP along with a noun or an adjective, as shown in (23) and (24).

- (23) a. picture of Ottawa <R<Th>>
b. president of the association <R<Th>>
- (24) a. proud of my daughter
b. fond of his pets

Nouns like *picture* and *president* in (23) and adjectives like *proud* and *fond* in (24) appear to be transitive, something which differentiates them from nouns like *dog* and adjectives like *good*. Although the internal arguments of these nouns and adjectives are not obligatory, in the strict sense a transitive verb takes an object, they still indicate that nouns and adjectives also have argument structures. We could further say that the internal argument of ‘transitive nouns’ has a theme role, as it is the case in (23), but this is not the same for the internal argument of adjectives. Therefore, B&B (2002) label the potential internal argument of nouns and adjectives with X.

As for the argument structure of suffixes, of the approaches reviewed in the previous sections, only Williams (1981) tends to propose that suffixes are devoid of AS. Instead, he claims that it is the rule that changes the AS of the base word and not the combination of the root and the suffix. However, Selkirk (1982), Lieber, (1980/1990), DiSciullo & Williams (1987), Hoekstra (1986) assume that suffixes have their own AS or subcategorization frame. B&B (2002: AS-15) follow this line of reasoning and claim that “the argument structure of an affix must be inferred from the change that it effects in the properties of the derived word that contains it, as compared to the properties of the simple word”. For instance, the fact that a derived noun ends up with *R* as its external argument is explained by Williams (1981) as a consequence of the rule I(0). In contrast, B&B assume that *R* must come from the suffix³¹. This exemplifies their view of the argument structure of the derived word as a combination of the AS properties of the base verb and the suffix.

³¹ Although these two alternatives, suffixes with AS and suffixes without, do not give clear predictions with respect to how they would influence lexical access, in accordance with Williams (1981) the verbal root is strictly the only source of AS for the deverbal nominal, while for the others (Lieber, 1980; Selkirk, 1982; Baker & Bobaljik, 2002), the suffix has an equal contribution. This might turn out to be an important variable.

This combination and exchange of thematic properties between the base and the suffix takes place via several thematic operations, depending on the suffix. However, there are two operations which are common to every kind of derivation. The first one is called the *Node Labelling Convention* (NLC) (B&B, 2002: AS-15). According to this convention, the properties of an affix take precedence over the properties of a root in determining the properties of a derived word. However, the *Percolation Convention* postulates that in the special case when the affix is not specified for any particular features, the derived word can get its features values from the root instead (B&B, 2002: AS-17). In other words, although precedence is given to the head, when this cannot adequately describe the derived word, the nonhead contributes. This is common to Selkirk's, Lieber's and DiSciullo & Williams's models. However, as we have already seen, B&B claim that the *Percolation Convention* applies only when the suffix does not have an AS of its own. Some examples are cases like *re-*, as in *send* > *resend*, and *non-* as in *entity* > *nonentity*. In all other cases, as we will see in the following sections, the *Percolation Convention* is inactive. However there is more to the AS of a deverbal nominal than simple identity with one of its lexical elements. The following sections, based on B&B, examine a number of additional operations and constraints that are necessary steps in determining the features of deverbal adjectives (section 3.1) and deverbal nouns (section 3.2).

3.3.1 Deverbal Adjectives (DVAdjs)

As was noted earlier, two types of existing lexical elements are recruited in the formation of DNs. These are a verbal base and a suffix. For the derivation to succeed, the verb and the suffix should match with respect to a number of grammatical properties that are eventually inherited by the derived word, which then emerges with its own feature specifications.

For example, the formation of a DVAdj of the type of *readable* involves a verbal base and a suffix which are matched with respect to a set of general grammatical properties as follows. The base of *readable* has certain properties; for example, it is a transitive verb, it involves two participants ('a reader' and 'the object being read') and it can be equated with the encyclopaedic information regarding the type of event that one may refer to when using the word 'TO READ'. Similarly, the suffix *-able* has its own properties; for instance, it attaches to verbs involving at least two participants, it creates adjectives, and it semantically

introduces a ‘possibility operator’. Hence, in order to form a legitimate word, the grammatical properties of the base must be able to satisfy the requirements of the suffix.

In addition, B&B consider that both the base and the suffix carry *thematic* properties that they contribute to the derived word. For instance, *read* is predicated of the Agent and the Theme argument, with the Agent as the external and the Theme as the internal argument (<Ag<Th>>). The suffix *-able* has an argument structure consisting of an external Theme argument together with the X internal argument, which can be represented as <Th<X>>. However, when it comes to deverbal word formations, the dummy internal argument X gets replaced by an Event argument <Ev>, to account for the fact that the verbal root describes an event.

As illustrated in (25a) and (25b), the internal argument of the verb (*the book*) in (25a) becomes external in (25b) when *-able* combines with the verb to derive the adjective *readable*. In other words, the suffix *-able* creates an adjective with a Theme external argument and an Agent internal argument whose realization is optional.

- (25) a. Tom read the book.
b. The book is readable (by Tom).

The Theme argument is also understood as being identical to the Theme of the verb root. This is the result of an operation which Baker and Bobaljik (2002) call *argument binding*. The term *argument binding* is used when a designated argument of the head may *bind* a designated argument of the nonhead as required by the lexical entry. When this happens, no distinct phrase will express the bound argument, and it will be understood that both argument roles are filled by a single element (Baker & Bobaljik, 2002: AS-39). We can represent this by putting the same subscript on the binding argument and the bound argument, as in Figure 1. Thus, when it comes to the formation of *readable*, the argument structures of *read* and *-able* would be <Ag<Th_i>> and <Th_i<Ev>>, respectively. The notation indicates that the two arguments must be interpreted as sharing an identity. However, in order to arrive at the AS of *readable*, *substitution linking* must take place. The term *substitution linking* is used to express the fact that the argument structure of the non-head of a word can replace one argument of the head (Baker & Bobaljik, 2002: AS-31). In the case of *readable*, after

argument binding takes place, the rest of the argument structure of the verb (the Agent argument) is substituted into the argument structure of *-able* and is passed on to the derived word, via the Node Labelling Convention. In other words, the Event argument gets replaced by the argument structure of the verb as shown in Figure 2. The result is a two-argument adjective, with a Theme external argument and an Agent internal argument that is inherited from the verbal root. This implies that both the AS of the verb and the suffix are involved in *-able* suffixation and that their combination is possible via the operations of argument binding and substitution linking.

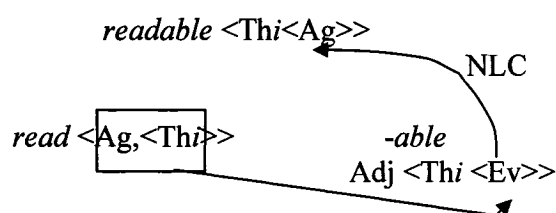


Figure 2: *-able* derivation

The same thematic properties associated with derived words can vary. For example, (26a) and (26b) illustrate that the DVAdj *prohibit-ive* has the same external argument (*the law*) as the verb *prohibit*. The argument structure of the verb *prohibit* is <Ag<Th>>, while the argument structure of the suffix *-ive* is <Thi<Ev>>. The Agent argument of the verb and the Theme argument of the suffix are co-indexed because they are understood as being the same. Thus, only *external* argument binding is involved in *-ive* suffixation. Furthermore, it is the lack of substitution linking that prevents this DVAdj from inheriting the argument structure of the verb root. The derivation of *prohibitive* is illustrated in Figure 3.

- (26) a. The law prohibits the use of drugs.
 b. The law is prohibitive.

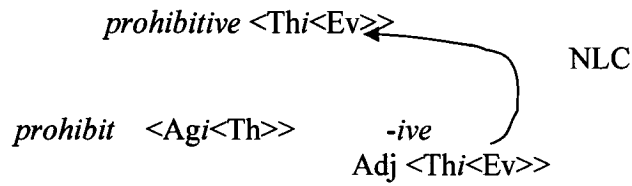


Figure 3: *-ive* suffixation

The above theoretical descriptions provide detailed information about the properties of DVAdjs. All this information is presumably listed in the lexical entry of a DVAdj. However, we do not know whether it is exhaustively used in order to retrieve the particular item from the lexicon. Nor do we know how each property influences lexical access. Before we address these questions, let us examine Deverbal Nouns, which demonstrate similar properties to DVAdjs.

3.3.2 Deverbal Nouns (DVNs)

As with the deverbal adjectives, the formation of DVNs also requires a verbal base and a suffix. These two elements contribute their properties, grammatical and thematic, to the derived word. For instance, the formation of the word *teacher* (as illustrated in Figure 4) involves a number of operations which are responsible for its TFs.

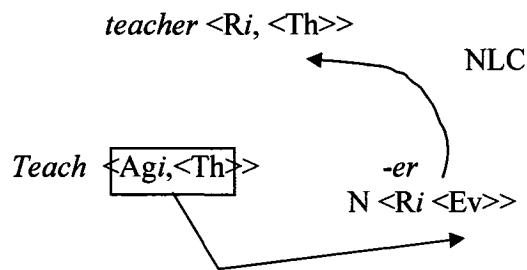


Figure 4: *-er* suffixation

As can be seen in the above figure, the suffix *-er* has the argument structure <R<Ev>> (a typical noun argument structure), which permits substitution linking. However, *-er* also has the specification that its external argument binds the external argument of the root. As with the identity that comes from *argument binding*, we can represent this by putting

the same subscript (*i*) on both the binding argument and the bound argument. This notation indicates that the two arguments must be interpreted as having a shared identity.

This new binding relationship is also like *argument linking* in that it ‘uses up’ the agent argument of the verb root. Since the agent argument of the verb is now tied to the R argument of *-er*, it cannot be expressed as a distinct phrase in the syntax; therefore, it does not belong in the argument structure of the derived word. The rest of the argument structure of *teach*, however, is substituted into the argument structure of *-er*, and is passed on to the word by the Node Labelling Convention. The result is a two-argument noun, with an R external argument and a Theme argument that is inherited from the verbal root. Furthermore, the R argument of the noun is understood as the Agent argument of the verb.

The preceding examples of the derivation of both DVAdjs and DVNs illustrate that the thematic properties of the base verb and suffix trigger the various thematic operations (such as argument binding, substitution linking etc.) which take place during derivation. These thematic operations, which combine properties from the verb and the suffix, are responsible for the presence of specific TFs in newly formed deverbal word formations.

These TFs are presumably catalogued in the mental lexicon alongside the other features that the newly derived word has inherited through the process of derivation. The question which arises now is whether these features, being inherited and not inherent, are processed during lexical access of DNs. This adds a new dimension to our previous questions regarding the processing of syntactic/semantic features and their interaction with complex morphological structure and grammatical category. The following section provides a description of DNs in MG, which will form the stimulus set of these questions.

3.4 Modern Greek Deverbal Nominals

Modern Greek (MG), the language under investigation, demonstrates a rich derivational system and a variety of derived nominals that allow us properly to address our questions. In addition to examining the application of percolation to MG nominalizations, this section provides other pertinent information about MG nominals. The section begins with a presentation on deverbal adjectives, since the first experiment to be reported in Chapter 6 uses adjectival stimuli.

3.4.1 Deverbal Adjectives

There are four categories of deverbal adjectives in Modern Greek. These are formed with the suffixes *-simos*, *-menos*, *-tos*, and *-tikos*. In the following subsections I will provide detailed information about each of them in turn.

3.4.1.1 The suffix *-simos*

The suffix *-simos* attaches to perfective verbal stems and creates adjectives with the meaning of their referent being ‘appropriate to, able to, deserves to undergo the process described by the base verb’, such as *fago-simos* ‘edible’, *eisprak-simos* ‘money receivable’. In terms of TFs, its derivation includes *internal argument binding* and *substitution linking*. For example, the formation of a DVAdj with the suffix *-simos* of the type of *epekserga-simos* ‘processable’ involves a verbal base and a suffix that are matched with respect to a set of general grammatical properties as follows. The base of *epeksergasimos* ‘processable/treatable’ is a transitive verb involving two participants with the meaning ‘TO PROCESS’. In terms of TFs, the verb *epeksergazomai* ‘to process/to treat’ is predicated of the Agent and the Theme argument, with the Agent being the external and the Theme the internal argument (<Ag<Th>>). Similarly, the suffix *-simos* (*-able*) has its own properties; it attaches to verbs involving two participants, it creates adjectives, it means ‘ABLE TO BE Ved’. Its argument structure consists of an external Theme argument and an Event internal argument, that can be represented as <Th<Ev>>. As illustrated in (27a) and (27b), the internal argument of the verb (*vamvaki* ‘cotton’) in (29a) becomes external in (27b) when the addition of *-simos* combines with the verb to derive the adjective *epeksergasimos* ‘processable/treatable’. In other words, the suffix *-simos* creates an adjective with a Theme external argument and an optional Agent internal argument.

- (27) a. *I viotexnia epeksergazetai vamvaki*
the factory processes/treats cotton
- b. *To vamvaki einai epeksergasimo (apo ti viotexnia)*
the cotton is processable/treatable (by the factory)

The Theme argument is also understood as being the same as the Theme of the verbal root. This is done via *argument binding*. We can represent this by putting the same subscript on the binding argument and the bound argument, as in Figure 4. Thus, when it comes to the formation of *epekserga-simos* ‘processable/treatable’, the argument structures of *epeksergazomai* ‘process/treat’ and *-simos* ‘-able’ would be <Ag<Thi>> and <Thi<Ev>>, respectively. The notation indicates that the two arguments must be interpreted as sharing an identity. The rest of the argument structure of the verb (the Agent argument) is substituted into the argument structure of *-simos* and is passed on to the derived word through NLC. In other words, the Event argument gets replaced by the argument structure of the verb via *substitution linking*, as shown in Figure 5. The result is a two-argument adjective, with a Theme external argument and an Agent internal argument that is inherited from the verb root. This implies that both argument binding and substitution linking are involved in the *-simos* suffixation.

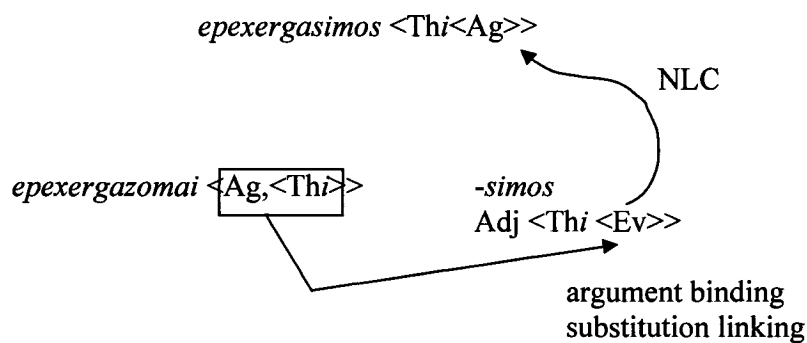


Figure 5: *derivation of DVAdj-simos*

3.4.1.2 The suffix *-menos*

Deverbal adjectives with the suffix *-menos* are formed on the passive base of the past tense and could be seen as the equivalent of the English past participles. An adjective with the suffix *-menos* denotes that the modified noun was the recipient of the activity described by the base verb. Its derivation, in terms of percolation of TFs, is identical to the derivation of those adjectives with *-simos*. In other words, it involves internal argument binding and substitution linking.

Both DVAjds with *-simos* and *-menos* implicate the involvement of an agent participant. In addition, they are very similar in terms of meaning. However, since *-menos* refers to an action which has already taken place, and, therefore, the presence of an agent is a given, as opposed to those DVAdjs with *-simos* where the agent can only be seen as 'potential', as the whole action seems to have a future referent. For instance, a word like *eklegmenos* 'elected' refers to an entity that has been already elected by somebody. There is definitely an agent involved in the action. In contrast, a word like *ekleksimos* 'eligible' refers to somebody who has the potential to be elected, but he/she is not yet elected. Thus, the involvement of an agent (the person or persons to elect) has not yet taken place.

3.4.1.3 The suffix *-tos*

According to the Modern Greek Dictionary (1999), the DVAjds with the suffix *-tos* indicate that the modified noun:

- a. can be subject to the activity described by the base verb, e.g. *spazo* > *spastos* 'break > breakable' or
- b. deserves to receive the activity described by the verb, e.g. *agapo* > *agapitos* 'love > lovable'.

The same suffix also assigns to the modified noun a permanent and stable characteristic, such as *plektos* 'knit', *skistos* 'split', *sfragistos* 'sealed'.

In terms of TFs, the main difference between the derivation of a DVAdj with *-tos* and those with *-menos* and *-simos* is that in the *-tos* derivation no substitution linking takes place. In other words, the new derivative does not inherit the thematic properties of the base verb to the fullest. The most important consequence of this is that *-tos* lacks the agent argument. Markantonatou et al. (1996) observe that while the DVAdjs-*menos* denote the result of the activity described by the base verb, the DVAdjs-*tos* denote the state that corresponds to the result by-passing some aspects of the verb meaning. In this sense, DVAdjs-*menos* carry more verbal features, since they receive complements that denote the agent as well as complements that denote the instrument. Both these types of complements are related to verbal complements, such as the logical subject and the instrument modifier, as well as to the presence of a semantic argument which shows volitionality (e.g. agent). In contrast, DVAdjs-

tos do not allow these types of complements, thus demonstrating a less verbal nature. This is demonstrated in the examples below.

- (28) a. *Vrika tin porta anoig-meni me losto*
 I found the door openedMenos/Fem with crowbar
- b. **Vrika tin porta anoix-ti me losto*
 I found the door openedTos/Fem with crowbar

The verbal nature of the *-menos* adjectives is reinforced by phenomena of incorporation, which means that these adjectives form compounds with adverbs of manner, in the same way as verbs do, while *-tos* adjectives do not. This happens even when the *-menos* adjectives appear in the typical adjective position immediately following verbs such as *fainomai* ‘seem’, *deixno* ‘show/seem’ etc.

- (29) a. *Afta ta papoutsia fainondai proheirorammena*
 These the shoes seem roughly- sewnMenos/Neut/Pl
- b. **Afta ta papoutsia fainondai proheirorapta*
 These the shoes seem roughly-sewnTos/Neut/Pl

A further difference between these suffixes is demonstrated in (30), where the ‘I am *-menos*’ formations have the structure of copula + attribute, unlike those with *-tos*.

- (30) a. *To kotopoulo itan pio psimeno/*psito apo to arni*
 The chicken was more roastedMenos/*Tos than the lamb
- b. *To kotopoulo mou fainetai psimeno/*psito*
 The chicked meGEN seems roastedMENOS/*TOS
 ‘the chicken seems roasted to me’

In the previous paragraph, B&B's tools have been used to illustrate how the thematic properties of the base verb and suffix trigger the various thematic operations (for example, argument binding, substitution linking) which take place during the derivation of MG deverbal adjectives. These thematic operations, which combine properties from the verb and the suffix, are responsible for the presence of specific TFs in newly formed DVAdjs. These TFs are presumably catalogued in the mental lexicon alongside the other features that the newly derived word has inherited through the process of derivation. In the following section I will demonstrate how the same operations apply in the derivation of MG deverbal nouns, with an emphasis on the differences and similarities among these nominals.

3.4.2 Modern Greek Deverbal Nouns

Modern Greek (MG) contains a variety of deverbal nouns which are formed with different types of suffixes. From a semantic point of view they can be divided into three categories: those denoting the person who acts, those indicating the instrument or means by which the action is completed and finally, and those describing the action and its results.

The first category, deverbal nouns which denote the person who acts, can be formed with a variety of suffixes. These include nouns which are formed with the suffix *-tis* or *-istis* (depending on the stem), which is the semantic equivalent of *-er* in English, e.g. *tragoudo* 'sing' > *tragoudistis* 'singer'. Less common in this category is *-(a)toras*, e.g. *eisprato* 'collect' > *eispraktoras* 'ticket collector'.

The second category, which denotes the instrument or means with which the action is carried out or the premises in which it is carried out, are formed with the suffixes *-tiras*, *-tiri*, *-tirio*, such as *vrazo* 'boil' > *vrastiras* 'kettle', *skalizo* 'dig' > *skalistiri* 'hoe', *ekpaidevo* 'educate' > *ekpaideftirio* 'educational institute'.

The third category, which denotes action and its result, is by far the most complicated. This category contains a variety of nominals, comprising DVNs with the suffixes *-mos* (*lytrono* 'deliver' > *lytromos* 'deliverance'), *-si* (*vrazo* 'boil' > *vراسi* 'boiling'), *-simo* (*trexo* 'run' > *treksimo* 'running'), *-ma* (*kladevo* 'prune' > *kladema* 'pruning'), *-idi* (*kendo* 'embroider' > *kendidi* 'embroidery'), *-ito* (*paramilo* 'mutter' > *paramilito* 'muttering'), *-oura* (*kleino* 'close' > *kleisoura* 'fug'), *-a* (*anasaino* 'to breath' > *anasa*

'breath'), *-i/-io/-os* (*gelo* 'to laugh' > *gelio* 'laugh'), *-ia* (*milo* 'speak' > *milia* 'speech'), *-eia* (*latrevo* 'to worship' > *latreia* 'worship').

3.4.2.1 Selection criteria

Ideally, a thorough study of DNs should include samples from all the above categories. However, a psycholinguistic study has to respect certain technical specifications in order to isolate confounding factors that can condition the final result. One of these factors is suffix frequency and productivity. Suffixes such as *-idi*, *-oura*, *-ito* are not productive in MG. According to the Reverse Index of Modern Greek Vocabulary (Anastasiadis-Symeonidis, 1999), there are only 16 DVNs with the suffix *-idi*. While the number of attested tokens for the suffixes *-oura* and *-ito* is slightly larger, 19 and 42 respectively, the majority of these are either low frequency items or terms found only in the literature. As the low frequency and productivity of such items could potentially confound the results of an on-line task, they have been excluded from the stimulus sets of the studies reported here.

Another potentially confounding factor is polysemy associated with the suffix. Most of the above suffixes denoting activity are not exclusively used for the creation of deverbal nouns. Nor do they exclusively denote activity. This is the case for the suffixes *-ia*, *-eia*, *-a*, *-io*, *-i*. For instance, according to Efthymiou (1999), the suffix *-ia* denotes either an action that takes place once or the result of an action e.g. *dagono* 'bite' > *dagomatia* 'biting', *tsimbo* 'to pinch' > *tsimbia* 'a pinch' etc. However, the same suffix primarily creates denominal nouns, denoting either the tree name (*kerasi* 'cherry' > *kerasia* 'cherry tree'), or the activity performed with the instrument described by the root, e.g. *pinelo* 'paint-brush' > *pinelia* 'brushwork', *veloni* 'needle' > *velonia* 'stitch'. The suffix also describes country names, e.g. *Germanos* 'German' > *Germania* 'Germany', as well as the name for feminine inhabitants' names, such as *Thessaloniki* > *Thessalonikia*. It also creates deadjectival nouns to describe the state of the adjective of the base, as in cases such as *anthropos* 'human' > *anthropia* 'humaness', *aglossos* 'speechless' > *aglossia* 'speechlessness'.

The suffix *-eia* is equally polysemous. It creates deverbal nouns denoting the activity or the result of the activity described by the base verb, such as *kalliergo* 'cultivate' > *kalliergeia* 'cultivation', *kolakevo* 'flatter' > *kolakeia* 'flattery'. However, it also creates abstract nouns from nouns, such as *asthenis* 'ill' > *astheneia* 'illness', *diarkis* 'everlasting' >

diarkeia ‘duration’. The suffix *-a*, is by far the most polysemous of the ones mentioned above. It creates feminine nouns denoting property, occupation or nationality, e.g. *theos* ‘god’ > *thea* ‘goddess’, *daskalos* ‘teacher/Masc.’ > *daskala* ‘teacher/Fem.’, *Roumanos* ‘Romanian/Masc.’ > *Roumana* ‘Romanian/Fem.’. It also creates augmentatives (*vareli* ‘barrel’ > *varela* ‘big barrel’), collective nouns, *horto* ‘grass’ > *hortarika* ‘vegetables’, and adverbs, *kalos* ‘good’ > *kala* ‘well’.

As for the suffixes *-io*, *-os*(neut), and *-i*(neut), all three are unproductive and rare when it comes to Deverbal Word Formation (DWF). For instance, *-io* creates neuter nouns from verbs, such as *kathomai* ‘sit’ > *kathisio* ‘inaction’, *koutsoubolevo* ‘to gossip’ > *koutsoubolio* ‘gossip/gossiping’ which are really limited in number. Similarly, the deverbal nouns formed with *-os* are rare and they mostly belong to the older language (e.g. *pseudos* ‘lie’, *feggos* ‘light’, *vathos* ‘depth’, *rigos* ‘quiver’). Finally, there are only limited cases of deverbal nouns with the suffix *-i*, e.g. *zygizo* ‘weigh’ > *zygi* ‘weight’, fact which reflects a rare and unproductive rule.

Therefore, based on the above brief description, we are left with a limited number of deverbal nouns that could provide a solid, homogeneous basis for further investigating issues of their particular features, such as TFs. These are DVNs formed with the suffixes *-tis*, *-si*, *-ma*, and *-simo*. These four suffixes allow us to examine a variety of TFs and thematic operations as well as to cover a semantically broader area including process as well as agentive nominalizations. As opposed to deverbal adjectives, DVNs have been extensively studied within the frame of syntactic approaches to nominalization. As mentioned earlier, these syntactic approaches seek to determine the underlying triggers for the expression of semantic participants in syntax. As this issue is outside the scope of the present thesis, we will not present their accounts here. However, we will look into how these nominals behave in sentential context and try to draw inferences about their more general properties.

Alexiadou (2001: 35) broadly divides activity DNs in MG in four categories depending on the base verb:

- 1) nominals derived from agentive transitive Vs (*katastrefo* ‘destroy’ > *katastrofi* ‘destruction’).
- 2) nominals derived from intransitive Vs (e.g. *afixi* ‘arrival’).
- 3) nominals derived from ditransitive verbs (e.g. *dosimo* ‘giving’).

- 4) nominals derived from psychological verbs (e.g. *endiaferon* ‘interest’).

For the purpose of the present study we will focus on those nominals derived from transitive verbs, since we want to examine a homogeneous class with prominent TFs. This class of nominals is further divided into two distinct groups. Those that always receive a process/event reading (*katastrofi* ‘destruction’) and always have an implicit agent/causer component, and those that are ambiguous between a process and a result reading (*perigrafi* ‘description’). The complements of these nominals are not affected and their meanings alternate between a telic and atelic one³². In order to ensure homogeneity of the experimental sample and the sufficiently prominent status of TFs for the DVNs, the stimulus set included only nominals of the ‘destruction’ type. In the following section I describe the particular features of each class of deverbal nominal that was included in the study.

3.4.2.2 The suffix *-tis*

Semantically, the DVNs with the suffix *-tis* denote the person who acts, or who performs the activity described by the base verb, e.g. *dioko* ‘chase’ > *dioktis* ‘chaser’, *klevo* ‘steal’ > *kleftis* ‘thief’, *kyverno* ‘govern’ > *kyvernitis* ‘governor’. By extension, it can also denote occupation, as in *xtizo* ‘build’ > *xtistis* ‘builder’, *ekfono* ‘announce’ > *ekfonitis* ‘announcer’, *propono* ‘to coach’ > *proponitis* ‘coach’. Finally, it also creates nouns which denote the instrument used to perform the activity described by the base verb, such as *styvo* ‘squeeze’ > *styftis* ‘squeezer’, *ektypono* ‘print’ > *ektypotis* ‘printer’. For the present study we will focus on the agentive nominalizations, because they can receive event interpretation, as opposed to the *-er* nominalizations that refer to instruments (Levin & Rappaport, 1988; 1992). As shown in Figure 7, the creation of a DVN with the suffix *-tis* involves a number of thematic operations. Let us consider the case of *kataktitis* ‘conqueror’.

³² For instance, the use of the nominal *katastrofi* ‘destruction’ is only grammatical in (i) but not in (ii), since it always receives a process/telic meaning and takes an affected object. In contrast, both examples (iii) and (iv) are grammatical, since the nominal *perigrafi* ‘description’ can have both process/atelic and result/telic readings and its object is not affected.

- (i) *i katastrofi tis polis se pende lepta* ‘the destruction of the city in five minutes’
PROCESS/TELIC
- (ii) **i katastrofi tis polis (se pende lepta) itan anakrivis* ‘the destruction of the city (in five minutes) was inexact’ ?RESULT/TELIC
- (iii) *i perigrafi tou Gianni gia mia ora* ‘the description of John for an hour’ PROCESS/ATELIC
- (iv) *i perigrafi tou Gianni itan anakrivis* ‘the description of John was inexact’. RESULT/TELIC

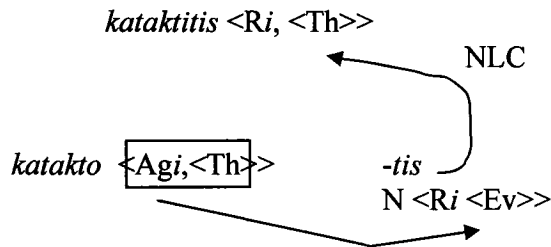


Figure 7: derivation of DVN-*tis*

In Figure 7, the suffix *-tis* has a typical deverbial noun argument structure, $\langle \text{R} \langle \text{Ev} \rangle \rangle$, that permits substitution. However, *-tis* also has the specification that its external argument binds the external argument of the root. As with the identity that comes from *argument binding*, we can represent this by using the same subscript (*i*) on the binding argument and the bound argument.

This new binding relationship ties the agent argument of the verb to the R argument of the DVN-*tis*. Hence, it cannot be expressed as a distinct phrase in syntax and, consequently, it does not belong as such to the argument structure of the derived word. The rest of the argument structure of *kataкто* ‘conquer’, however, is substituted into the argument structure of *-tis*, and is passed on to the word by the Node Labelling Convention. The result is a two-argument noun, with an R external argument and a Theme argument that is inherited from the verb root. Furthermore, the R argument of the noun is understood as the Agent argument of the verb.

Although DVNs-*tis* inherit the TFs of the verbal base, in a sentential context they do not behave exactly as their verbal counterparts do. Instead, they are subject to serious limitations. For instance, they do not permit manner adverbials (example 32a). Nor do they bear aspectual modification (example 32b).

- | | | | | |
|------|----|---------------------------|----------------|---------------------|
| (32) | a. | <i>*O katharistis tou</i> | <i>ktiriou</i> | <i>prosektika</i> |
| | | the cleaner theGEN | building | carefully |
| | b. | <i>*O katharistis tou</i> | <i>ktiriou</i> | <i>epi ena mina</i> |
| | | the cleaner theGEN | building | for a month |
- (Alexiadou, 2001: 129)

As Alexiadou (2001: 129-130) observes, DVNs-*tis* have a diminished verbal character³³ even in their agentive reading. According to her analysis, all event nominals demonstrate event readings and can license internal arguments because of the presence of certain functional heads in their structure, such as vP and AspectP. However, when it comes to DVNs-*tis*, the fact that DVNs-*tis* do not accept manner and aspectual modifications suggests that they probably lack AspectP. Moreover, the little v in their structure is different from the one found in other event nominals. In other words, the little v in *xoreftis* ‘dancer’ contains agentivity features, and this makes it different from the v in *katastrofi* ‘destruction’ type nominals. As Alexiadou (2001: 137) further observes, MG DVNs-*tis* have an (agentive) intransitive v in their structure, which can still license arguments. However, the combination of the absence of AspectP and the presence of agentive intransitive v contribute to the diminished verbal character demonstrated by these nominals.

3.4.2.3 The suffix -*si*

The suffix -*si* creates deverbal nouns which could be classified as the prototypical process nouns. They describe the activity expressed by the base verb, such as *dilitiriazō* ‘to poison’ > *dilitiriasi* ‘poisoning’, *aixmalotizō* ‘capture’ > *aixmalotisi* ‘captivity’, *anatinazō* ‘explode’ > *anatinaxi* ‘explosion’. There is some controversy in the literature with respect to the relationship of the suffix -*si* and the notion of perfectivity. Alexiadou and Stavrou (1998) postulate that there is a formal and semantic link between the presence of -*s*- in DVNs and perfectivity. On the other hand, Horrocks and Stavrou (2000) show that no such link exists and that nouns with -*si* are derived on the basis of a stem ending in -*s* (*sizitis*- ‘discuss’, *pidiks*- ‘jump’, *treks*- ‘run’) which lacks any fixed morpho-syntactic and semantic properties. This stem is the product of a remorphologization process according to which the verb root and the initial segment -*s*- of a number of ancient derivational suffixes (e.g. -*sis* as in *taks-is* ‘order’) came to be reanalyzed as a single entity. The perfective marker -*s*- has lost its independent character and is now considered to be part of the verb stem. Ralli (1988) differentiates between those suffixes that show an allomorphic variation when added to an *s*-

³³ The term *verbal character*, as well as the terms *eventive character* or ‘*verb-like*’ *character*, will be used throughout this thesis to refer to nominals which accept complements, by-phrases, manner adverbials, and aspectual modification denoting duration. The more of these properties a nominal demonstrates, the more “verb-like” or “eventive” it will be considered.

stem and those that are lexically listed as having an initial /s/. In both categories the /s/ is deprived of any perfective value. The first category includes deverbal derivatives that contain a /s/ in spite of the fact that their suffixes do not begin with /s/. Examples include *-ma*, *-mos*, *-tis*, *-tos*, *-menos*, which can appear as *-sma*, *-smos*, *-stis*, *-stos*, *-smenos*. This is not the case for the suffix *-si*, which is listed as such in the lexicon.

When it comes to AS properties, the derivation of a DVN-*si* involves a number of thematic operations that are responsible for transmitting the TFs of the verb and of the suffix to the new derivative. The derivation of a DVN-*si* can be seen in Figure 8.

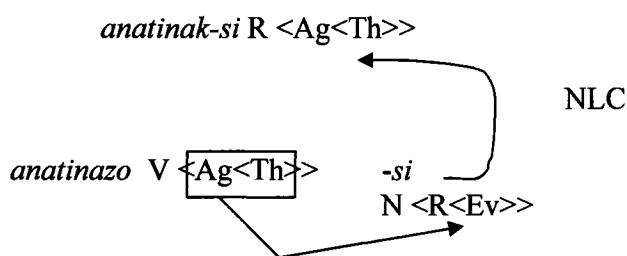


Figure 8: *derivation of DVN-si*

As can be seen in Figure 8, the suffix *-si* has the argument structure <R<Event>>, which is considered to be a typical noun argument structure. Furthermore, the suffix *-si* permits substitution, in the sense that the <Ev> argument can be replaced by the argument structure of the base verb. Following this, the Node Labeling Convention is responsible for transmitting the TFs of both the verb and the suffix to the new word. Thus, through the application of *substitution linking* and the *node labeling convention*, the whole word has the argument structure of the embedded verb plus the new external argument.

Although DVNs-*si* are considered to be the prototypical process nouns, they do not seem to tolerate aspectual modification denoting repetition, when placed in sentential context, as shown in example (33).

- (33) **i syxni* *anatinaksi* *tis* *gefyras* *apo to strato*
the frequent blowing theGEN bridgeGEN by the army
‘the frequent blowing up of the bridge by the army’

This observation suggests the existence of certain limitations with respect to their verbal properties, giving rise to a reconsideration of a fully eventive character associated with them.

3.4.2.4 The suffixes *-ma/-simo*

The suffixes *-ma* and *-simo*, according to Malikouti-Drachman & Drachman (1989) are allomorphic realizations of the same deverbal suffix, the distribution of which is determined by the number of syllables of the perfective verb stem. In other words, *-simo* selects monosyllabic stems, while *-ma* is attached to stems of more than one syllables (*klev-o* ‘steal’ *klep-simo* ‘stealing’ vs. *anoig-o* ‘open’ *anoig-ma* ‘opening’). For this reason we will treat them as a single suffix, rather than as two separate ones.

The DVNs-*ma/-simo* are formed by adding the suffixes *-ma/-simo* usually to transitive verbs, e.g. *ravo* ‘to sew’ > *rap-simo* ‘sewing’, and more rarely to intransitive verbs, such as *ksananiono* ‘perk up’ > *ksananioma* ‘perking up’. Semantically, they describe the activity or the result of the activity expressed by the base verb.

The derivation of a DVN-*ma/-simo* is illustrated in Figure 9, with the example of *diorthoma* ‘correcting’.

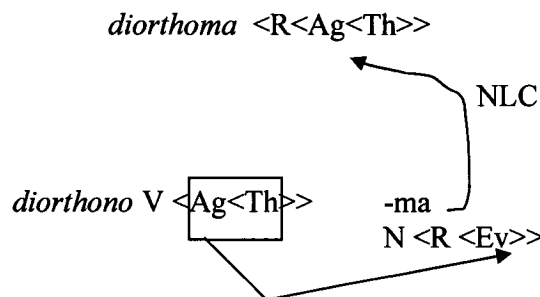


Figure 9: *Derivation of DVN-ma/-simo*

The verb *diorthono* ‘to correct’ is predicated of an Agent external argument and a theme internal argument. The suffix *-ma/-simo* has the argument structure <R<Ev>>. In *-ma* suffixation, the Event argument of the suffix is replaced by the argument structure of the base verb, via *substitution linking* and the new argument structure is transmitted to the whole word via the node labeling convention. As is the case with DVNs-*si*, the new word has the argument structure of the base verb plus the new R external argument.

Based on the derivation specifications of DVNs-*ma/-simo* and DVNs-*si*, there appear, at first, to be striking similarities between them. However, there are considerable differences as well. A comparison between DVNs-*si* and DVNs-*ma/-simo*, especially in sentential context, reveals interesting facts about these two types of nominals. An obvious difference between the two is that the DVNs-*ma/-simo* involve the (alleged) infix *-m-*, which according to Alexiadou (2001: 42), is related to non-active voice morphology, a fact with further consequences. For instance, in example (34b) (DVN-*ma*), we understand that the clothes have been changed by someone, while in (34a) it is the ‘situation’ that has changed (Alexiadou, 2001: 42). However, this is not true of every case. Moreover, Alexiadou’s claim creates a number of additional problems. First of all, one could claim that MG does not have infixes, and therefore, the element *-m-* can have neither an identity of its own nor any properties of its own³⁴. Yet, there is a more serious problem with Alexiadou’s claim. That is, although nominals of the type *perpati-ma* ‘walking’, *pidi-ma* ‘jumping’, *skarfalo-ma* ‘climbing’, *skyp-simo* ‘bending’ incorporate *-m-*, they definitely lack a ‘passive’ reading, in the sense that there is no affected object of the activity.

- (34) a. *I* *allag-i* *tis* *katastasis*
 the change-I theGEN situationGEN
 ‘the changing of the situation’
- b. *To allag-ma* *ton* *rouhon*
 the change-MA theGEN clothesGEN
 ‘the changing of the clothes’

(Alexiadou, 2001: 42)

Nevertheless, the differences between DVNs-*ma/simo* and DVNs-*si* pointed out by Alexiadou (2001) can be further delineated and expanded upon more specific terms. Firstly, DVNs-*ma/-simo* accept *by*-phrases in cases where DVNs-*si* do not. However, the converse,

³⁴ On the other hand, given that the term ‘infix’ is a descriptive one, we cannot exclude the possibility that *-m-* is an infix just because there are no other infixes in MG.

where the DVNs-*si* tolerates *by*-phrases but the DVNs-*ma/-simo* does not, is not possible. In example (35), the *by*-phrase ‘*by the funeral home*’ renders the sentence ungrammatical.

- (35) a. *To kapsimo tou horiou apo tous Germanous*
 the burning-IMO theGEN villageGEN by theACC GermansACC
 ‘the burning of the village by the Germans’
- b. *I kafsi nekron *apo to grafeio kideion*
 the burning-SI deadGEN by the office funeralsGEN
 ‘the cremation of the dead by the funeral home’

In addition, as shown in example (36), DVNs-*ma* accept adjectival aspectual modification denoting repetition, while DVNs-*si* do not.

- (36) a. *To syxno ply-simo ton piaton*
 the frequent washing-SIMO theGEN dishesGEN
 ‘the frequent washing of the dishes’
- b. **I syxni anatinaksi tis gefyras apo to strato*
 the frequent blowing up-SI theGEN bridgeGEN by the army
 ‘the frequent blowing up of the bridge by the army’

Furthermore, DVNs-*si* can occur without complements more easily than DVNs-*ma/-simo*. As shown in examples (37a) and (38a), the DVN-*si odigisi* ‘driving’ can stand on its own in the sentence. It is not necessary to specify its theme. However, this is not the case with the DVN-*ma odigima* ‘driving’, since it is either odd without its theme (37b) or completely ungrammatical (38b).

- (37) a. *prosthimo gia epikindyni odigi-si*
 fine for dangerous driving-si

- b. *?prosthimo gia epikindyno odigi-ma*
 fine for dangerous driving-ma
- (38) a. *mathaino odigisi*
 learn1SG driving
 ‘I learn to drive’
- b. **mathaino odigima*
 learn1SG driving
 ‘I learn to drive’

Furthermore, whenever there are pairs of DVN-*si* and DVN-*ma/-simo* formed on the same verbal base, the DVNs-*ma/-simo* denote more specific activities, while the DVNs-*si* denote figurative and abstract notions (see examples 39 and 40), or even notions related to the activity, but not describing it (examples 41). In contrast, -*ma/-simo* nominals cannot be used figuratively, and they always illustrate the literal aspects of the activity of the base verb. This is shown in examples (41) and (42).

- (39) a. *to kap-simo/*i kaf-si tou horiou apo tous Germanous*
 the burning-SIMO/*burning-SI theGEN villageGEN by the Germans
 ‘the burning of the village by the Germans’
- b. *o organismos tou kanei kales kafseis*
 the organism his does good combustions
 ‘he has a good metabolism’
- (40) a. *to ply-simo/*i ply-si ton rouhon/piaton/dontion*
 the washing-SIMO/*washing-SI theGEN clothes/dishes/teethGEN

- b. *ply-si/*ply-simo* *stomahou/egkefalou*
washing-SI/*washing-SIMO stomach/brainGEN
‘brain washing, stomach washing/pumping’
- (41) a. *To gemisma tou vareliou*
the fillingMA theGEN barrel
‘the filling of the barrel’ (to describe the actual activity of filling the barrel)
- b. *I gemisi tis galopoulas*
the filling theGEN turkeyGEN
‘the stuffing of the turkey’ (to describe the materials with which the turkey was stuffed)
- (42) a. *To kopsimo ton dendron egine me ilektriko prioni.*
the cutting theGEN treesGEN became with electric saw.
‘the cutting of the trees was done by chain saw’.
- b. *I kopsi tou spathiou*
the cutting theGEN knife
‘the blade of the knife’

Finally, only the DVNs-*ma/-simo* are compatible with modifiers such as *for an hour* (Alexiadou, 2001: 52-53), as shown in (43).

- (43) a. *I diorthosi ton grapton se pende lepta/*ja mia ora*
the correction theGEN papersGEN in five minutes/for an hour
‘The correction of the papers in five minutes/for an hour’
- b. *to diorthoma ton rouhon se pende lepta/ja mia ora.*
the correcting theGEN clothesGEN in five minutes/for an hour
‘the mending of the clothes in five minutes/for an hour’

Based on the above comparisons, nominals with the suffixes *-ma/-simo* appear to have greater verb-like properties than those with *-si*. This is suggested by two facts. First, DVNs *-ma/simo* more evidently involve participants, whose expression in syntax is realized via the inclusion of complements (*?prosthimo gia epikindyno odigima*) and *by*-phrases. Second they receive aspectual modification denoting repetition (example 36). Furthermore, the more frequent figurative use of DVNs-*si* further suggests that these nominals have their own substance and reference as stand alone nouns, independently from the denotations of the base verb. This is not the case for DVNs-*ma/-simo*, which closely adhere to the semantics of the base verb.

3.4.2.5 Summary of Modern Greek DVNs

In the above sections we have described the derivation and the properties of those DVNs that will comprise the stimulus set in the present study. While we have demonstrated similarities among them, in the sense that their derivation involves thematic operations via which they acquire their TFs, we have also shown striking differences among them, both in terms of the number and type of particular thematic operations involved, as well as in their general semantic and syntactic properties. For instance, both argument binding and substitution linking are responsible for the TFs of DVNs-*tis*, resulting in an AS consisting of R <Th>, where R is co-indexed with the external argument of the base verb. Furthermore, these nominals denote subject nominalizations referring to an animate entity. In a sentential context, they neither permit manner adverbials nor bear aspectual modification. Therefore, we can conclude that they demonstrate a diminished verbal character.

In contrast, DVNs-*si* refer to process/result nominalizations. Their argument structure is <R<Ag<Th>>, where R is not co-indexed with the external argument of the base verb. In sentential context, they usually tolerate neither adjectival aspectual modification denoting repetition, nor a *by*-phrase, although this is not entirely categorical. Moreover, there is an arbitrary relationship between the reference of the deverbal nominal and the arguments of the base verb, in the sense that the DVNs-*si* can remain without complements.

Finally, the DVNs-*ma/-simo* also refer to process nominalizations. As in the derivation of DVNs-*si*, their derivation also includes substitution linking, which is responsible for transmitting the AS of the base verb to the derived word. However, both their

semantics and their syntactic behaviour bring them closer to nominal gerunds than to simple nouns. In fact, they are the most ‘verb-like’ nominalizations of all the types examined, since they imply the involvement of participants, they tolerate adjectival aspectual modification denoting repetition and receive *by*-phrases.

Although we have thus far identified the AS properties of these DNs, we still know very little about whether and how these properties might influence their lexical access. Also, we do not know whether the processor is able to detect thematic violations and if it is able to differentiate them from other types of violations. These topics are addressed in the following chapter.

Chapter 4 ISSUES UNDER INVESTIGATION AND RESEARCH QUESTIONS

The present thesis investigates two separate, though inter-related, issues. The first one deals with the processing of Thematic Features (TFs) of Deverbal Nominals (DNs); the second examines the processing of the same features in unattested complex words, which violate the thematic specifications of their constituents. Evidence from these two research directions will shed light on the interaction of various features in lexical access and ultimately will contribute to our understanding of lexical access and the organization of mental representations. In this chapter, I state the specific research questions that will be the focus of the present investigation.

4.1 Background, hypotheses and research questions

In Chapter 2, we saw that previous psycholinguistic research has identified a number of linguistic properties that appear to affect lexical access. For instance, complex morphological structure, phonological transparency/opacity, semantic concreteness/abstractness, ambiguity, and grammatical class are among the types of features that seem to have an effect on word recognition. However, little is known about how these features interact and whether they are hierarchically ordered with respect to lexical access. Addressing these questions will add significantly to our understanding of how the lexicon is organized.

A potentially fruitful approach to these questions is through the study of Deverbal Word Formation (DWF). Deverbal nominals exhibit complex morphological structure, and more interestingly, mixed categorical properties. They belong to the nominal class, but at the same time they exhibit the types of argument structure properties that verbs do (e.g., Grimshaw, 1990; Alexiadou, 2001). This results from the fact that their derivation involves significant contributions of various TFs from both the verb and the suffix. However, it is not clear whether the TFs of DNs are as prominent as those of verbs. Consequently, it is not clear whether the nominal or verbal properties of DNs take precedence in lexical access, and what implications this might have for the organization of the lexicon.

Evidence from several experimental techniques converges to suggest that the grammatical category of a word may determine how it is stored and how it is related to other words (e.g. Jenkins, 1970; Caramazza & Hillis, 1991; Damasio & Tranel, 1993). However, we also have evidence that features related to word meaning and syntactic properties greatly

influence word access. For instance, not only does the argument structure of verbs affect performance as measured by reaction times and brain responses (in ERP studies e.g., Friederici & Frisch, 2000), but it does so very early in lexical access in a way that is claimed to be an automatic operation to which even aphasic populations are sensitive (e.g., Shapiro, Gordon, Hack & Killackey, 1993).

The evidence further suggests that the lexical representation of verbs specifies the number and type of their arguments and that this type of information has a salient effect on accessing verbs. Given that TFs are inherited by a DN, the central aim of the present study is to investigate whether the processor uses these features when accessing a DN. In other words, I plan to investigate the status of these features in lexical access in order to obtain insight into their prominence in the mental representation of DNs. If TFs are part of the lexical entry of deverbal nominals, and if the recognition of DNs implies access to their TFs, then we would expect them to increase the processing load during lexical access, as do the TFs of verbs. Furthermore, if thematic information is indeed lexically specified and constitutes a necessary component of the mental representation of a DN, then TFs should also be a necessary step in creating novel deverbal word formations.

Following the discussion of the previous chapters, the present investigation is based on two basic sets of assumptions:

1) Representations stored in the mental lexicon carry a certain amount of information that is reflected in on-line processing. Thus, if we accept the linguistic view (Lieber, 1980/1990; Hoekstra, 1986; Selkirk, 1982; Baker & Bobaljik, 2002) that TFs percolate from the verbal root to the derived nominal, then we hypothesize that although DNs clearly belong to the class of nominals, their mental representation should include a component dedicated to the thematic information that specifies the particular nominal. If this information differentiates DNs from other types of nominals, thus defining their special character, then it should be available during lexical access. Consequently, we would expect that when the nominal is accessed, this type of information is also accessed, because it forms part of the lexical properties of the nominal.

2) The second set of assumptions is exclusively related to pseudo-words (Pseudo-Ws) and novel words (Novel-Ws). In investigating Pseudo-W formation, we can actually manipulate the thematic operations that follow derivation by inducing a violation of their

thematic structures. In this way, the contribution of the thematic information of both the verb and the suffix becomes visible. Based on the assumption that word formation requires obedience to various restrictions stemming from the properties of both the base and the suffix, the thematic information carried by words and affixes should also impose its own restrictions in DWF. Since native speakers are sensitive to word formation restrictions, we expect them to be sensitive to violations of thematic information as well. Therefore, given the special status of thematic features, atypical derivatives (Pseudo-Ws deviant *only* in terms of TFs) should have a different effect on word recognition than that of other types of Pseudo-Ws. In the present study, Pseudo-Ws with categorial violations would be one of these other types of Pseudo-Ws.

Thus, the following research questions were investigated:

- 1) Does the processor make use of TFs when retrieving a deverbal nominal? In other words, is the processing of TFs reflected in increased RTs in deverbal word recognition?
- 2) Can we isolate the effect of TFs in on-line processing of novel word formations? In other words, do native speakers react differently to Pseudo-Ws with thematic violations than to Pseudo-Ws with other types of violations, such as lexical categorial violations?

Before proceeding with a detailed description of the methodology of the present studies, I will briefly discuss the results of two of my previous studies that dealt with the above questions.

4.2. Previous studies

Despite the theoretical basis for assuming that DVNs inherit TFs that constitute part of their lexical entry, and despite the considerable amount of research on verb TFs, only two studies have looked at whether TFs are processed during the lexical access of deverbal nominals (Manouilidou 2004; Manouilidou et al. 2004). In this section, I report on the results of these two studies and on the insights that they provide into the above issues.

4.2.1 Manouilidou (2004)

In a pilot study using stimuli from Modern Greek (MG), Manouilidou (2004) targeted the on-line processing of TFs in deverbal nouns and adjectives. The study looked into the effect

of two specific operations that manipulate TFs during derivation, Theta Role Saturation³⁵ (for nouns) and Argument Externalization³⁶ (for adjectives). RTs to deverbal nouns with Theta Role Saturation, formed with the suffix *-tis* (agentive *-er*) as in *agorastis* ‘buyer’, were compared to RTs obtained from deverbal nouns without Theta Role Saturation (e.g. *lytromos* ‘deliverance’). A similar comparison was carried out for adjectives, comparing those which demonstrated Argument Externalization, formed with the suffix *-simos* (-able) as in *anagno-simos* ‘read-able’, with those without Argument Externalization (e.g. *vevaio-tikos*³⁷ ‘affirmat-ive’). The results indicated longer RTs for adjectives with Argument Externalization (e.g. *katanoi-simos* ‘comprehensible’) than for their controls. However, the same significant difference was not observed for nouns with Theta Role Saturation (e.g. *kataktitis* ‘conqueror’), as they yielded RTs similar to those of their controls (*lytromos* ‘deliverance’). This dissociation was attributed to the fact that the processing of TFs appears to be strongly dependent on the nature of the suffix and the thematic operations following derivation. Namely, a coincidence of semantic and thematic processing of the suffix *-tis* (*-er*) was observed, with a resulting acceleration of the recognition process of the whole word. The same coincidence was not observed for the suffix *-simos* (-able), making the processing of TFs more visible.

In order to obtain a preliminary measurement of native speakers’ reaction to Pseudo-Ws that violate thematic constraints, the same study also included two sets of Pseudo-Ws with thematic and categorial violations with the suffixes *-tis* and *-simos*. The study focussed specifically on whether native speakers differentiate between Pseudo-Ws of this type and Pseudo-Ws that violate another type of constraint, namely a lexical categorial one. For instance, participants had to make lexical decisions for Pseudo-Ws such as **exister*,

³⁵ An example of a word with theta role saturation is *teacher*. In the derivation of *teacher*, the suffix *-er* binds the external argument of the base verb, saturating it into the derived nominal. As a result, both the external argument and the suffix have the same referential index. In Baker and Bobaljik’s (2002) terms, this operation could be described as External Argument Binding.

³⁶ The term is from Williams (1981). The basic thesis of his paper is that morphological rules can alter argument structure in two ways: a rule can either externalize an internal argument (Argument Externalization) or internalize the external (Argument Internalization). Argument Externalization can be described in the same way as Internal Argument Binding.

³⁷ As we will see later, deverbal adjectives with the suffix *-tikos* also bear TFs. However, their type of features could not be described as either Argument Externalization or Argument Internalization according to Williams’s terminology. Similarly, although deverbal nouns with the suffix *-mos* do not demonstrate Theta Role Saturation, they also bear TFs. Therefore, this pilot study could best be described as addressing the question of how different thematic operations affect processing.

**arrivable*, that violate the thematic specifications of the suffix and the verb, as opposed to **chairer*, **spoonable*, that represent a mismatch in terms of the lexical category of the base. Results showed that there was a difference in participants' performance for both suffixes depending on the type of violation. Participants largely rejected Pseudo-Ws with categorial violations (rejection rate 90.13%), while they showed a greater acceptance of Pseudo-Ws containing thematic violations (rejection rate 71.9%) ($p < .0001$). The study concluded the TFs and violations thereof are indeed processed during Pseudo-W recognition, independently of the suffix.

4.2.2 Manouilidou, Kehayia, Schneiderman (2004)

Although the results of Manouilidou (2004) are quite clear with respect to Pseudo-Ws, there are still unresolved issues with existing words, possibly related to specific suffixes. To further explore the role of the suffix with respect to the processing of TFs, Manouilidou et al. (2004) focused solely on deverbal nouns. Based on Baker & Bobaljik's (2002) percolation framework as described in section 3.3, their primary goal was to determine whether specific derivational suffixes and the operations they are involved in differentially affect the degree to which TFs are processed in accessing deverbal nouns. Furthermore, given that the number of argument grids of verbs has a measurable effect in lexical access (Shapiro et al., 1993), the present study investigated whether processing is likewise affected by the number of the argument positions related to deverbal nouns and the number of thematic operations involved in their derivation.

The study employed an on-line lexical decision task for nouns formed with a variety of suffixes and involving different thematic operations (argument binding, substitution linking). The stimulus set comprised deverbal nouns formed by the suffixes *-tis* (-er) and the suffixes *-ma*, *-si*, *-mos*. These suffixes respectively form neuter, feminine and masculine deverbal nouns which denote the activity described by the base verb. The stimuli designed to investigate the effects of argument positions were composed of three sets of deverbal nouns, each formed by a different suffix. Each set consisted of deverbal nouns differing in terms of their argument positions, such as *metafras-tis* 'translator' vs. *kolympi-tis* 'swimmer'; *moudias-ma* 'numbing' vs. *dokimas-ma* 'testing'; *anarro-si* 'recovery' vs. *katakti-si* 'conquest'. To address the effects of thematic operations, deverbal nouns with external argument binding and substitution linking (e.g. *syntiri-tis* 'maintainer') were compared to

deverbal nouns that demonstrated only substitution linking, but no argument binding (e.g. *diortho-ma* ‘repair’).

The results revealed no significant differences between nouns with one argument position (for example, *walker* <R>) versus those with two (for example, *translator* <Ag<Th>>). Similarly, no significant differences were observed in the RTs for deverbal nouns that involved different numbers of thematic operations (for example, *translator* versus *translation*). Hence, Manouilidou et al. (2004) did not demonstrate any RT differences between nouns bearing different types and numbers of TFs, something which is in contrast with what we know about verbs.

4.3. Summary and implications

The results of the above-mentioned small-scale experiments offer only preliminary insights into the role of TFs in lexical access and the mental representation of DVNs, providing some indication that TFs play a role in Pseudo-W recognition. Furthermore, although the difference between DVAdjs with Argument Externalization versus their controls without Argument Externalization suggests that the type of thematic operation might affect processing, Manouilidou et al. (2004) failed to confirm this. To the contrary, they reported that the number of thematic operations and the number of argument positions do not seem to affect processing.

These earlier studies provide only a preliminary understanding of the processing of TFs in deverbal word formation, with many issues remaining to be investigated. Chapter 5 introduces the basic methodology for the ensuing experimental investigations.

Chapter 5 **METHODOLOGICAL BACKGROUND AND CLARIFICATIONS**

The research questions for the present dissertation were addressed in a series of three on-line lexical decision experiments and one off-line grammaticality judgment task. This chapter provides the necessary background for understanding the research design and methodology used in these experiments. After discussing some basic differences between on-line and off-line tasks, the non-linguistic lexical properties that can influence visual word recognition are briefly outlined and their relevance to the present study is discussed. In the final section of the chapter, I present the experimental set-up and the general procedure followed in the experiments.

5.1 Lexical access: Eliciting information about the word

Different types of information regarding the process of lexical access can be elicited depending upon the task that an individual is performing. Existing standard paradigms can be broadly divided into on-line and off-line tasks. Off-line tasks are those in which participants are aware of the kind of information sought and are permitted sufficient time to reflect consciously on the nature of the stimuli included in the task. Given these parameters, individuals may use both implicit and explicit/metalinguistic knowledge. For instance, off-line tasks such as segmentation, category judgment and acceptability judgment require that the participants respond following an analysis of a stimulus based on its linguistic characteristics. In contrast, on-line tasks are carried out in 'real time' and force rapid processing that does not allow for conscious reflection, thus aiming at eliciting implicit linguistic knowledge. Comparing results obtained with on-line and off-line measures allows us to examine whether processing that admits conscious strategies differs from that which takes place during the 300 to 1000 milliseconds that typically elapse during the on-line processing of a word. For instance, if similar error rates are obtained for certain lexical items violating particular constraints of word formation (e.g. **maturer*) in both off-line acceptability tasks and on-line lexical decision tasks, then we can argue that conscious processing does not differ from automatic processing with respect to the violation of constraints. When significant differences are observed between the results elicited from the

two types of tests, then we can argue that particular phenomena, e.g. the violation of word formation constraints, are only visible during a particular type of processing.

Ideally, investigations of the mental lexicon would include both on-line and off-line measures in order to capture participants' implicit and explicit linguistic knowledge. However, by focusing on on-line processing, one can more directly investigate the real time, automatic processes which underlie word recognition. Hence, an important part of our knowledge about the mental lexicon comes from on-line studies of lexical access, which provide us with a window into the lexical representation. The present investigation falls within this general framework. The following section provides a brief description of the lexical decision task, the main experimental tool employed in the study.

5.1.1 The on-line lexical decision task as an experimental tool

The lexical decision task is the major tool employed in this research. As with every other experimental tool, it has its strengths and limitations. In contrast to off-line measurements for eliciting information about the linguistic features of a word, the lexical decision task is typical of as other on-line measurements in that it allows for the collection of response latencies in addition to accuracy measurement. It is an immediate measure of processing activities which may not be susceptible to postperceptual and metalinguistic biases. It allows the experimenter to see lexical access in real time, with the participant largely unaware of the goal of the experiment. Thus, differences in response latency and accuracy detected on-line can be interpreted as an unbiased measure of the relative processing difficulty among stimuli. Also, lexical decision is considered to be very sensitive to lexical similarity effects, it is the appropriate tool to examine structural relationships among words stored in the mental lexicon.

Lexical decision tasks are often combined with other experimental techniques, such as priming. In this technique, the participant is 'primed' with a certain stimulus before the actual lexical decision on the target occurs. The priming technique has been widely used to reveal how the semantic, morphological or phonological relatedness of usually³⁸ two lexical items affect word recognition. Also, the manipulation of the time between when the prime is

³⁸The prime does not have to be a single word: it can be a whole sentence, or even a supralexic item, such as an affix or a bound root as well as a non-linguistic item, e.g. a picture.

first presented and the start of the target (*stimulus-onset asynchrony* or SOA) can reveal when different types of information (phonological, morphological or semantic) emerge during lexical access. Thus, it is the appropriate tool to target the time-course of activation of various linguistic features.

The goal of the present study was to detect the effect of TFs during lexical access of deverbal nominals. Based on the premise that the more features to be processed the greater RTs will be elicited, a simple lexical decision task was judged more appropriate than a priming task. A priming experiment would target the effect of specific features as revealed through the relationship between two items. However, as this is the first time the issue of the processing of TFs in deverbal nominals is under investigation, a cautious way to launch this investigation appeared to be the simple lexical decision task. Had the research been in a more advanced stage, then different type of research questions would have emerged, which would probably have required the application of different types of experimental techniques.

Despite its advantages, many researchers do not consider the lexical decision task not to be a reliable measurement for detecting subtle linguistic variables. Among its limitations, especially when it targets linguistic variables, is the strong effect of word frequency. Frequency effects, as will shown in section 5.2.1, are the most common and the most robust effects that the lexical decision task can reveal. Also, orthographic similarities between words can affect processing. However, with careful design it is possible for the researcher to isolate the effect of the variables under investigation. We assume that our experimental manipulations target only particular aspects of processing, with everything else remaining constant and therefore, canceling out. In the following section, I outline the role of certain non-linguistic word properties which, though not always informative of the organization of the lexicon, can nonetheless greatly influence the process of word recognition.

5.2 Non-linguistic word properties that influence lexical access: Issues in designing stimuli

Numerous studies have shown that *non-linguistic*³⁹ lexical properties affect the speed with which a specific item is retrieved from the lexicon. For instance, the written *frequency* and

³⁹ As stated earlier (see ft. 4, p. 10), the term *non-linguistic* refer to properties that cannot be described or explained in linguistic terms. In other words, it refers to word properties which are not predicted by any linguistic rule. For, instance, the fact that the word *cat* consists of one single syllable, while the word *banana*

general *familiarity* of a lexical item, as well as the *length* of a word, as counted in numbers of letters and number of syllables, appear to influence speeded tasks such as letter matching, naming, classification tasks, lexical decisions. Moreover, visual and sublexical properties such as syllables, onsets and rhymes and even letters of a word have also been found to affect lexical access (Balota, 1994: 308). However, these types of word properties rarely reveal information about a word's particular lexical entry and the organization of the lexicon in general. Nonetheless, *non-linguistic* word properties were taken into account in the present investigation, not as manipulating factors, but in order to ensure that the process of lexical access would not be influenced by them. In this section, I present those non-linguistic lexical properties that appear to be most influential and discuss how they might influence word recognition.

5.2.1 Frequency effect

Among non-linguistic lexical properties, word *frequency* is thought to have a very strong influence on word recognition in general. Frequency effects have been observed in almost every type of experimental task involving lexical access, including lexical decision, pronunciation performance, on-line reading etc. Individuals tend to recognize high-frequency words more quickly than low-frequency words. However, word frequency seems to be more important when it comes to lexical decision tasks. For instance, Balota & Chumbley (1984) report large frequency effects in lexical decision tasks, moderate frequency effects for naming tasks and only a small effect for category verification tasks⁴⁰. These findings lead them to conclude that frequency influences not the general word recognition process, which is required by all three tasks, but rather, *lexical decision processes*. Therefore, controlling for frequency effects is a matter of priority in designing stimuli for lexical decision tasks.

Depending on the theoretical model one is working with, the effect of frequency in lexical access can stem either from the frequency of the lexical item as a whole (surface frequency) or from the frequency of its parts, in the case of complex words. Therefore, although the surface frequency of the whole word should undoubtedly be controlled for, there are other frequency issues which apply to multimorphemic words. If the recognition of

consists of three syllables, appears to be an arbitrary fact, rather than something which linguistic theory can predict.

⁴⁰ In this type of task, subjects have to indicate whether a statement is True or False, e.g. *is the pigeon a bird?*

a multimorphemic word always takes place via its decomposition into stem and affix, then the higher the frequency of its *stem*, the faster the lexical decision response should be when the surface frequency of the word is controlled. Although this is not always the case, it has been demonstrated in a variety of experiments (e.g. Baayen, Dijkstra & Schreuder, 1997; Betram, Schreuder & Baayen, 2000; Schreuder & Baayen, 1997; Burani & Caramazza, 1987; Burani, Salmaso & Caramazza, 1984; Cole, Beauvillain & Segui, 1989; Taft, 1979). Based on evidence from the effect of base frequency, the strict decomposition model emerged in the literature, postulating that morphological decomposition is an obligatory stage and that it occurs at the early stages of word recognition.

Models of obligatory decomposition handle the base frequency very easily. The more often a unit is used, the more readily it will be activated. Therefore, responses to a word like *seeming* will be faster than to a word like *mending*, although they have the same surface frequency, because of the stronger activation of the base for *seem*. However, just because recognition is affected by base frequency does not mean that effects of surface frequency do not emerge. This can happen at a later stage, namely the combination stage, where the base and the affix are recombined (Taft, 1979)⁴¹. The idea that base frequency effects arise at an early stage, whereas surface frequency effects emerge at a later stage, was further supported by eye movement experiments such as those reported in Beauvillain (1996) and in Niswander, Pollatsek & Rayner (2000).

In a different type of model (i.e. AAM-Augmented Addressed Morphology), where whole word activation precedes morpheme activation, base frequency still plays a role, although it emerges at a different stage (Burani & Caramazza, 1987; Caramazza, Laudanna & Romani, 1988). For instance, in such a model, surface frequency effects arise at an early stage of processing, since the word has its own form-level representation which is activated initially. This initial activation of the whole form allows further activation of the corresponding morphemes and it is here where base frequency emerges.

Finally, in a dual route model such as the one assumed in this dissertation (i.e. Schreuder & Baayen, 1995), the existence of base frequency effects has been taken as evidence for the decompositional access route, while surface frequency effects were

⁴¹ In this study, Taft found that RTs for words with low frequency were slower than for words with high frequency when they were matched for base frequency.

considered as support for the existence of the whole word access route. Indeed a number of studies show only base frequency effects for some words, while there are only surface frequency effects for others (Bertram, Laine & Karvinen, 1999; Bertram et al., 2000).

In order to ensure no effect from the stem, all stimuli employed in the present study were controlled both for stem and surface frequency.

5.2.1.1 Familiarity instead of frequency

Closely linked to frequency is *familiarity*. While frequency reflects only the rate of the written appearance of a word as it figures in frequency tables or electronic corpora, familiarity also takes into consideration spoken word frequency and is based on subjective ratings. This is usually reflected in the general nature of the instructions given to the participants in order to obtain familiarity ratings. Participants are usually asked to rate how well people in their environment know the words they are supposed to rate (see Barca, Burani & Arduino, 2002: 434) or how often they use them.

Balota, Ferraro, & Connor (1991) raise an important issue with respect to subjective familiarity ratings. They point out that subjects may base their ratings on a variety of sources of information. For instance, their ratings may be based on counts for the written frequency of the word, or the availability of a clear meaning of the word, or even an indication of the extent to which an individual can identify a specific context for that word. Thus the authors note that familiarity may be connected with meaningfulness, concreteness, and contextual availability, thus reflecting a broader dimension of a word and not just its written frequency.

There are precedents in the literature for relying on subjective familiarity ratings in addition to or instead of printed word frequency norms. Despite the fact that the majority of the researchers working on lexical access follow available printed word frequency norms (e.g. Kucera & Francis, 1967; Leech, Rayson & Wilson, 2001; CELEX⁴² for English), some others have turned to subjective familiarity norms, claiming that frequency measures may not be the most sensitive estimates of the impact of frequency of occurrence on lexical representations (Boles, 1983; Connine, Mullennix, Shernoff & Yelens, 1990; Gernsbacher, 1984; Nusbaum, Pisoni & Davis, 1984; McClelland & Chapel, 1998; McLennan, 2005).

⁴² The CELEX database was developed by Baayen, R. H., Piepenbrock, R. & Gulikers, L. (1995) in *The CELEX lexical database [CD-ROM]*. Philadelphia, PA: Linguistic Data Consortium, University of Pennsylvania.

More specifically, Connine et al. (1990) conducted lexical decision and pronunciation tasks which provide evidence for familiarity effects above and beyond frequency effects. Furthermore, the same group of researchers observed that familiarity ratings predicted ease at performance of production in a delayed pronunciation task, whereas word frequency measures yielded no performance predictions. The conclusion of this study is that subjectively rated familiarity can account for frequency in production, as well as for frequency in print (Connine et al., 1990: 1094).

Although controlling for other factors that affect lexical access such as length, phonological probability and imageability can be easily achieved without the use of additional references or data sources, researchers commonly depend on frequency tables or electronic corpora to provide an objective measurement of frequency. Unfortunately, there are no frequency tables for MG and the creation of reliable electronic corpora for psycholinguistic research was still in the early stages when the present research began⁴³. For this reason, instead of frequency measurements, familiarity ratings were obtained for every word used in the experiments. By the time we were ready to begin the second experiment, the ILSP corpus for psycholinguistic purposes was already well-balanced, but still not without problems. Thus, as the assurance of low frequency items was a key variable for the second experiment, the familiarity ratings obtained for the stimulus set used in the second experiment were also checked against the frequency ratings provided by the ILSP corpus.

To summarize, both measurements (frequency and familiarity) present with inherent difficulties, as well as with advantages; ideally both should be controlled for⁴⁴. However, in the absence of reliable electronic corpora for MG, a reasonable case can be made for the use of subjective familiarity ratings in place of frequency counts.

⁴³ The ILSP (Institute for Language and Speech Processing) Corpus is the only one which provides frequency measurements for MG words. The CTI (Computer Technology Institute of the University of Patras) Corpus is still under construction.

⁴⁴ Correlated to frequency and familiarity is also the *neighbourhood* effect. This is the result of the considerable overlap in spelling patterns across different words. For instance, the words *pane*, *cane*, *line*, *late* and *land* are all orthographic neighbours of the word *lane*. Neighbourhood effects can be found either because of the neighbourhood size (how many neighbours) or the neighbourhood frequency (how frequent the neighbours are). Also, Baayen and his co-workers recently established the so-called *family size effect*: simplex words which occur as constituents in many complex words are processed faster than words with few morphological family members (e.g. Schreuder & Baayen, 1997). In other words, the verb *bake* (*baker*, *bakery*, *baking*) will be processed slower than the verb *cook* (*cookbook*, *cooker*, *cookery*, *cooking*, *cookhouse*, *cookware*, *cookstove*, *cookie*, *cookout*). Unfortunately, due to the lack of electronic corpora for Greek, the neighbourhood effect was not controlled for in any of the experiments reported here. Similarly, the unavailability of electronic corpora also precluded the measurement of any family size effects.

5.2.2 Length effect

When we talk about the length of a word, we refer either to the number of phonemes and syllables or to the number of letters it contains. In this section I will present evidence regarding the role of the length of a word as defined by the number of letters it contains. Evidence for the role of length comes from various sources, such as pronunciation tasks, on-line tasks (lexical decisions and naming) and eye movements. Results are highly inconsistent, varying from inhibitory effects (longer words are recognized more slowly) to null effects (where length does not appear to be an issue).

Although there is clear evidence that longer words take more time to pronounce (Forster & Chambers, 1973) and to name (Henderson, 1982; Ziegler, Perry, Jacobs & Braun, 2001; Balota, Cortese, Marshal, Spieler & Yap, 2004) and also produce longer fixation durations in reading (Just & Carpenter, 1980; Vitu, O'Regan & Mittau, 1990), there has been some conflicting evidence regarding the effect of word length on lexical decision tasks. For instance, although earlier studies (Richardson, 1976; Frederiksen & Kroll, 1976) found null effects in lexical decision tasks, inhibitory effects were reported in more recent studies. Chumbley & Balota (1984) reported large length effects in lexical decision tasks when words and Non-Ws were equated on length and regularity. Similarly, Hudson & Bergman (1985) obtained reliable inhibitory length effects for words with 4 to 12 letters in both naming and lexical decision. Furthermore, inhibitory length effects were reported in O'Regan & Jacobs (1992), while Balota et al. (2004) found that the main effect of length was eliminated for young adults' response latencies, although the effect did appear in the accuracy data. In the same study, the length effect was significantly larger for low frequency words than for high frequency words, suggesting that the length effect can be moderated by word frequency. Finally, a study by New, Ferrand, Pallier & Brysbaert (2006) reported facilitatory length effects for English words of 3 to 5 letters, no effect for words between 5 and 8 letters and inhibitory effects for words between 8 and 12 letters. The length effect found in New et al. (2006) was independent of printed frequency, number of syllables, and number of orthographic neighbours.

Although it appears that the relationship between length and lexical decision times is less straightforward than originally anticipated, the above findings suggest that length is a less powerful overall predictor of lexical decision performance than other factors such as

frequency/familiarity. However, it appears that the length of a word does slow response latencies primarily for lower frequency words (see Balota et al., 2004). Thus, in designing stimuli for lexical decision tasks using low frequency words, the influence of stimulus length and its interactive effects with word frequency should clearly be taken into consideration. This is the case for experiment 2, as described in the following chapter.

5.2.3 Number of syllables

Another way to measure word length is by measuring the number of syllables. In earlier studies, syllabic effects were obtained only for poor and slow readers (Frederiksen, 1976; Mason, 1978). More recently, Prinzmetal, Treiman & Rho (1986) reported an important set of experiments that investigated the impact of syllabic structure on early-level perceptual operations in word recognition. These experiments demonstrated that syllables are an access unit in visual word recognition. However, Seidenberg (1987) has questioned Prinzmetal et al.'s findings by attributing their results not to syllable structure, but to certain orthographic patterns.

Disagreement over how to parse words into syllables may at least partially account for the considerable disagreement that exists regarding the role of the syllable in visual word recognition. In other words, before one can address the functional role of the syllable in word recognition, one must have some agreement on how to parse words into syllables. Although there is considerable disagreement regarding the placement of syllabic boundaries in English, this is not the case for MG. For the vast majority of MG words, there is agreement on how words are parsed into syllables. Therefore, if syllabic structure has an effect in lexical access, this effect should be measurable in a language such as Greek, which has a fairly clear-cut syllabic pattern. Of course this presumes that native speakers have access to syllabic information when accessing visually presented words. Despite controversy in the experimental literature with respect to this last point, the stimuli involved in each experiment in the present thesis were also matched for number of syllables and syllabic structure.

5.2.4 Non-Words

In addition to the experimental stimuli, every lexical decision experiment requires an equal number of non-word (Non-W) stimuli. The purpose of the Non-W stimuli is to give subjects

the option of responding 'no' when making lexical decisions. Non-Ws can be of different types. They can either resemble real words in their letter composition or they can be made up of relatively uncommon letter combinations. In the first case, they are obtained by changing either one or two letters of an existing word of a given language. Thus, **tecognition* (from *recognition*), **locination* (from *combination*) could be Non-Ws resembling real words of English. In the latter case, they can be random letter strings, e.g. **fregtrpe*, **dergjk*.

Different types of Non-Ws have proved to influence participants' behaviour with respect to the experimental stimuli. For instance, James (1975) reported faster responses to concrete than to abstract words in a lexical decision task when using very word-like Non-Ws. The same effect was not found when using Non-Ws which did not resemble existing words. This was taken as an indication that subjects made use of semantic information to categorize the items, and thus the difference between abstract and concrete words could surface in lexical access. Also, Forster & Veres (1998) report on two priming experiments where Non-Ws which resembled real words primed real words in the same way as existing words.

Based on results such as the above, it has also been claimed (Binder, McKiernan, Parsons, Westbury, Possing, Kaufman & Buchanan, 2003) that the type of Non-W can force subjects to access specific word information during lexical decision. This becomes more apparent if we consider that the difference between words and Non-Ws cannot only be described in terms of meaning, but also in perceptual quantities such as familiarity of phonological and orthographic form. By using random letter strings as Non-Ws, in a sense we may lead our subjects to view the difference between words and Non-Ws at a strictly orthographic/visual level, thereby promoting this kind of processing for existing words in the stimulus set. In the opposite case, when we increase the orthographic similarity between words and Non-Ws, we induce spelling-to-sound regularity effects and, therefore, the lexical decision may rest on specific word information, such as phonological, lexical, and semantic codes.

Hence, a common practice when we target the use of specific word information in lexical access is to ensure that lexical processing rests on the lexical level and not simply on orthographic conventions. That is why, when designing the stimuli for the present experiments, Non-Ws were made to orthographically resemble real words as closely as possible.

In the following section, we move from a discussion of the variables that were taken into consideration in the designing of the stimulus material for the experiments in the present dissertation to a discussion of the experimental procedures employed.

5.3 On-line tasks: Procedure

As the same procedure and methodology were employed for each of the three on-line experiments presented in this thesis, these will be described and explained here in detail and only be briefly reiterated in subsequent chapters.

5.3.1. Familiarity verification and on-line procedure

Each experiment was conducted in two phases; the first phase always consisted of *familiarity verification*. For each experiment, participants were asked to indicate how often their friends use each word. Subjects answered on a scale numbered from 1 to 5 (1 being 'very infrequently' and 5 being 'very frequently'). The group mean for each word constituted its *familiarity rating*. These ratings were only used to select the final experimental stimuli and to match them with respect to familiarity; they were not used for any further analysis. Every item used in the final tests was subject to this rating process. Depending on the specifications of each experiment, either the more frequent (see Experiment 1, section 6.1) or the less frequent items (see Experiment 2, section 6.2) were selected. Thus many of the items rated in the selection process were never actually used in the experiments reported here.

The second phase comprised the on-line lexical decision task. The stimulus set varied in each experiment and is described in detail in chapter 6. However, the actual procedure is identical for all three on-line tasks. Letter strings were presented on a Macintosh computer screen and participants were asked to indicate whether or not these were MG words. Both RTs in milliseconds and the number of errors were recorded. The program Psyscope 1.2.5 for Power Macintosh was used to present the stimuli and record responses. Stimuli were presented in a standard lowercase Greek typeface. Participants first saw a mask comprising a series of pound signs (#####) in the centre of the screen, matching the number of characters of the preceding stimulus. As the forward mask limited visual persistence, it served to stop the processing of the previously presented item. The mask was presented for 200ms and was followed by a pause of 150 ms. The target appeared immediately after the

pause. By introducing a brief interval between each response and the presentation of the subsequent stimulus, the response accuracy of access can be greatly facilitated. Stimuli were presented in blocks of 80. The actual test was preceded by a practice session comprising 10 items and a pretest comprising 10 trial items. During the practice session participants had the chance to familiarize themselves with the demands of the task and ask questions to the experimenter. The pretest items were not part of the stimulus set and were not counted in the analysis.

5.3.2 Participants

Participants in each of the studies were Greek-speaking University students, pursuing either a graduate or undergraduate degree, who volunteered to participate. For the familiarity verification the number varied between 30 and 50 participants, while for the on-line tasks, the number of participants was between 20 and 30. All studies included both males and females.

5.3.3. Scoring and analysis

All reported RTs represent a mean of participant responses in milliseconds. Prior to the analysis, erroneous responses were removed. Responses exceeding 1500ms were considered to be 'off-line' and were removed as well. Outliers (response times below and above two standard deviations from the overall means for "yes"/ "no" responses) were also removed from the dataset. This resulted in a by subject loss of data varying for each test. The exact range for each experiment is given in chapter 6. The dependent measure for all analyses was lexical decision latency reported as RTs in milliseconds. The percentage of erroneous responses for each item (error rate) was also subject to further analysis for the third experiment. In all analyses, separate ANOVAs by item and by subject were conducted, treating items as independent variables. This was done in order to ensure the consistency and generalizability of our results across stimuli and across participants. Paired t-tests were also conducted, when licensed and considered necessary.

The above paragraphs outline the standard methodology followed throughout the studies presented here. Additional methodological details are provided before each of the

experiments, as necessary. The following chapter presents the experimental investigation of the present thesis.

Chapter 6 THE EXPERIMENTS

The experiments described in this chapter were carried out to address the research questions stated in chapter 4. The experiments were formulated in the light of the results of Manouilidou (2004) and Manouilidou et al. (2004).

Through a pilot investigation of the lexical access of pseudo words (Pseudo-Ws), Manouilidou (2004) found evidence for the processing of TFs as distinct from the processing of other lexical features. In the same study, deverbal adjectives (DVAdjs) with TFs (e.g. *readable*) demonstrated an increased processing load compared to their adjectival controls, while deverbal nouns (DVNs) with TFs (e.g. *buyer*) behaved similarly to their nominal controls. This dissociation was originally attributed to the specific nature and the semantic properties of the suffixes involved in the various derivations.

In order to further delineate the role of the suffix, Manouilidou et al. (2004) focused exclusively on DVNs. By using a variety of suffixes, we investigated the effect that the different number of arguments of DVNs and the different number of thematic operations taking place during their derivation can have in lexical access. A lack of significant differences across categories for both types of variables (number of arguments and thematic operations) suggests that neither of them influence lexical access.

The results obtained by Manouilidou (2004) and Manouilidou et al. (2004) left a number of issues open. For instance, Manouilidou et al. (2004) confirmed the fact that TFs might not affect lexical access for DVNs. However, the same study was unable to account for the differences between DVNs and DVAdjs and between DVNs and Pseudo-Ws, as observed in Manouilidou (2004). These discrepancies could be interpreted either as a difference of lexical category, such that TFs might be detectable in DVAdjs, but not in DVNs, or as a difference between forms accessed after decomposition (e.g. Pseudo-Ws) and forms accessed as whole words (e.g. DVNs).

Given a number of issues pertaining to decomposition and TF access remained unanswered in our previous studies, we decided to pursue our investigation by focusing in turn on DVAdjs, low frequency DVNs, and Pseudo-Ws. The new studies were also designed to detect the lexical access route of these stimuli. Thus, the first experiment of the series, described in the following section, targets the processing of TFs by focusing exclusively on DVAdjs. The second experiment is based on the findings of the first experiment with

DVAdjs and investigates the hypothesis that it is the viewing of a verbal root of a deverbal word formation which triggers the processing of its TFs. Finally, the third experiment investigates the general status of TFs in deverbal word formation and within the framework of the morphological theory of constraints by focusing on various types of non-attested stimuli.

6.1 Experiment 1: Accessing TFs of deverbal adjectives

The studies discussed above (Manouilidou, 2004; Manouilidou et al., 2004), revealed that the processing of TFs might only be detectable in DVAdjs and not in other types of Deverbal Nominals (DNs). In order to determine whether this was an adjective-specific phenomenon, we decided to further investigate the role of TFs in lexical access by focusing exclusively on DVAdjs in a study comparing their lexical access to that of Denominal Adjectives (DNAdjs), which are also derived, but do not carry TFs. Both DVAdjs and DNAdjs were compared to non-derived adjectives (NDAjds) in order to factor out the effects of derivation and detect their lexical access route. The following section presents in detail the questions, hypotheses, design and results of a lexical decision task probing word recognition of DVAdjs.

6.1.1 Experiment 1: Rationale, Research Questions, and Hypotheses

Given that our previous studies suggested that TFs may be accessed in the retrieval of DVAdjs, but not in the retrieval of DVNs, the goal of Experiment 1 was to determine whether speakers process TFs while accessing DVAdjs. The study addresses the following questions:

- 1) Is the processing of TFs reflected in the Reaction Times (RTs) obtained during the lexical access of DVAdjs and can this be differentiated from the effects of the derivational process itself?
- 2) Is it possible to differentiate between various types of DVAdjs based on the number of thematic operations involved in their derivation?

Our hypotheses were based on three working assumptions. The first was that, within a dual route model, our derived stimuli could either be recognized through decomposition or as a whole. Decomposition, when it occurs, is at least partially responsible for longer RTs observed during the processing of complex forms (e.g. Chialant & Caramazza, 1995;

Schreuder & Baayen, 1995). Therefore, Hypothesis 1 stated that we expected derived forms (DVAdjs and DNAdjs) to take longer to process than non-derived forms (NDAdjs).

Our second assumption was that mental representations carry a certain amount of information that is reflected in on-line processing. Specifically, we assumed that the lexical entry of a DVAdj is specified for TFs inherited from both the base and the suffix through various operations taking place during derivation. Thus Hypothesis 2 stated that DVAdjs would take longer to process than DNAdjs.

Finally, we assumed that the greater the number of thematic operations associated with a DVAdj, the greater its processing complexity, which should be reflected in longer processing times. Therefore, Hypothesis 3 stated that DVAdjs with a greater number of thematic operations would take longer to process than those with fewer thematic operations.

6.1.2 Experiment 1: Method

In order to test these hypotheses, we carried out an on-line simple lexical decision task using stimuli from MG. The experiment was completed in two phases.

Phase I: Frequency Verification

To select the stimulus set, and in the absence of frequency and familiarity tables for MG, off-line **familiarity** ratings were obtained for a total of 238 derived and non-derived words. Ratings were also obtained for the stems of the derived forms, using the standard rating procedure for all my experiments, as described in 5.3.1. Participants were 45 Greek-speaking university students.

Phase II: On-line Experiment

The second phase of the study consisted of an on-line, visual simple lexical decision task. See 5.3.1 for a detailed description of the procedure employed for all the on-line experiments presented in this chapter.

Participants

Twenty-four (24) native speakers of MG volunteered to participate in the study. The sample included males and females from 21 to 28 years old (mean age 24.3). All were undergraduate and graduate students at Aristotle University of Thessaloniki.

Stimuli

Stimuli (see Appendix A) included three groups of MG adjectives: DVAdjs (group 1), DNAdjs (group 2) and non-derived adjectives (group 3). Each group's average familiarity rating was 3.5. The inclusion of non derived adjectives (NDAdjs) allowed us to factor out the effect of derivation (which was anticipated for both DVAdjs and DNAdjs) from the effect of derivation plus TFs (which was only expected for the DVAdjs). To determine whether DVAdjs and DNAdjs are actually accessed in a similar manner (either as whole words or through decomposition) both groups (DVAdjs and DNAdjs) were matched with a control group of NDAdjs. DVAdjs were further divided into four categories depending on the suffix they bear and the thematic operations involved in their derivation, such as internal/external argument binding and substitution linking. The characteristics of each category of derived adjectives are described in the following paragraphs.

- *Deverbal Adjectives (DVAdjs)*

Four categories of DVAdjs were employed in the study, with 8 adjectives in each. Each category was formed with a different suffix. The thematic operations involved in the derivation of each category are described in detail in section 3.4 and are summarized in Figure 10.

1. **DVAdjs-*simos***. Formed by adding the suffix *-simos* (the semantic equivalent of English *-able*) to a strictly transitive verb, these adjectives manifest both internal argument binding and substitution linking.

Example: *anatrepo* > *anatrep-simos*

'to reverse' > 'reversible'.

2. **DVAdjs-*menos***. Formed by adding the suffix *-menos* to a transitive verb, these DVAdjs also demonstrate internal argument binding and substitution linking.

Example: *skepazo* > *skepas-menos*

'to cover' > 'covered'.

3. **DVAdjs-*tikos***. Formed by adding the suffix *-tikos* to a transitive verb, these DVAdjs carry external argument binding, but not substitution linking.

Example: *periorizo* > *perioris-tikos*
 ‘to restrict’ > ‘restrictive’.

4. **DVAdjs-*tos***. Formed by adding the suffix *-tos* to a transitive verb, DVAdjs-*tos* demonstrate internal argument binding, but not substitution linking.

Example: *ypofero* > *ypofer-tos*
 ‘to bear’ > ‘bearable’.

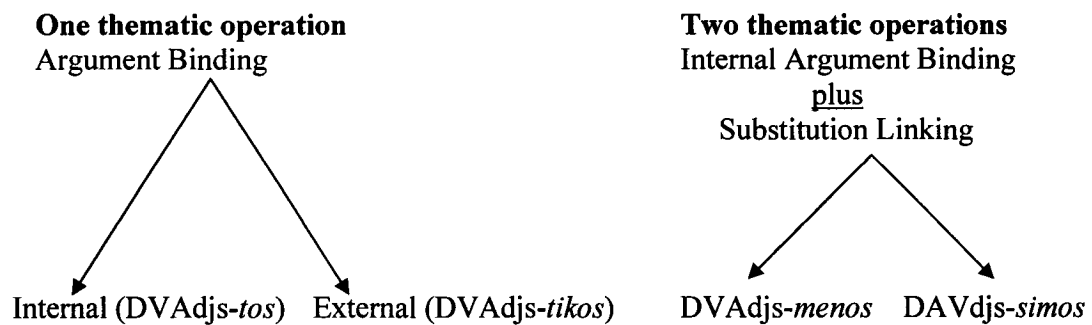


Figure 10: *DVAdjs according to type and number of thematic operations*

- *Denominal Adjectives (DNAdjs)*

Within the group of DNAdjs, there were two separate categories, with 8 adjectives in each category. Unlike the DVAdjs, the denominal adjectives lack TFs:

1. **DNAdjs-*ikos***. Formed from various nouns with the suffix *-ikos*.

Example: *georgia* > *georg-ikos* ‘agriculture’ > ‘agricultural’.

2. **DNAdjs-*eros***. Formed from various nouns with the suffix *-eros*.

Example: *vroxi* > *vroxeros* ‘rain’ > ‘rainy’.

- *Nonderived Adjectives (NDAdjs)*

The stimulus set also comprised 48 NDAdjs that were matched for familiarity, length and number of syllables with the actual experimental stimuli. There were six groups of 8 NDAdjs, each serving as controls for a group of derived adjectives (e.g. nonderived *thetikos* ‘positive’ as a control for DNAdjs-*ikos*).

- *Fillers*

In addition to the experimental items, the stimulus set also included filler word targets to distract participants from the purpose of the experiment. The 44 filler words consisted of various types of non-derived nouns and verbs.

- *Non words*

The 138 Non-Ws employed as stimuli were obtained by replacing one or two letters of a real MG word in accordance with the phonotactic constraints of the language. The presence of non-words allowed participants to legitimately reject some of the stimuli as not being words in MG.

Data analysis

The dependent measure for all analyses was lexical decision latency reported as RTs in milliseconds. In all analyses, separate ANOVAs by subject (F1) and by item (F2) were conducted, treating groups of stimuli as independent variables. Pairwise comparisons with Bonferroni adjustments for multiple comparisons were also carried out. All reported RTs represent a mean of participant responses. Prior to the analysis, erroneous responses were removed, resulting in a loss of less than 3% of observations. Furthermore, responses exceeding 1500ms were considered to be ‘off-line’ and were removed as well. Outliers (response times below and above two standard deviations from the mean) were also removed from the dataset. This resulted in a by subject loss of data varying from 2 to 7%. The majority of errors and outliers were concentrated in non-words. Neither subjects nor items were removed from the data set.

6.1.3 Experiment 1: Results and Discussion

Table 1 displays RTs and standard deviations (SDs) for each group of stimuli. An ANOVA revealed a main effect of category both by subject [$F(3, 69) = 15.59, p < 0.0001$] and by item [$F(3, 92) = 10.41, p < 0.0001$], while pairwise comparisons showed a significant difference between the DVAdjs and DNAdjs [$t(69) = -4.63, p < 0.0001$], as well as between the DVAdjs and NDAajs [$t(69) = -6.04, p < 0.0001$]. However, no significant difference was found between DNAdjs and NDAajs [$t(69) = 1.06, p = 0.29$]⁴⁵.

⁴⁵ Fillers and Non-words were not analyzed since they are not relevant to the research questions of the present study.

Table 1: Mean RTs (with SDs) in Milliseconds by Stimulus Type in Experiment 1

DVAdjs	688 (46)
DNAdjs	644 (46)
NDAjds	634 (45)
Fillers	646 (59)
Non-words	783 (60)

Hypothesis 1, which predicted that derived forms (both DVAdjs and DNAdjs) would yield longer RTs than NDAjds, was only partially supported. However, Hypothesis 2 was fully supported, as DVAdjs yielded significantly longer RTs than DNAdjs. Thus, it seems that the presence of TFs increased processing load in the lexical access of DVAdjs. According to our third hypothesis, DVAdjs would differ depending on the number of thematic operations involved in the derivation. Table 2 displays the RTs for each group of DVAdjs formed by a different number of thematic operations. The results indicate that DVAdjs involving two thematic operations take significantly longer to process than those involving only one [$t(23) = 3.055, p = 0.006$]. Thus, Hypothesis 3 is supported.

Table 2: Mean RTs (with SDs) in Milliseconds for DVAdjs Grouped by Number of Thematic Operations in Experiment 1

DVAdjs with 1 thematic operation (-tikos + -tos)	674 (36)
DVAdjs with 2 thematic operations (-simos + -menos)	702 (42)

The reasoning behind the present study has been that both the process of derivation (with the consequent need to decompose derived words) and the presence of TFs would independently add to processing time. We presumed that the presence of TFs would account for longer RTs for DVAdjs than for DNAdjs, while decomposition alone would account for a difference between DNAdjs and NDAjds while both factors would contribute to a difference between DVAdjs and NDAjds. Although DVAdjs did take significantly longer to process than DNAdjs, we did not find a significant difference between DNAdjs and NDAjds. If we assume that NDAjds are accessed as whole words, then the lack of a difference between

DNAdjs and NAdjs suggests that derivation alone did not increase the processing load for DNAdjs. This raises the possibility that the DNAdjs tested here may have been accessed as whole words, instead of being decomposed. If this were the case, then we would not be able to reliably attribute the difference between DVAdjs and DNAdjs to the added weight of processing TFs, despite the fact that the number of thematic operations apparently affects processing within the DVAdj category. The difference between DVAdjs and DNAdjs could equally well be due to whether or not decomposition occurs.

To address this issue, we carried out a more detailed analysis of the variation within and across all three groups of adjectives, with the goal of shedding some light on the relative processing weights of derivation and TFs. The first part of this analysis looked at how the issue of derivation may have interacted with the lexical access route used. To this end, we conducted ANOVAs in which each group of adjectives derived with the same suffix was compared with the group's non-derived control adjectives. This differed from the previous analyses, where all non-derived adjectives were treated as a single group. The results, shown in Table 3, indicate that all groups of DVAdjs, with the exception of the DVAdjs-*tos* group, differed significantly from their non-derived controls. The two groups of DNAdjs showed divergent results. The DNAdjs-*eros* group differed significantly from their non-derived controls, while the DNAdjs-*ikos* group did not. As there were only two groups of DNAdjs, this divergence may explain the lack of a significant difference between DNAdjs and NAdjs noted earlier.

Table 3: Mean RTs (with SDs) in Milliseconds for Each Adjective Group and for its ND Controls in Experiment 1

Derived Adjectives	Non-derived Controls	F-values	p-values
DVAdj- <i>simos</i> 711 (43)	NAdjs- <i>simos</i> 632 (24)	F(1,253) = 46.15	p < 0.0001
DVAdjs- <i>menos</i> 695 (42)	NAdjs- <i>menos</i> 636 (39)	F(1,253) = 35.94	p < 0.0001
DVAdjs- <i>tikos</i> 687 (31)	NAdjs- <i>tikos</i> 633 (57)	F(1,253) = 17.49	p < 0.0001
DVAdjs- <i>tos</i> 661 (38)	NAdjs- <i>tos</i> 640 (41)	F(1,253) = 0.38	p = 0.53 NS
DNAdjs- <i>eros</i> 657 (39)	NAdjs- <i>eros</i> 615 (59)	F(1,253) = 19.93	p < 0.0001
DNAdjs- <i>ikos</i> 629 (39)	NAdjs- <i>ikos</i> 627 (20)	F(1,253) = 0.06	p = 0.80 NS

The lack of significant differences between DNAdjs-*ikos* (e.g. *georgikos* ‘agricultural’) and DVAdjs-*tos* (e.g. *skalistos* ‘engraved’) and their respective non-derived controls suggested that adjectives derived with DNAdjs-*ikos* and DVAdjs-*tos* may not be accessed through decomposition and raised the issue of lexicalization for certain groups of derived adjectives. We decided to further examine Hypothesis 2 in the light of these new findings by attempting an additional analysis for which we divided the DVAdjs and DNAdjs into two groups, based on whether or not they differed from their non-derived controls. Thus the DVAdjs -*menos* (e.g. *kallymenos* ‘covered’), -*simos* (e.g. *katedafisimos* ‘demolishable’) and -*tikos* (e.g. *vevaiotikos* ‘affirmative’) were placed in the *decomposed* category, separate from -*tos*, which did not differ from its non-derived controls. DNAdjs with -*eros* (e.g. *vroxeros* ‘rainy’) were presumed *decomposed*, while the -*ikos* group was not. We then ran a one-way ANOVA comparing the mean for all DVAdjs accessed through decomposition to DNAdjs-*eros*, the only DNAdj accessed through decomposition (see Table 4). Furthermore, a one-way ANOVA was also run for the apparently non-decomposed DVAdjs-*tos* group versus the non-decomposed DNAdjs-*ikos* group. By holding the presence or absence of decomposition constant in each analysis, we hoped to isolate the effects of the processing of TFs. Based on Hypothesis 2, our prediction was that the decomposed DVAdjs would differ significantly from the decomposed DNAdjs-*eros*. We also expected a significant difference between non-decomposed DVAdjs-*tos* and non-decomposed DNAdjs-*ikos*.

The results, shown in Table 4, bore out our prediction for decomposed DVAdjs versus decomposed DNAdjs-*eros*. That is, DVAdjs differ significantly from their denominal controls. We viewed this result as providing additional evidence for the processing of TFs of DVAdjs, as stated in Hypothesis 2. The lack of a significant difference in RTs between non-decomposed DVAdjs-*tos* and DNAdjs-*ikos* was more difficult to interpret, as the presence of TFs did not appear to add to the processing load of DVAdjs-*tos*. This result strongly suggested that decomposition may be a necessary prerequisite to the processing of TFs of DVAdjs.

Table 4: Comparison of DVAdjs and DNAdjs, Grouped by Lexical Access Route in Experiment 1

DNAdjs-eros 657(39)	DVAdjs-menos/simos/tikos 697 (38)	F2(1,32) = 6.236, p = 0.018
DNAdjs-ikos 629 (39)	DVAdjs-tos 661 (38)	F2(1,15) = 2.637, p = 0.127

In the light of the results reported in Table 4, a further analysis was conducted with respect to Hypothesis 3. The reasoning behind this hypothesis was that a greater number of thematic operations would increase the complexity of DVAdjs and, consequently, their processing time. However, in order to avoid confounding the processing of TFs with decomposition, the results were reanalyzed such that we compared DVAdjs that were consistent with respect to their lexical access route. Thus DVAdjs-*tos*, which are the only DVAdjs that appear to be accessed as whole words, were excluded from the new analysis. The remaining DVAdjs all seemed to be accessed through decomposition. Thus the means of DVAdjs-*simos* and DVAdjs-*menos* (with two thematic operations) were compared with DVAdjs-*tikos* (with one thematic operation). Table 5 displays the means and standard deviations for this regrouping of items. A one way ANOVA [F2(1,23) = 0.862, p = 0.36] showed no statistical significance between DVAdjs involving two thematic operations (-*simos/-menos*) versus DVAdjs-*tikos* involving one thematic operation. Thus, in the light of this reanalysis, Hypothesis 3 was not confirmed. In other words, the number of thematic operations involved in the derivation of a DVAdj did not appear to affect its processing load. Given the results supporting Hypothesis 2, we obtained evidence that TFs are detected during lexical access. However, the failure to support Hypothesis 3 indicates that the parser does not seem to differentiate between different numbers of thematic operations involved in derivation. This result is in accordance with the findings of Manouilidou et al. (2004). We could thus speculate from the combined results of the two experiments that, although the parser detects the presence of TFs during visual single word recognition, it may not differentiate between DVAdjs formed after different numbers of thematic operations have taken place. However, it is also possible that the lexical decision paradigm was not sufficiently sensitive to detect difference in RTs associated with processing one versus two thematic features.

Table 5: Mean RTs (with SDs) in Milliseconds for DVAdjs Regrouped by Number of Thematic Operations Controlling for Decomposition in Experiment 1

DVAdjs with 1 thematic operation (-tikos)	687 (31)
DVAdjs with 2 thematic operations (-simos + -menos)	702 (42)

6.1.4 Experiment 1: Preliminary Interpretation

In this section a preliminary interpretation of the results of Experiment 1 is presented. Our study was based on the premise that derivational processes and other lexical properties are processed during lexical access and that this processing is reflected in increased RTs. We investigated this question with respect to the processing of TFs in DVAdjs, finding that TFs of DVAdjs are processed during word recognition depending on the **access route**. Although only the **decomposition** access route permits processing of TFs, our results nonetheless suggest that inherited features play a distinct role in the formulation of the mental representation of DVAdjs and in their lexical access. Furthermore, the role of these inherited features is not diminished by a change in grammatical class from verb to adjective.

The role of decomposition also suggests that the processing of TFs can be observed only in later stages of processing, after morphological parsing has taken place. This further implies that accessing of lexical features occurs in stages, with the first one being decomposition, followed by processing of TFs, before finally arriving at the lexical representation. Thus, TFs of DVAdjs are not accessed in the initial stage of processing. Staged accessing is well demonstrated in the literature and has implications for several theoretical proposals regarding the nature of lexical representation, lexical access and the organization of the lexicon. For instance, it has been shown (e.g. Feldman, 2000; Tsapkini, Jarema & Kehayia, 2002) that different kinds of information influence lexical access at different time intervals. In other words, the various processes and features that influence lexical access may each have their own independent time course of activation.

Schreuder & Baayen's (1995) model of lexical access is in accordance with this line of thinking. According to Schreuder & Baayen (1995), each stimulus at an initial stage is transformed into an *intermediate access representation* which can be identical either to the whole word (e.g. *distraction*) or to the word decomposed into its constituents (e.g. *distraction*). In the process of lexical access as described by Schreuder & Baayen (1995), the

recognition of a lexical item involves activation of the various concept nodes in order for the final lexical representation to be accessed. What is of particular importance for our study is that these nodes receive feedback from syntactic and semantic representations associated with them. The speed of activation depends on the complexity of the mapping process from the intermediate stages to the access representation proper. Since TFs do not appear to be accessed for every DVAdj, but only for those accessed after decomposition, we can postulate that when the *access representation* has the form of the whole word, activation feedback from TFs is not a necessary step in accessing the lexical representation. In the opposite case, when the access representation has the decomposed form, the concept nodes receive activation feedback from TFs and this process is reflected in longer RTs.

The results of Experiment 1 imply that not all features of a word are immediately accessible. Thus, although TFs may constitute part of the lexical entry of DVAdjs, their staged access, filtered through decomposition, suggests that TFs might only be necessarily part of the recognition process of a DVAdj under certain circumstances, at least for visual word recognition. Since TFs are inherited features for DVAdjs, stemming from the verbal root, and since decomposition appears to be a special condition which triggers their surfacing, we could assume that it is *viewing the verbal root* that activates the processing of TFs in DVAdjs. This is in accordance with the fact that TFs are highly salient features of verbs which are always processed during lexical access.

Unfortunately, Experiment 1 did not allow us to determine with certainty either the role of decomposition or the role of the verbal root. This became the focus of the next study, which aimed, firstly, at determining that the lexical access route opted for during lexical access matters, with decomposition favoring the processing of TFs; at a second step our goal was to explore to what extent the verbal root plays a key role in triggering the processing of TFs.

6.2. Experiment 2: Low Frequency Deverbal Nouns: Probing the effect of the verbal root

6.2.1 Experiment 2: Rationale, Research Questions, and Hypotheses

In Experiment 1 we saw that a lexical access route involving decomposition might be a determining factor for the processing of TFs of DVAdjs, since it triggers the surfacing of the

verbal root. Experiment 2 sought to determine whether decomposition is a prerequisite for the processing of TFs of deverbal nouns, thereby permitting direct access to the features of the verbal root. The study compared on-line lexical access times for three groups of low frequency nouns that differ with respect to their structural complexity and TFs. The three groups are deverbal nouns (DVNs), such as *syntiritis* ‘maintainer’, denominal nouns (DNNs), such as *sfouggaras* ‘sponge-diver’ and non-derived nouns (NDNs), such as *adartis* ‘partisan’. Our reasoning was as follows: In order to probe decomposition during lexical access, we needed to use low frequency items. This was based on the claims of dual route models such as Caramazza et al. (1988) and Schreuder & Baayen (1995), which were adopted for the present thesis (see section 2.2.1.3). These models postulate that low frequency words are accessed after being decomposed into their constituents. A comparison of derived nouns with NDNs would reveal whether or not decomposition actually occurred. We could then compare the decomposed DVNs to the decomposed DNNs. If longer RTs were observed for the DVNs, this could be attributed to the presence of their TFs. Thus our research question was the following: Does decomposition and the consequent viewing of the verbal root facilitate accessing the TFs of DVNs?

As with the Experiment 1, our hypotheses were based on two working assumptions. The first was that the low frequency of the stimuli will induce their surfacing and consequently their access after decomposition. As decomposition has been shown to be at least partially responsible for longer RTs observed during the processing of complex forms (Chialant & Caramazza, 1995; Schreuder & Baayen, 1995), Hypothesis 1 stated that we expect derived forms (DVNs and DNNs) to yield longer processing times than non-derived forms (NDNs).

Our second assumption was that the lexical entry of a DVN is specified for TFs inherited from the verbal root through various operations taking place during derivation. This is not the case for DNNs, as nouns do not normally carry TFs. Once decomposition has taken place, allowing the verbal root of a DVN to be viewed, its TFs will be activated. This activation should be reflected in longer processing times. Thus Hypothesis 2 stated that RTs would be longer for DVNs than for DNNs.

6.2.2 Experiment 2: Method

As with Experiment 1, the method used to address the research questions was a simple lexical decision task. The experiment was conducted in two phases.

Phase 1: Familiarity ratings

In the first phase, off-line familiarity ratings were obtained for a total of 256 items in order to select the stimulus set. The list included derived nouns (potential stimuli) and their nominal or verbal bases. The 36 Greek university students who participated followed the standard procedure as described in section 5.3.1.

Phase 2: On-line task

Procedure

The second phase comprised the on-line task. There were no deviations from the standard procedure as described in section 5.3.1.

Participants

Twenty-four (24) native speakers of MG volunteered to participate in the on-line study. The study included males and females from 20 to 28 years old (mean age 23.5). All were undergraduate and graduate students at Aristotle University of Thessaloniki.

Stimuli

Stimuli (see Appendix B) included Modern Greek DVNs, DNNs and NDNs. The three groups of nouns were matched for frequency (with a mean of 2.3 on a scale from 1 to 5), length, number of syllables, and imageability. Each group of nouns is subdivided into separate categories, which are described below for each group. As the characteristics of each group of deverbal nouns were described in detail in section 3.4.2, they are only briefly summarized in the following paragraphs.

- *Deverbal Nouns (DVNs)*

Three categories of DVNs were used in Experiment 2, with 16 items in each. Each category was formed with a different suffix and demonstrates distinct sentential properties and TFs.

1. **DVNs-tis**. These are formed by adding the suffix *-tis* (the semantic equivalent of English *-er*) to a strictly⁴⁶ transitive verb. The suffix *-tis* creates subject nominalizations, which refer to animate entities, e.g. *katakto* > *kakti-tis* ‘to conquer’ > ‘conqueror’. As they do not demonstrate behaviour that is comparable to verbs, i.e. they do not permit manner adverbials (example 44a), cannot bear aspectual modification (example 44b) and do not take *by*-phrases in a sentential context (example 44c), we could say that *-tis* nominals demonstrate a diminished verbal character.

- (44) a. *O katharistis tou ktiriou *prosektika*
 the cleaner theGEN buildingGEN carefully
 *‘the cleaner of the building carefully’
- b. *O katharistis tou ktiriou *epi ena mina*
 the cleaner theGEN buildingGEN for a month
 ‘the cleaner of the building for a month’ (Alexiadou, 2001: 129)
- c. *O katharistis tou ktiriou *apo to Jianni*
 The cleaner theGEN building by the Jiannis
 *‘the cleaner of the building by Jiannis’

2. **DVNs-si**. These are formed by adding the suffix *-si* (the semantic equivalent of English *-ion/-ation*) to a strictly transitive verb. They refer to process/result nominalizations, e.g. *diorthono* > *diortho-si* ‘to correct’ > ‘correction’. In a sentential context, they do not tolerate aspectual modification denoting repetition, as illustrated in (45).

- (45) **I syxni anatinaksi tis gefyras apo to strato*
 the frequent blowing theGEN bridgeGEN by the army
 ‘the frequent blowing up of the bridge by the army’

⁴⁶ For instance, optionally transitive verbs like *eat* that can be used either transitively (e.g. *I eat an apple*) or intransitively (e.g. *John went to eat*) were avoided.

3. **DVNs-*ma/-simo***. These are formed by adding the suffixes *-ma/-simo* to a transitive verb and are the semantic equivalent of English nominal gerunds with *-ing*. They denote mainly acts and more rarely results, e.g. *ravo* > *raps-imo* ‘to sew’ > ‘sewing’. In a sentential context, they tolerate adjectival aspectual modification denoting repetition and *by*-phrases, as shown in (46).

- (46) *To syxno* *plysimo* *ton* *piaton* *apo to Jianni*
the frequent washing theGEN dishesGEN by the Jiannis
‘the frequent washing of the dishes by Jiannis’

The comparison between DVNs-*si* vs. DVNs-*ma/-simo*, as outlined in section 3.4.2.4, revealed that although both *-si* and *-ma/-simo* nominals have similar semantic properties, they also demonstrate considerable differences when placed in context. These differences suggest that the DVNs-*ma/-simo* demonstrate a behaviour which is closer to that of verbs.

What we should keep in mind with respect to the above descriptions is that the three groups of DVNs demonstrate diverse sentential and argument structure (AS) properties. For instance, those formed with *-tis* are the least ‘verb-like’, since they refer to animate entities and do not accept modifications which typically occur with verbs. The DVNs-*si* retain more verbal properties than the DVNs-*tis*, but not as many as the *-ma/-simo* ones. These differences cannot be described as being the byproduct of any morphological rule. Instead, they seem to result from inherent semantic properties for each nominal. DVNs-*si* and DVNs-*ma/-simo* are formed in an identical way; they both involve the same type and number of thematic operations and they both denote activity or its result. However, when placed in a sentential context, subtle differences emerge, which result in different behaviours. Although there is no particular hypothesis with respect to the emergence of these differences in sentential context, we should keep in mind that some nominals demonstrate more ‘verb-like’ properties than others. It remains to be seen whether these properties differentially affect lexical access.

- *Denominal Nouns (DNNs)*

The study comprised three groups of DNNs, with 16 items in each group. Unlike the DVNs, the DNNs lack TFs:

1. **DNNs-*as***. Formed from various nouns with the suffix *-as*, these DNNs serve as controls for *-tis* nominals and denote occupation or profession, e.g. *sfouggar* > *sfouggar-as* ‘sponge’ > ‘sponge diver’.

2. **DNNs-*ia***. Formed from various nouns plus the suffix *-ia*, these DNNs serve as controls for *-si* nominals and denote qualities associated with the base noun, e.g. *zitianos* > *zitania* ‘beggar’ > ‘beggary’.

3. **DNNs-*adiko***. Formed from nouns plus the suffix *-adiko*, these DNNs serve as controls for *-ma/-simo* nominals and denote the place associated with the base noun, e.g. *psaras* > *psaradiko* ‘fisherman’ > ‘fishery’.

- *Length Controls*

One group of DVNs differed in length from their denominal controls. That is, the average number of letters for the DVNs-*ma/-simo* was 7.8 as opposed to 10.9 for their controls, DNNs-*adiko*. In light of this difference, an extra group of stimuli, called Length Controls (LCs), was added to the study to serve as additional controls for the DVNs-*ma/-simo*. The reasoning behind the use of length controls is the following: DVNs-*ma/-simo* differed from their controls (DNNs-*adiko*) in terms of both TFs and length. Thus, if these two categories were to differ significantly in RTs, we would be unable to determine whether this was due to the presence/absence of TFs or to a difference in length. DVNs-*ma/-simo* were similar in length to the LCs, but differed in terms of TFs. Hence, any difference in RTs between DVNs-*ma/-simo* and the LCs could be attributed to the presence of TFs. DNNs-*adiko* differed from the LCs in terms of their length. Therefore, any RT difference between them could be attributed to the length difference. However, if there were to be no difference in RTs between LCs and DNNs, then we could conclude that length was not an issue. This would allow a direct comparison between DNNs-*adiko* and DVNs-*ma/-simo*. In this case, an RT difference between the two groups could be attributed exclusively to the presence of TFs. The LC group consisted of 16 nouns with an average of 7.06 letters. They were denominal or

deadjectival nouns varying in gender and in semantic properties, e.g. *asprila* ‘whiteness’, *voutyras* ‘butter seller’.

- *Non-derived Nouns (NDNs)*

The stimulus set also comprised 48 NDNs that were matched for familiarity, length, gender and number of syllables with the actual experimental stimuli. There were three groups of 16 NDNs, each serving as controls for a group of derived nouns. In other words, each group of non-derived nouns served as control for two groups: one group of DVNs and its DNN controls.

- *Fillers and Non words*

The stimulus set also included filler word targets to distract participants from the purpose of the experiment. The 44 filler words consisted of various types of non-derived verbs. The 138 non-words in the list were obtained by replacing one or two letters of a real MG word in accordance with the phonotactic constraints of the language. The presence of non-words allowed participants to legitimately reject some of the stimuli as not being words in MG.

Data analysis

The dependent measure was lexical decision latency reported as RTs in milliseconds. In all analyses, separate ANOVAs were conducted, treating items as independent variables. Pairwise comparisons with Bonferroni adjustments for multiple comparisons were also carried out. All reported RTs represent a mean of subject responses. Prior to the analysis, erroneous responses were removed, resulting in a loss of less than 3% of observations. Responses exceeding 1500ms were considered to be ‘off-line’ and were removed as well. Outliers (response times below and above two standard deviations from the mean) were also removed from the dataset. This resulted in a by subject loss of data varying from 3 to 6%. As with the previous experiment, the majority of errors and outliers were concentrated in non-words. No subjects or items were removed from the data set.

6.2.3 Experiment 2: Results

Table 6 presents mean RTs and SDs for each group of stimuli. A 3X3 ANOVA revealed an overall effect of category both by subject [$F(1, 23) = 4.80, p < 0.0001$] and by item [$F(2, 101) = 3.65, p = 0.029$], while pairwise comparisons showed a significant difference between the derived forms and the non-derived ones: DNNs vs. NDNs [$F(1,23) = 2.13, p=0.0009$; $F(2,101) = 2.01, p=0.031$], DVNs vs. NDNs [$F(1,23) = 3.14, p = 0.029$; $F(2,101) = 3.02, p = 0.013$]. However, no difference was observed between DVNs and DNNs [$F(1,23) = 0.29, p = 0.81$; $F(2, 101) = 0.15, p = 0.906$].

Table 6: *Mean RTs (with SDs) in Milliseconds by Stimulus Type in Experiment 2*

Type of stimuli	RTs (SD)
DVNs	714 (62)
DNNs	713 (41)
NDNs	688 (44)

In the light of these findings, Hypothesis 1, which predicted that derived forms (DVNs and DNNs) would yield longer RTs than NDNs, was supported. This further indicates that decomposition and consequently, activation of the verbal root, did occur for derived nominals. However, the lack of any difference between DVNs and DNNs showed that, while the verbal root was activated during lexical access, this activation did not influence the processing of TFs. Therefore, Hypothesis 2 does not seem to be supported.

A more detailed analysis, which intended to investigate the existence of any concomitant variation in processing across DVNs, by category, was carried out. Instead of grouping together all the DVNs, the DNNs and the NDNs, each subtype of stimulus category constructed with a different suffix was treated separately. The new analysis sought to identify possible differences within the group of DVNs, thus allowing us to look at how the specific properties attributed to each group of DVNs may have interacted with the processing or lack thereof of TFs. In other words, with the new analysis, differences between nominals in terms of their 'verb-like' character (see sections 3.4.2.2 and 6.2.2) could be taken into consideration. RTs by subgroup are shown in Table 7.

Table 7: Mean RTs with (SDs) in Milliseconds by Stimulus Subtype in Experiment 2

Deverbal Nouns		Denominal Nouns		Non-derived Controls	
DVNs- <i>ma/-simo</i>	754 (34)	DNNs- <i>adiko</i>	722 (23)	NDNs- <i>adiko</i>	688 (45)
DVNs- <i>tis</i>	690 (35)	DNNs- <i>as</i>	702 (43)	NDNs- <i>as</i>	657 (39)
DVNs- <i>si</i>	706 (35)	DNNs- <i>ia</i>	713 (25)	NDNs- <i>ia</i>	699 (66)
		LC	711 (23)		

A 3X3 ANOVA revealed significant differences across categories. Pairwise comparisons showed that two groups of DVNs (DVNs-*ma/-simo*, DVNs-*tis*) differed significantly from their non-derived controls [$F(1,23) = 4.93$; $p = 0.0001$; $F(2,101) = 4.80$, $p = 0.001$] and [$F(1,23) = 1.02$, $p = 0.049$; $F(2, 101) = 1.23$, $p = 0.057$] respectively. However, this was not the case for DVNs-*si* group, which yielded similar RTs to their ND controls [$F(1,23) = 0.09$, $p = 0.81$; $F(2,101) = 0.30$, $p = 0.928$]. A similar disparity occurred within DNNs. Those formed with the suffixes -*adiko* and -*as* differed significantly from their non-derived controls [$F(2,101) = 3.52$, $p = 0.01$; $F(1,23) = 3.02$, $p = 0.023$] and [$F(2,101) = 2.16$, $p = 0.011$; $F(1,23) = 2.96$, $p = 0.031$] respectively, while DNNs with -*ia* did not [$F(2,101) = 0.45$, $p = 0.81$; $F(1,23) = 0.08$, $p = 0.928$]. These results strongly suggested that DVNs-*si* and DNNs-*ia* were not accessed through decomposition. Interestingly, the LCs differed significantly from the DVNs-*ma/-simo* [$F(1,68) = 3.99$, $p = 0.041$; $F(1, 170) = 3.43$, $p = 0.057$], but they did not differ from the DNNs-*adiko* [$F(1,68) = 3.06$, $p = 0.081$; $F(1,272) = 2.76$, $p = 0.095$]. This indicated that length was not an issue, and permitted us to make a straightforward comparison between DVNs-*ma/-simo* and DNNs-*adiko*.

In the light of these new findings, Hypothesis 2 was re-examined via an additional analysis for which the DVNs and DNNs were divided into two groups, based on whether or not they differed in RT from their non-derived controls. Thus DVNs-*ma/-simo* and DVNs-*tis* and their respective controls, DNNs-*adiko* and DNNs-*as*, were placed in the *decomposed* lexical access route category. DVNs-*si* and DNNs-*ia* were placed in the non-decomposed lexical access route category. Results of this analysis are shown in Table 8.

Table 8: Mean RTs with (SDs) in Milliseconds and Comparison of DVNs and DNNs, Grouped by Lexical Access Route in Experiment 2.

Nouns minus decomposition		
DVNs- <i>si</i>	706 (35)	p = NS
DNNs- <i>ia</i>	713 (25)	

Nouns plus decomposition		
DVNs- <i>ma/-simo</i>	754 (34)	p = S
DNNs- <i>adiko</i>	722 (23)	
DVNs- <i>tis</i>	702 (43)	p = NS
DNNs- <i>as</i>	690 (35)	

There was no significant difference between the non-decomposed deverbal and denominal nouns DVNs-*si* and DNN-*ia* [$F(1,23) = 0.091$, $p = 0.68$; $F(2,28) = 0.074$, $p = 0.74$]. The lack of a difference between DVNs-*si* versus DVNs-*ia* was compatible with our prediction that only decomposition would trigger processing of TFs. Therefore, we could still maintain that decomposition might be a necessary prerequisite for the processing of TFs of DVNs, as originally hypothesized. However, there was still no uniformity within the decomposed DVNs group. The decomposed DVNs-*ma/-simo* differed significantly from their DN controls ($F(1,23) = 3.74$, $p = 0.009$; $F(2,28) = 3.13$, $p = 0.038$). We took this difference to reflect processing of TFs for DVNs-*ma/-simo*. Nevertheless, the effect of TFs was not detected for decomposed DVNs-*tis*, since they did not differ significantly from their DN controls ($p=0.491$). This further suggested that the processing of TFs might be due to other factors, such as the specific properties of each nominal and not simply due to the viewing of the verbal root. We address this issue in the following section.

6.2.4 Experiment 2: Discussion

The aim of Experiment 2 was to determine to what extent the decomposition access route and the subsequent activation of the verbal root would result in the surfacing of TFs of a DVN as measured in longer RTs. This was based on theoretical proposals such as the one by Baker and Bobaljik (2002), according to which the TFs of the verbal root are passed on to

deverbal nominals via the derivational suffix, and on the findings of Experiment 1, which indicated that TFs of a DVAdj. might be processed only when decomposition takes place. As we saw, two groups of DVNs, those formed with the suffixes *-ma/-simo* and those formed with the suffix *-tis*, were accessed after decomposition. Nevertheless, only the DVNs-*ma/-simo* yielded longer RTs than their denominal controls. This difference was attributed to the processing of TFs. However, the lack of a significant difference in RTs between decomposed DVNs-*tis* and DNNs-*as* suggested that the presence of TFs did not appear to add to the processing load of DVNs-*tis*. Therefore, we could not maintain that viewing the verbal root automatically triggers the processing of TFs.

We can perhaps explain the disparity in processing of TFs in decomposed DVNs by examining possible conditioning factors of the specific properties of each item type. In sections 3.4.2.2 and 6.2.2 we saw that there are significant differences between nominals formed with *-ma/-simo* and those formed with *-tis*. Namely, while DVNs *-tis* refer to an animate entity and do not show any ‘verb-like’ behaviour, those formed with *-ma/-simo* are the prototypical process nouns; they are semantically eventive and they demonstrate ‘verb-like’ sentential properties. This line of thinking allows us to make a link with the results obtained in Experiment 1 for the DVAdjs, where the processing of TFs was only observed in those items formed with the suffixes *-simos/-menos/-tikos* (see section 6.1.3). The suffixes *-simos* and *-menos* form adjectival passives which by default have increased ‘verb-like’ properties compared to other descriptive adjectives. Similarly, DVAdjs-*tikos* are ‘agentive’ adjectives, in the sense that they attribute an agentive/active property to their referent. Therefore, with respect to our research question, it seems that the role of the verbal root in triggering the processing of TFs is not as prominent as originally anticipated. Instead, it appears that it is the specific properties of a particular item that are responsible for the processing or not of its TFs. Moreover, these properties are determined to a great extent by the particular suffix. For instance, although the DVNs *read-er*, *read-ing*, *read-able* are formed on the same base, they are very distinct from one another in every other respect. Their differences can only be attributed to the particular suffix used to derive each one.

This claim is still compatible with the role of decomposition, which we consider to be a facilitatory, but not a sufficient condition for the processing of TFs in DVNs. Namely, decomposition not only facilitates the activation of the verbal root, but it equally facilitates

the activation of the suffix. When the suffix is activated, all the specific properties of a word become visible. If these properties happen to indicate an increased ‘verb-like’ character, then TFs have a more prominent role for that DVN. This results in the TFs of the DVN being processed in a similar manner to the TFs of verbs.

The results of Experiment 2 have further implications for the description of the mental representation of DVNs and for theories of deverbal word formation. The major finding of Experiment 2 is that TFs are processed only for those DVNs with increased verbal properties. This further implies that TFs are not a defining characteristic for every DVN. Only those with increased ‘verb-like’ properties have TFs as an integral part of their representation in as much as they are processed during word recognition. This observation contrasts with verbs, in that TFs have been demonstrated to be an integral part of their processing and representation independently of the specific verb type. Hence, it seems that DVNs do not have a uniform mental representation, with some of them sharing more properties with verbs and others with nouns. Based on this finding, we can question the status of grammatical class as a unit of lexical organization in the mental lexicon.

Furthermore, it seems that the parser may have to decompose a DVN into its constituents in order for the TFs to be accessed. As postulated for the same finding in Experiment 1 (see section 6.1.4), this could be taken as evidence for a layered mental representation for DVNs in which their various properties exist at different levels and are not accessed at the same time during the recognition process. Thus, the findings of the present study provide further support for previous claims of a different time-course of activation for various features.

On the basis of Experiment 1, in which we noted the facilitatory role of decomposition, we speculated that viewing the verbal root might trigger the processing of TFs (see section 6.1.4). However, Experiment 2 has shown that viewing the verbal root is not the sole determining factor in triggering the processing of TFs. Instead, the processing of TFs seems to depend on the verbal character of the particular nominal, which results from the properties of the suffix. If this is indeed the case, the theories of deverbal word formation should take into account the role of the suffix in determining the properties of the derived form. Hence, the role of the suffix should not just be seen as simply transmitting the TFs of

the verb to the DVN, but more importantly as determining the actual AS properties of the new word formation.

The following experiments allowed us to further examine the role of various suffixes in word formations and the subsequent processing of TFs. The stimuli in these experiments consisted of pseudo and novel words. As these non-attested items are devoid of certain additional factors that influence lexical access of existing words, such as frequency of occurrence and lexicalization, their use permitted us to investigate the role of TFs more directly.

6.3 Experiments 3 and 4: Thematic constraints on deverbal word formation: evidence from lexical access of Pseudo-Ws

In the light of the results of the two previous experiments investigating the status of TFs in accessing DVNs and DVAdjs, the off-line and on-line experiments discussed in the present section seek to determine the status of TFs in pseudo and novel word formation. We have seen that the processing of TFs does not occur inevitably when accessing a DN. Instead, it is only detected in certain nominals, depending on their verbal properties and possibly on whether or not they are accessed after decomposition into their constituents. The results of the previous experiments led us to conjecture that the crucial factor might be the view of the suffix, since it determines the AS properties of the nominal.

In Experiments 3 and 4, we attempt to investigate the status of TFs in pseudo word formation by using the same suffixes that appear in the stimuli of Experiments 1 and 2 to create Pseudo-Ws which violate the thematic specifications of both the verb and the suffix. Thus, the stimuli include Pseudo-Ws with the suffixes *-tis*, *-simos*, *-tikos*, and *-tos* paired with existing verbal roots, the thematic specifications of which do not permit suffixation with the above suffixes. For instance, pairing *-tis* with a verb which is not predicated of an Agent external argument, such as *die*, will result in an ungrammatical combination in terms of TFs (i.e. *dier*). Focusing on Pseudo-W formation allows us to eliminate the effects of lexical frequency and lexicalization that might affect recognition of existing lexical items, thus better isolating the effect of TFs. The use of Pseudo-Ws also guarantees that lexical access will take place via decomposition.

Before launching into a description of the study, I will briefly review the theoretical background which touches upon relevant issues of word formation and the role of various constraints.

6.3.1 Constraints in word formation

Every theory of word formation acknowledges that not all suffixes can attach to all bases. This is usually discussed as a matter of *constraints* on collocations of elements (e.g. Ralli, 2005: 53). The use of the term *constraints* has the advantage of indicating that ‘the restrictions are not necessarily absolute’ (Bauer, 2001: 126). They can be classified as *stronger* and *weaker*. A *stronger* constraint describes a process in which an affix attaches only to a particular type of base, such as the suffix *-ness* in English (e.g. *happi-ness*, *white-ness*). A *weaker* constraint refers to the fact that an affix prefers a particular type of base or usually attaches to a particular type of base while also permitting larger classes of words to act as potential bases. For instance, the English *-er* prefers verbal agentive bases (e.g. *teacher*), but it can also attach to non-agentive Vs (e.g. *hearer*) and nouns (e.g. *villager*).

There are various types of constraints related to lexical factors in MG, such as the lexical or morphological features of the base (Ralli, 2005: 155). For example, the feature of +/-learned seems to play a role in the case of the suffix *-ios*, which can only attach to +learned bases. That is why MG permits *opisth-ios* ‘posterior’ from the +learned base *opisthen* ‘backwards’, but not **pisios* from the -learned base *piso* ‘backwards’. Similarly, in some cases the base has to be of a particular structure; i.e. the suffix *-adoros* attaches only to bases with the feature +Romance, e.g. *kombin-adoros* ‘fiddler’. Finally, various sources (e.g. Ralli, 2005: 156) mention constraints related to general principles of a language such as blocking. For instance, in MG the existence of the word *mageiras* ‘cook’ blocks the occurrence of the word **mageiref-tis* ‘cook-er’.

The experiments discussed below focus on a different category of constraints, called *interaction constraints*, which result from the relation of morphology to other components of grammar. These are constraints imposed by systems external to morphology, but which nonetheless confine morphological operations (compounding, inflection, derivation). Instances of such *phonological*, *syntactic*, and *semantic* constraints are described in the

following sections⁴⁷. These constraints are considered to be universal, seemingly applying to every type of derivation (e.g. Ralli, 2005). However, their function does not preclude the existence of other constraints specific to certain derivational operations.

Phonological constraints

Phonologically conditioned allomorphs illustrate constraints on the collocation of morphological elements. For instance, the /tʒ/ allomorph of the English plural results from the phonotactic impossibility of clusters of stridents in English. Likewise in MG, phonological constraints on morphological compatibility are well-attested and not at all unusual. For example, the MG suffix *-ma* (nominal *-ing*) attaches to multi-syllabic bases, while its semantic equivalent, the suffix *-simo*, prefers monosyllabic bases (Ralli, 2005; Malikouti-Drachman & Drachman, 1989, 1995).

Syntactic constraints

Syntactic constraints are context-based. Since a word's usage also depends to some extent upon its class membership, context and class membership can be seen as inextricably linked to one another. The most widespread syntactic constraint is that affixes are generally restricted to a particular word class (nouns, verbs, adjectives). Thus, the MG suffix *-mos* strictly selects verbs as opposed to nouns or adjectives (e.g. *dioko* 'persecute' > *diog-mos* 'persecution').

Class-based constraints can be even more specific. For example, there are many types of deverbal affixation that are sensitive to the transitivity of the verbal base. Both the Dutch suffix *-baar* and English *-able* are used with transitive, but not intransitive verbs, so that **becomable* and its Dutch equivalent are not possible words.

Semantic constraints

In some cases, semantic constraints are based on general world knowledge. For instance, the MG suffix *-enios* attaches to the names of materials (such as *lamarina* 'steel sheet' > *lamarinenios* 'made of steel'). Since the only things that items can be made of are their materials, this is simply a matter of making sense.

⁴⁷ The majority of the examples from MG in the following sections are from Ralli (2005).

Thematic constraints

The above mentioned constraints (phonological, syntactic, and semantic) are obligatory in every type of word formation. However, there are other constraints which seem to apply only to specific types of word formation. Thus, in addition to phonological, syntactic and semantic constraints, deverbal word formation is subject to further constraints deriving from AS properties that both the verbal base and the suffix bear. Such constraints are referred to as *thematic constraints*. Although these constraints were alluded to earlier in section 3.3.2, they are reiterated here for purposes of clarity. We will use several examples based on Baker and Bobaljik (2002) to illustrate such constraints.

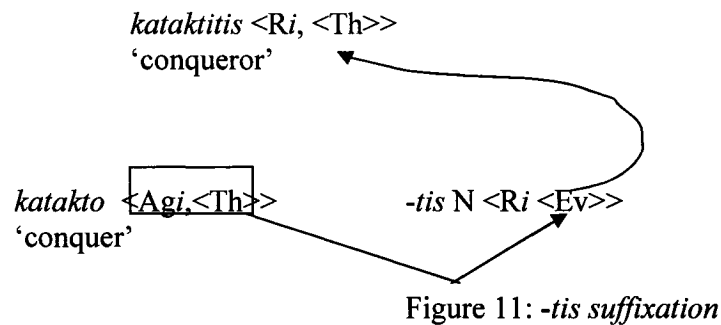


Figure 11: *-tis* suffixation

Figure 7 (p. 76), repeated here as Figure 11, illustrates the derivation of *kataktitis* 'conqueror' with the MG suffix *-tis* (-er) within Baker and Bobaljik's (2002) framework. Baker and Bobaljik (2002) describe how the thematic properties of the base and the verb interact in order to form a DN by using their representational tools of Argument Binding, Substitution Linking and the Node Labelling Convention (NLC). The AS of the noun *kataktitis* 'conqueror' consists of the external R argument, common to every noun, as well as a Theme internal argument.

B&B arrive at this particular AS specification through the following process. The verb *katakto* 'conquer' takes an Agent external argument and a Theme internal argument. The suffix *-tis* (-er) creates Nouns with a typical noun argument structure $\langle \text{R} \langle \text{Ev} \rangle \rangle$. The R argument is also understood as being the same as the Agent of the verb root. Baker and Bobaljik (2002) call this *argument binding*. We can represent this by putting the same subscript on the binding argument and the bound argument. In *-tis* (-er) suffixation, the $\langle \text{Event} \rangle$ argument is replaced by the AS of the verb via *substitution linking*. This new AS is

passed on to the nominal via another mechanism, which is called the *node labelling convention*.

In contrast to Figure 11, when the appropriate thematic constraints are not respected, we end up with word formations such as the one illustrated in Figure 12.

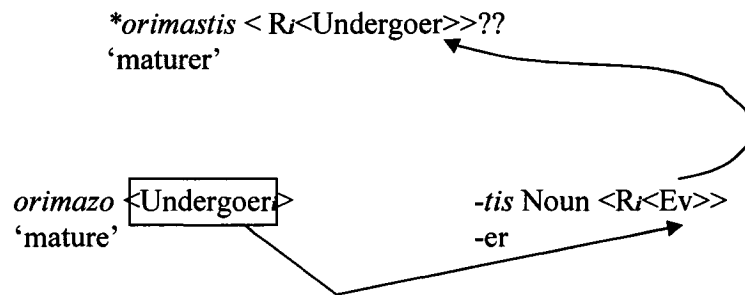


Figure 12: *-tis violation*

The word formation **orimastis* (**maturer*) is ungrammatical because it violates the thematic constraints of *-tis* suffixation. The verb *orimazo* 'to mature' takes a single internal argument, which is a type of *Undergoer*. The suffix *-tis* (-er) needs to bind the external Agent argument of the base verb (via *argument binding*), but in this case, there is none. If we insist, nonetheless, on continuing with this derivation, the consequent substitution linking and node labelling convention will yield the word *orimastis* (**maturer*), which has an AS consisting of basically two *Undergoers*, since the R external argument is co-indexed with the *Undergoer* argument of the base verb. Note, however, that if there is no argument binding that takes place, then the AS of the word *maturer* will consist of an R external argument and an *Undergoer* internal argument and it could be interpreted as meaning 'somebody who causes somebody else to mature, to grow'. In this sense, the word would not be ungrammatical. However, argument binding and the consequent co-indexation of the R argument of the suffix with the *Undergoer* argument of the base verb is an essential part of *-tis* suffixation. For this reason we cannot overlook it and attribute a causative meaning to the word *maturer*.

Similar constraints apply with other deverbal word formations, such as those with the suffix *-simos* (-able), which must bind the internal Theme argument of a verb predicated of an agent and a theme, as illustrated in Figure 5 (p. 68), repeated here as Figure 13.

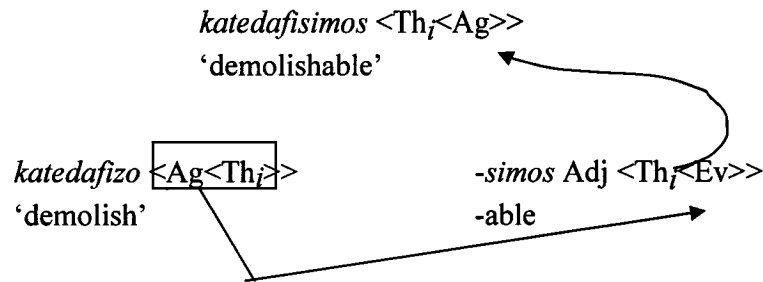


Figure 13: *derivation of DVAdj-simos*

The AS of *katedafizo* 'demolish' is <Ag<Th_i>> and that of *-simos* (-able) is <Th_i<Ev>>. The notation indicates that the two arguments must be interpreted as sharing an identity. Of crucial importance here is the presence of an 'implicit' agent. The rest of the AS of the verb (the Agent argument) is substituted into the AS of *-simos* and is passed on to the derived word. In other words, the Event argument gets replaced by the AS of the verb via *substitution linking*. The result is a two-argument adjective, with a Theme external argument and an Agent internal argument that is inherited from the verb root.

As in Figure 12 above, if these constraints are not respected, then the derivation results in ungrammatical formations such as the word '*orimasimos*', illustrated in Figure 14.

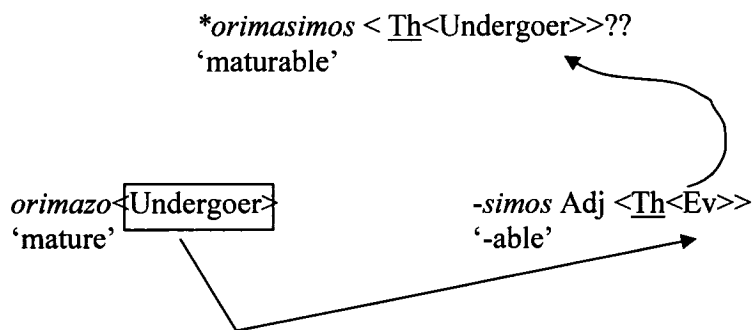


Figure 14: *-simos violation*

The AS of *orimazo* 'to mature' is <Undergoer> and the AS of *-simos* (-able) is <Th<Ev>>. The suffix *-able* needs to bind the external Theme argument of the base verb, but in this case there is none. Instead, there is just an internal undergoer/theme argument. If we, nonetheless, decide to proceed with the derivation, then the result will be a two-argument adjective, with a Theme external argument and an undergoer (or another theme) internal argument.

Thus derivation with the suffixes *-tis* and *-simos* must respect certain thematic constraints which can be summarized as follows: The suffix *-tis* attaches to a verbal base with the feature +Agent and the suffix *-simos* attaches to verbal bases with the argument structure <Ag<Th>>. Failure to respect these constraints would give one of two results. The first is a type of Pseudo-W with *categorical* violations as in (1), where the lexical category of the base is inappropriate. The second is a type of Pseudo-W with *thematic* violations as in (2).

(1) Pseudo-Ws with Categorical Violations (*N+tis/simos)

**karekla-tis* (*chair-er)

**trapez-imos* (*table-able)

(2) Pseudo-Ws with Thematic Violations

a. [V *(-Ag) + tis]

e.g. **aimorragi-tis* (*bleed-er)

b. [V *(-Ag<Th>>) + simos]

e.g. **kathis-imos* (*sit-able)

According to the definition given at the beginning of the section (p. 129), both types of constraints, the one imposed by *-tis* and the one imposed by *-simos*, are classified as strong in Modern Greek⁴⁸.

In the above section I have illustrated the existence of constraints and the ill-formed lexical items that result from failure to comply with them. However, there are still questions about constraints that need to be addressed which are relevant to the processing of TFs. Foremost among these is whether all constraints on word formation are equally strong. Although linguistic theory draws a line between permissible and not permissible formations, depending on whether they respect the constraints, it is not clear how any hypothesis about the relative strengths of constraints can be tested within a purely theoretical framework. One way to investigate potential differences between theoretically strong constraints, such as thematic versus categorical constraints in deverbal word formation, is to look for behavioural

⁴⁸ Note that there might be a few exceptions to these thematic constraints. These are basically remnants from Ancient Greek, such as *akroatis* 'listener', and do not reflect synchronic derivations.

correlates to word formations which violate them. To this end, the psycholinguistic experiment described below examines the processing of Pseudo-Ws that contain such violations (e.g. **kareklatis* ‘*chairer’ versus **orimastis* ‘*maturer’). A comparison of individual’s behaviour to these two types of Pseudo-Ws will be informative with respect to the processing of TFs. Before launching into a description of the actual study, we will take a brief look at some basic facts about the processing of Pseudo-Ws.

6.3.2 Processing of Pseudo-Ws

There are a few undisputed facts in the literature about the processing of Pseudo-Ws. First of all, a number of studies have shown that Pseudo-Ws are always accessed by decomposing³ them into their constituents (Butterworth, 1983; Caramazza et al., 1988; Schreuder & Baayen, 1995). Moreover, a number of psycholinguistic studies indicate that additional morphological processing takes place for Pseudo-Ws, differentiating those with partial morphology from those entirely composed of existing morphemes of a language (e.g. Caramazza et al., 1988; Laudanna et al., 1992; Burani et al., 1999). For instance, a word like **dref-able* will be more easily rejected than **sleep-able*.

There is also evidence to suggest a multi-staged lexical access for Pseudo-words entirely formed from existing morphemes of a language. More specifically, Libben (1990, 1993a, 1993b, 1994a, 1994b) conducted a series of studies to investigate the question of whether native speakers and aphasic patients who show deficits associated with formal aspects of morphological processing compute morphological structures. The main focus of his studies was to discover whether morphological structure plays a role in on-line processing. The work cited here was designed to investigate the role of selectional restrictions and hierarchical structure in the recognition of multimorphemic English words. Libben compared performance on two types of multimorphemic strings (left-branching: *relearnability* and right-branching: *remodernization*). What is of interest to our study is the inclusion of two types of Pseudo-Ws, one respecting and the other violating morphological structure. Both types of Pseudo-Ws had the structure *prefix + stem* (non existing) + *suffix*. An

⁴⁹ This can be explained as follows. In a Dual Route model such as the one assumed in the present thesis, the two routes are said to work in parallel and in competition. The whole word access route is faster unless the item frequency of the complex word is very low. In this case, the compositional route wins out and the whole word representation is never accessed. In the case of pseudo-Ws, there is no whole word representation. Therefore, the compositional route is the only way we can access a pseudo item.

example of a Pseudo-W respecting morphological structure would be *re-birm-able*, which presupposes that *birm* is a verbal root, since both *re-* and *-able* attach to verbs. In contrast, an example of a Pseudo-W violating morphological structure would be *re-birm-ity*, since there would be a conflict regarding the grammatical class of *birm*, given that *re-* attaches to verbs and *-ity* to adjectives.

On the basis of a variety of tasks (lexical decision, naming, paraphrase), both non brain-damaged and aphasic participants in the above studies demonstrated increased RTs in the morphologically illegal condition. This suggests that the selectional restrictions of affixes are activated and play a role in morphological computation (Libben, 1994a: 53). Based on these findings, Libben proposes a four-stage process in the recognition of multimorphemic Pseudo-Ws. In a letter string consisting of a *prefix* + *stem* (non existing) + *suffix*, such as *re-birm-able* or *re-birm-ity*, the first stage scans a string from left to right, exposing all lexicalized substrings, such as *re-birm-able* or *re-birm-ity*. The second stage can be conceived of as *morphological computation*. This morphological stage creates (possible, multiple) interpretable structures from the lexical substrings. For example, it recognizes the combination [*re* + *birm*] + *able* or *re* + [*birm* + *able*]. The third stage yields an interpretation for each of these representations. For instance the combination [*re* + *birm*] + *able* would mean ‘something which can be *rebirmed*, while the combination *re* + [*birm* + *able*] would actually fail to yield an interpretation, given that *re-* does not attach to adjectives. The fourth stage chooses between these interpretations and, hence, promotes or rejects one or another combination. That is, it prefers [*re* + *birm*] + *able* over *re* + [*birm* + *able*].

Although originally designed to interpret left-branching, right-branching or morphologically illegal words, Libben’s stage-like process can be generalized to describe lexical access of other types of Pseudo-Ws, since it reveals both the steps involved in processing a word and the units of analysis. Thus, it allows us to see whether certain features of a word and a suffix (such as selectional restrictions) are processed, and also whether this processing takes place at the same stage as other features of the same word. The following experiment, which was designed to investigate the status of thematic *vs.* categorial constraints in MG deverbal word formations, assumes the existence of such a stage-like process.

6.3.3 The experiments

The aim of the experiments presented in this section was to determine whether Greek native speakers differentiate between Pseudo-Ws which violate different types of constraints, i.e. thematic and categorial. This would help us determine whether TFs play their own, distinct role in the processing of deverbal word formations. We examined this question in two experiments, one using an off-line and the other, an on-line task. The off-line task not only captured the speakers' meta-linguistic knowledge, but it also served as a basis for forming our specific hypothesis for the on-line experiment, which allowed us to capture subjects' performance in real time processing.

6.3.3.1 Experiment 3 Off-line task: Background and Hypotheses

Experiment 3 focused on patterns of rejection/acceptance of Pseudo-Ws in an off-line task, especially with respect to violations of thematic and categorial constraints. We clearly expected participants to reject the majority of Pseudo-Ws as non-possible words of MG. Furthermore, as the two types of constraints are classified as 'strong', in the sense that they apply invariably to only a particular type of base in terms of grammatical class and thematic specifications, we had no reason *a priori* to expect different rejection patterns for them. On the other hand, if the two types of violated constraints differ from each other in terms of relative strength, then we could expect this strength difference to be reflected in differential acceptance/rejection rates for the two groups of Pseudo-Ws⁵⁰.

Finally, Experiments 1 and 2 showed that TFs are processed during lexical access of deverbal nominals with the suffix *-simos*, but they did not appear to be processed for those nominals formed with the suffix *-tis*. Based on this finding, we assumed that TFs might be more prominent for word formations with *-simos*, but not for those with *-tis*. This on-line finding suggested that participants might be able to differentiate between Pseudo-Ws on the basis of their specific suffixes. That is, Pseudo-Ws which violate the thematic constraints of *-tis* might be more acceptable than violations formed with the suffix *-simos*. Of course, this presumes that one can extrapolate from the results of an on-line task to an off-line task that targets native speakers' metalinguistic knowledge.

⁵⁰ In fact, pseudo-Ws with thematic and categorial constraints differed in the pilot study reported in Manouilidou (2004).

Based on the above reasoning, our hypotheses for the off-line task were the following.

Hypothesis 1: Subjects would reject the majority of Pseudo-Ws as non-possible words of MG.

Hypothesis 2: If there is a difference in the relative strengths of the constraints (thematic vs. categorial), this would result in different acceptance/rejection patterns.

Hypothesis 3: Pseudo-Ws with thematic violations formed with the suffix *-tis* would be more acceptable than Pseudo-Ws with thematic violations formed with the suffix *-simos*.

6.3.3.1.1 Experiment 3 Off-line task: Method

An off-line acceptability judgement task was employed.

Participants

Twenty-seven (27) native speakers of MG volunteered to participate in the study. The group included males and females aged between 21 and 30 years old (mean age 23.6). They were all undergraduate and graduate students at Aristotle University of Thessaloniki.

Stimuli

A total of 120 words were presented to the subjects (see Appendix C). Sixty (60) of them were Pseudo-Ws with categorial violations created using a noun with the suffixes *-tis* or *-simos*, e.g. **potiritis* ‘glasser’, **koutalimos* ‘spoonable’. The remaining 60 were Pseudo-Ws with thematic violations created by pairing a non-agentive verb with the suffix *-tis*, e.g. **misi-tis* ‘hat-er’ or by pairing intransitive verbs with the suffix *-simos*, e.g. **treksimos* ‘run-able’.

Procedure

Participants were presented with a typewritten list of Pseudo-Ws and asked to indicate for each one whether it could be a MG word and, if YES, what it would mean. The request for a meaning to be supplied ensured against random acceptance or rejection of forms⁵¹.

⁵¹ These results will not be reported because they are not relevant to the research or its interpretation.

6.3.3.1.2 Experiment 3 Off-line task: Results

Data analysis

Percentages of acceptance were calculated for all Pseudo-Ws with thematic or categorial violations, as well as for Pseudo-Ws grouped by suffix (*-tis*, *-simos*). As can be seen in Table 9, participants vastly rejected the majority of Pseudo-Ws with both types of violations, with an acceptance rate of less than 30% for Pseudo-Ws with thematic violations and less than 10% for those with categorial violations. Therefore, Hypothesis 1 was confirmed.

A one-way ANOVA, with type of stimulus as the independent variable and response type (YES or NO) as the dependent variable, indicated that participants accepted significantly more Pseudo-Ws with thematic than with categorial violations [$F(1, 26) = 10.65$, $p < 0.0001$; $F(1, 59) = 11.02$, $p = 0.0001$]. This was true of acceptance rates for both thematic and categorial violations with *-tis* [$F(1,26) = 7.24$, $p = 0.005$; $F(1, 29) = 5.82$, $p = 0.031$], as well as for those with *-simos* [$F(1,26) = 12.93$, $p < 0.0001$; $F(1,29) = 11.02$, $p = 0.0001$]. Thus, despite the overall low acceptance rates indicating that both constraints can be considered strong, there were differences in their relative strengths that supported Hypothesis 2.

Finally, the acceptance rates for Pseudo-Ws with thematic violations constructed with the suffix *-tis* did not differ significantly from the acceptance rates obtained for Pseudo-Ws with thematic violations formed with the suffix *-simos* ($F(1, 26) = 1.59$, $p = 0.69$; $F(1, 59) = 2.6$, $p = 0.894$). Thus, Hypothesis 3, which stated that Pseudo-Ws with thematic violations formed with the suffix *-tis* might be more acceptable than Pseudo-Ws with thematic violations formed with the suffix *-simos*, was not confirmed.

Table 9: *Percentages of Acceptance for Pseudo-Ws with Thematic vs. Categorial Violations in Experiment 3*

Pseudo-Ws	Thematic Violations	Categorial Violations
with <i>-tis</i>	24.6%	14.1%
with <i>-simos</i>	31.6%	5.5%
with both suffixes	28.1%	9.9%

In summary, the findings of the off-line Experiment 3, suggested that subjects differentiate between Pseudo-Ws which violate different types of constraints. Moreover, it appeared that thematic constraints might be easier to violate than categorial ones. Finally, the off-line task did not reveal any particular effect for the specific suffixes used in the study (*-simos* vs. *-tis*). Pseudo-Ws with both suffixes yielded similar acceptance patterns with respect to the type of constraint violated. The results of Experiment 3 did not support the speculation that subjects would show different patterns of acceptance for two suffixes that violated the same thematic constraints, even though TFs exhibited differential prominence in on-line processing of words with those suffixes.

6.3.3.2 Experiment 4: On-line task

Experiment 4 addressed some of the same issues as Experiment 3, but from an on-line processing perspective. One issue was whether native speakers would differentiate between Pseudo-Ws which violate thematic and categorial constraints in real time processing or whether the differences observed in the off-line task would disappear due to time pressure. More specifically, we sought to examine whether there are any temporal differences in accessing Pseudo-Ws with categorial violations vs. Pseudo-Ws with thematic violations. A second issue concerned suffix-specific effects. Despite the off-line results indicating that the specific type of suffix had no effect on acceptance patterns of Pseudo-Ws, results of our previous on-line studies on the processing of TFs in different types of existing nominals did yield suffix-specific effects. Thus, the on-line study looked for possible suffix-specific effects in the recognition of Pseudo-Ws by including Pseudo-Ws formed with suffixes which previously triggered performance differences during the on-line recognition of existing deverbal nominals. The set included DNs formed with two suffixes for which TFs has already been shown to be accessed (*-simos*, *-tikos* in Experiment 1) and DNs formed with two suffixes for which TFs did not seem to be accessed (*-tis*, *-tos* in Experiments 1 and 2).

In addition to Pseudo-Ws with thematic and categorial violations, Experiment 4 included other types of non-attested words bearing the same suffixes as the Pseudo-Ws with violations (i.e. *-simos*, *-tikos*, *-tis*, *-tos*). The first type were pure non-words (Non-Ws) that were formed by phonologically manipulating roots of existing deverbal word formations, thus keeping the suffix visible, e.g. *katakti-tis* > **kapakti-tis* ‘conqueror’ > *‘conperor’. The

Non-Ws served two purposes in the study. First, they fulfilled the necessary function of non-words in the lexical decision task, providing a set of stimuli that could be validly rejected as not being real words. Second, RTs to Non-Ws could be compared with those to Pseudo-Ws which violate constraints in order to determine whether subjects actually differentiated between the two types. Without such differentiation, one could claim that Pseudo-Ws that violate constraints were simply being treated as Non-Ws.

An additional type of stimuli employed in the study were non-attested words without violations, such as *xtypitis* ‘hitter’, to be referred to as Novel-Ws. These Novel-Ws were formed on the basis of an existing stem and an existing suffix. As their formation did not violate any constraints, they could be considered potential words of MG. The inclusion of Novel-Ws allowed us to measure processing differences between potential (Novel-Ws) and non potential words (Pseudo-Ws and Non-Ws). The Novel-Ws also formed additional minimal pairs with Pseudo-Ws with thematic violations. As the Novel-Ws differed from Pseudo-Ws with thematic violations in the sense that they were non-attested but still thematically appropriate, a comparison of the RTs to these two types of stimuli would permit us to better isolate the effect of thematic constraints.

Non-Ws and Novel-Ws played an extremely important role in the design of this study. If Pseudo-Ws with thematic violations (e.g. **orimasimos* ‘*maturable’) yielded distinct RTs from Non-Ws, Novel-Ws, and Pseudo-Ws with categorial violations, then we would be able to conclude that the processing of TFs has a distinct status, different from the processing of other features. If RTs of Pseudo-Ws with thematic violations patterned with Pseudo-Ws with categorial violations (e.g. **kareklimos* ‘*chairable’) or with Novel-Ws (e.g. *xtypitis* ‘hitter’), then we would not be able to differentiate the effect of TFs. For instance, if performance on Pseudo-Ws with thematic violations were similar to performance on Pseudo-Ws with categorial violations, we would have to assume that the processor handles the violation of thematic and categorial constraints in the same way. Similarly, if subjects failed to differentiate between Pseudo-Ws with thematic violations and Novel-Ws, then we would be forced to conclude that the effect of thematic constraints is not detected in on-line processing and that Pseudo-Ws with thematic violations are treated as well-formed, non-attested combinations. Table 10 summarizes the pertinent characteristics of the various stimulus types for Experiment 4.

Table 10: *Summary of the Characteristics of the Stimulus Set in Experiment 4.*

Type of stimulus	Characteristics	Examples
Non-Ws	non-existing stem existing suffix	* <i>kapakt-itis</i> ‘conperor’
Pseudo-Ws with categorial violations	existing stem existing suffix mismatch in terms of lexical category	* <i>karekla-tis</i> ‘chairer’
Pseudo-Ws with thematic violations	existing stem existing suffix mismatch in terms of TFs	* <i>orimas-tis</i> ‘maturer’
Novel-Ws	existing stem existing suffix no mismatch, non-attested combination	<i>xtypi-tis</i> ‘hitter’

6.3.3.2.1 Experiment 4: Hypotheses

Based on the results of the off-line task in Experiment 3, we expected higher error rates⁵ for Pseudo-Ws with thematic violations than for Pseudo-Ws with categorial violations. A corresponding difference was also expected in terms of RTs. Subjects would process Pseudo-Ws with categorial violations more accurately and possibly faster than Pseudo-Ws with thematic violations, since they rejected them with greater accuracy in the off-line task. Furthermore, we expected the results for Pseudo-Ws with thematic violations formed with specific suffixes to parallel the results for the suffixes in our earlier on-line studies with real words. Thus, we expected to detect differences in the processing of those Pseudo-Ws formed with the suffixes *-simos* and *-tikos* as opposed to those formed with the suffixes *-tis* and *-tos*. In other words, as TFs increased the processing load for existing words with *-simos* and *-tikos*, we expected a similar effect (longer RTs) for their pseudo counterparts. These longer RTs would reflect the time subjects spend contemplating an apparent thematic mismatch of a verbal base and a suffix which has ‘thematic gravity’. Pseudo-Ws with the suffixes *-tis* and *-tos* would yield the opposite pattern; that is, they should yield shorter RTs, since real words

⁵² In Experiment 4, for the on-line task I will be using the term *error rate*, as accepting Pseudo-Ws as real words is wrong.

with these suffixes did not appear to cause an increase in processing load that could be attributed to the presence of TFs.

Finally, the various factors involved in processing the four types of stimuli employed in this study should result in a continuum, with Novel-Ws exhibiting the highest error rates and the longest RTs, followed in turn by Pseudo-Ws with thematic and categorial violations and ending with NWs. We expected Non-Ws (e.g. **kapaktitis* ‘*conperor’) to be the easiest to reject due to the fact that they comprise a non-existing part (the root part). The Non-Ws would be followed by Pseudo-Ws with categorial violations and thematic violations. Despite the fact that both parts of a Pseudo-W exist in MG, their combination violates constraints of word formation. We expected the highest error rates and RTs for Novel-Ws, because they present individuals with a true conundrum. Although Novel-Ws are formed from existing words of MG without the violation of any constraints, they are nonetheless unattested. Therefore, it should be harder for participants to make a lexical decision on them. The hypotheses for the on-line task in Experiment 4 were stated as follows:

Hypothesis 1: We predicted a higher error rate for Pseudo-Ws with thematic violations than for Pseudo-Ws with categorial violations across all suffixes.

Hypothesis 2: An error rate continuum was expected, descending from Novel-Ws, with the highest error rate, to Pseudo-Ws with thematic and categorial violations and ending with Non-Ws.

Hypothesis 3: The same continuum as for error rates (see Hypothesis 2) was expected for Reaction Times, with the Novel-Ws showing the longest RTs.

Hypothesis 4: We predicted longer RTs for Pseudo-Ws with thematic violations than for Pseudo-Ws with categorial violations across all suffixes.

Hypothesis 5: We predicted longer RTs for Pseudo-Ws with thematic violations formed with the suffixes *-simos* and *-tikos* than for those formed with the suffixes *-tis* and *-tos*.

6.3.3.2.2 Experiment 4: Method

Phase I: Familiarity ratings

As was the case with the previous experiments, the test was completed in two phases. Before the actual on-line task, off-line familiarity ratings were obtained for a total of 256 nouns and verbs which would serve as potential bases for the creation of Pseudo-Ws. Forty-five Greek-

speaking university students volunteered to participate in this phase of the study. These ratings served to ensure that the words to be selected for the experiment shared the same or similar stem and surface familiarity. The second phase comprised the on-line task.

Phase II: On-line task

On-line task: Participants

Forty-six (46) male and female native speakers of MG volunteered to participate in the study. The group ranged in age from 20-28 years old, with an average age of 23.4. All participants were students at Aristotle University of Thessaloniki.

On-line task: Stimuli

A total of 512 words were used in the experiment. This included 4 different types of experimental items as listed in Appendix D: Pseudo-Ws with thematic violations (n=64), Pseudo-Ws with categorial violations (n=64) Novel-Ws without violations (n=64), Non-Ws (n=64). In addition, existing words (non-derived verbs) were used as fillers (n=256). The materials for the Pseudo-Ws were constructed by attaching one nominal suffix (*-tis*) or one of three adjectival suffixes (*-simos*, *-tikos*, *-tos*) to a variety of nominal and verbal bases violating the specifications of each suffix. Two of the above suffixes (*-simos* and *-tikos*) form nominals which demonstrated processing of TFs in earlier studies, and two (*-tis* and *-tos*) form nominals for which processing of TFs was not detected. All bases were controlled for familiarity and length in accordance with the results of the familiarity verification task. The stimuli were as follows:

For the Pseudo-Ws with *Thematic Violations* (henceforth ThemViol.) the stimulus material included:

- (a) 16 Pseudo-Ws with the suffix *-tis* (-er) onto a verbal non-agentive base, e.g. **aimorragitis* 'bleeder'.
- (b) 16 Pseudo-Ws with the suffix *-simos* (-able) onto a verbal base which does not receive an internal argument, e.g. **kathisimos* 'sittable'.
- (c) 16 Pseudo-Ws with the suffix *-tos* (-able) onto a verbal base which does not receive an internal argument, e.g. **gerastos* 'ageable'

(d) 16 Pseudo-Ws with the suffix *-tikos* (-ive) onto a verbal non-agentive basis, e.g. **orimastikos* ‘maturive’.

For the Pseudo-Ws with *Categorial Violations* (henceforth CatViol.) the stimulus material included:

(a) 16 Pseudo-Ws with the suffix *-tis* (-er) onto a nominal base, e.g. **kareklatis* ‘chair-er’.

(b) 16 Pseudo-Ws with the suffix *-simos* (-able) onto a nominal base, e.g. **potirimos* ‘glass-able’.

(c) 16 Pseudo-Ws with the suffix *-tos* (-able) onto a nominal base, e.g. **kouvertitos* ‘blanket-able’.

(d) 16 Pseudo-Ws with the suffix *-tikos* (-ive) onto a nominal base, e.g. **koutalitikos* ‘spoon-ive’.

The stimulus set for the *Novel-Ws* (well-formed, unattested word formations) included:

(a) 16 Novel-Ws with the suffix *-tis* (-er) added onto an agentive base, e.g. **xtypitis* ‘hitter’.

(b) 16 Novel-Ws with the suffix *-simos* (-able) added onto a base which receives an internal argument, e.g. **kathari-simos* ‘clean-able’.

(c) 16 Novel-Ws with the suffix *-tos* (-able) added onto a base which receives an internal argument, e.g. **skoupis-tos* ‘wipe-able’.

(d) 16 Novel-Ws with the suffix *-tikos* (-ive) added onto an agentive base, e.g. **stolis-tikos* ‘decorative’.

The stimulus material also included pure Non-Ws. The 64 Non-Ws in the list were obtained by replacing one or two letters of a real MG word containing the suffixes *-tis*, *-simos*, *-tos*, *-tikos*, while still respecting the phonotactic constraints of the language. The presence of Non-Ws allowed participants to legitimately reject some of the stimuli as not being words in MG.

Finally, in addition to the test items, the stimulus set included *Filler* real word targets to distract participants from the purpose of the experiment and to allow them to legitimately accept some of the stimuli as being words in MG. The 256 filler words consisted of various types of non-derived verbs matched to the target stimuli for familiarity, length and number of syllables.

On-line task: Procedure

The standard procedure, as described in section 5.3.1, was employed in Experiment 4.

A note on response categorization

For all types of Pseudo-Ws and for the Novel-Ws, the ‘YES’ reply was considered erroneous, since these word formations were not words of MG. Although Novel-Ws do not violate any principle of Greek word formation, they are unattested and therefore, they could not be listed in the mental lexicons of the participants in the study. In contrast, for the analysis of RTs, only the correct, ‘NO’ responses were taken into consideration. Both Chi square tests and ANOVAs were conducted as necessary. Details are provided below.

6.3.3.2.3 Experiment 4: Results

Error Analysis

Error analysis was used to examine Hypotheses 1 and 2. The error rate indicates how many times participants pressed the ‘YES’ button to indicate that unattested word formations such as Non-Ws, Pseudo-Ws, and Novel-Ws were words of MG. Results are shown in Table 11. The numbers indicate mean percentages for each stimulus type.

Table 11: *Error Rates (% ‘YES’ answers) for the Four Types of Non-attested Words Listed by Suffix in Experiment 4.*

Suffixes	Novel-Ws	Pseudo-Ws Them Viol.	Pseudo-Ws CatViol.	Non-Ws
<i>-tis</i>	49.9%	27.5%	17.6%	9%
<i>-simos</i>	53%	24.3%	12.7%	6%
<i>-tikos</i>	52%	23.1%	12.9%	10.2%
<i>-tos</i>	71%	29%	10.6%	7.5%
MEAN	56.4%	25.9%	13.5%	7.6%

In order to test Hypothesis 1, Chi square comparisons were carried out to compare error rates (‘YES’ responses) of Pseudo-Ws with thematic and categorical violations for all four

suffixes included in the stimulus set. The results for each of the suffixes are presented in Table 12.

Table 12: *Comparisons of Error Rates between Pseudo-Ws with Thematic and Categorical Violations Listed by Suffix in Experiment 4.*

Stimuli	Chi square	Degrees of freedom	p scores
ThemViol- <i>tis</i> vs. CatViol- <i>tis</i>	$\chi^2 = 4.01$	df = 1	$p < 0.05$
ThemViol- <i>simos</i> vs. CatViol- <i>simos</i>	$\chi^2 = 10.66$	df = 1	$p < 0.001$
ThemViol- <i>tikos</i> vs. CatViol- <i>tikos</i>	$\chi^2 = 10.63$	df = 1	$p < 0.001$

As can be seen from the above results, there was a significantly higher error rate for Pseudo-Ws with ThemViol than for those with CatViol. This result is according to the predictions of Hypothesis 1, which was thus confirmed.

With respect to Hypothesis 2, we first noted that the error rates across the four stimulus types by suffix followed the predicted continuum in descending order from the highest error rate for Novel-Ws to Pseudo-Ws with thematic violations, to Pseudo-Ws with categorical violations to Non-Ws (see Table 11). However, to ensure that the raw percentages represented significant differences, we conducted the following Chi square analyses:

For the combinations with the **suffix -tis**:

Novel-Ws-*tis* vs. ThemViol-*tis*: $\chi^2 = 3.92$, df = 1, $p < 0.05$

ThemViol-*tis* vs. CatViol-*tis*: $\chi^2 = 4.01$, df = 1, $p < 0.05$

CatViol-*tis* vs. Non-Ws-*tis*: $\chi^2 = 5.47$, df = 1, $p < 0.01$

For the combinations with the **suffix -simos**:

Novel-Ws-*simos* vs. ThemViol-*simos*: $\chi^2 = 7.23$, df = 1, $p < 0.005$

ThemViol-*simos* vs. CatViol-*simos*: $\chi^2 = 10.36$, df = 1, $p < 0.001$

CatViol-*simos* vs. Non-Ws-*simos*: $\chi^2 = 4.05$, df = 1, $p < 0.01$

For the combinations with the **suffix -tikos**:

Novel-Ws-*tikos* vs. ThemViol-*tikos*: $\chi^2 = 10.62$, $df = 1$, $p < 0.001$

ThemViol-*tikos*. vs. CatViol-*tikos*: $\chi^2 = 8.63$, $df = 1$, $p < 0.001$

CatViol-*tikos* vs. Non-Ws-*tikos*: $\chi^2 = 0.34$, $df = 1$, $p = NS$

For the combinations with the **suffix -tos**:

Novel-Ws-*tos* vs. ThemViol-*tos*: $\chi^2 = 8.55$, $df = 1$, $p < 0.001$

ThemViol-*tos* vs. CatViol-*tos*: $\chi^2 = 8.04$, $df = 1$, $p < 0.001$

CatViol-*tos* and Non-Ws-*tos*: $\chi^2 = 0.54$, $df = 1$, $p = NS$

We also conducted cross-stimulus type Chi square comparisons with the combined average error rates for all suffixes within a category. The results are presented in Table 13:

Table 13: *Comparisons of Error Rates for the Four Types of Non-attested Words in Experiment 4.*

Stimuli	Chi square	Degrees of freedom	p scores
Novel-Ws vs. ThemViol.	$\chi^2 = 14.39$	$df = 3$	$p < 0.001$
ThemViol. vs. CatViol.	$\chi^2 = 7.73$	$df = 3$	$p < 0.05$
CatViol. vs. Non-Ws	$\chi^2 = 1.35$	$df = 3$	$p = NS$

Thus, with the exception of CatViol. versus Non-Ws for *-tikos* and *-tos* and for the averaged data (Table 13), our results indicate distinct patterns of rejection/acceptance for each category of non-existing words, in real time processing. That is, it seems that there is a continuum with the highest error rate starting from Novel-Ws without violations, then Pseudo-Ws with thematic violations followed by Pseudo-Ws with categorial violations and ending with Non-Ws. Although this continuum is not supported by a statistically significant difference overall for Pseudo-Ws with categorial violations and Non-Ws, especially for the suffixes *-tikos* and *-tos*, we consider that our results support Hypothesis 2 regarding the existence of a continuum of errors across stimulus categories.

To summarize on the error analysis, the results presented so far clearly support the existence of processing differences between Pseudo-Ws with thematic and categorial violations. Furthermore, the results indicate that participants not only differentiate potential

from non-potential words, but that they also differentiate between Pseudo-Ws that violate different constraints and, to a certain extent, between Pseudo-Ws and pure Non-Ws (at least in the cases of *-tis* and *-simos*). Hypotheses 3, 4 and 5 were addressed through the analysis of RTs, presented in the following section.

Reaction Time Analysis

The dependent measure for all RT analyses was lexical decision latency for ‘NO’ responses reported in milliseconds. In all analyses, separate ANOVAs by item and by subject were conducted, treating items as independent variables. Pairwise comparisons with Bonferroni adjustments for multiple comparisons were also carried out. All reported RTs represent a mean of subject responses. Prior to the analysis, responses exceeding 3000ms⁵³ were considered to be ‘off-line’ and were removed. Outliers (response times below and above two standard deviations from the mean) were also removed from the dataset. This resulted in a by subject loss of data varying from 2 to 7%. Table 14 displays mean RTs and standard deviations for each group of stimuli. The numbers stand for mean RTs of *rejection* for Non-Ws, Pseudo-Ws with thematic violations, Pseudo-Ws with categorial violations and Novel-Ws.

Table 14: *Mean RTs with (SDs) in Milliseconds by Stimulus Type in Experiment 4*

Suffixes	Novel Ws	Pseudo-Ws ThemViol.	Pseudo-Ws CatViol.	NWs
<i>-tis</i>	984 (63)	929 (66)	877 (36)	799 (39)
<i>-simos</i>	1009 (59)	959 (53)	879 (35)	849 (38)
<i>-tikos</i>	1125 (54)	936 (54)	894 (29)	849 (29)
<i>-tos</i>	1084 (69)	937 (60)	894 (40)	843 (37)
MEAN	1050 (61)	940 (58)	886 (35)	835 (35)

A one-way ANOVA revealed a main effect of stimulus group both by subject ($F(3,78) = 25.13$ $p < 0.0001$) and by item [$F(3,140) = 14.15$, $p < 0.0001$], while pairwise comparisons showed the following:

⁵³ Since this test deals with pseudo-Ws and Novel-Ws processing times will be increased by definition. For this reason, I had to raise the upper limit for calculating the outliers as well.

For the combinations with the **suffix -tis**:

Novel-Ws-*tis* vs. ThemViol-*tis*: [F1(1,226) = 12.44, p = 0.0005; F2(3,140) = 10.45, p=0.004]

ThemViol-*tis* vs. CatViol-*tis*: [F1(1, 226) = 2.81, p = 0.06; F2(3, 140) = 2.45, p = 0.08]

CatViol-*tis* vs. Non-Ws-*tis*: [F1(1, 226) = 11.21, p = 0.0009; F2(3, 140) = 9.45, p = 0.015]

For the combinations with the **suffix -simos**:

Novel-Ws-*simos* vs. ThemViol-*simos*: F1(1,226) = 4.65, p=0.004; F2(3,140) = 3.96, p=0.009

ThemViol-*simos* vs. CatViol-*simos*: F1(1,226) = 8.24, p = 0.001; F2(3,140) = 5.67, p=0.005

CatViol-*simos* vs. Non-Ws-*simos*: F1(1,226) = 3.25, p = 0.055; F2(3,140) = 3.16, p = 0.059

For the combinations with the **suffix -tikos**:

Novel-Ws-*tikos* vs. ThemViol-*tikos*: [F1(1,226) = 3.78, p= 0.003; F2(3,140) = 3.69, =0.019]

ThemViol-*tikos* vs. CatViol-*tikos*: [F1(1,226) = 3.57, p = 0.013; F2(3,140) = 3.09, p = 0.027]

CatViol-*tikos* vs. Non-Ws-*tikos*: [F1(1,226) = 4.13, p = 0.033; F2(3,140) = 2.98, p = 0.049]

For the combinations with the **suffix -tos**:

Novel-Ws-*tos* vs. ThemViol-*tos*: [F1(1,226) = 11.29, p = 0.0009; F2(3,140) = 8.24, p=0.004]

ThemViol-*tos* vs. CatViol-*tos*: [F1(1,226) = 5.52, p = 0.011; F2(3,140) = 4.25, p = 0.033]

CatViol-*tos* vs. Non-Ws-*tos*: [F1(1,226) = 4.15, p = 0.042; F2(3,140) = 4.01, p = 0.049]

Since most differences across categories are significant across suffixes, and since there is the same descending pattern of RTs by stimulus type for all suffixes, we could group them together to obtain a more general idea of the processing times for the four types of non-attested items. This is summarized in the last row of Table 14, which reports the mean RTs for each of the four types of stimuli employed in the study, with all suffixes combined. Separate t-tests of these mean RTs revealed that the differences among them are all significant. Results are presented in Table 15.

Table 15: Comparisons of RTs for the Four Types of Non-attested Words in Experiment 4.

Stimuli	<i>t</i> scores	<i>p</i> scores
Novel-Ws vs. ThemViol.	$t(78) = -6.85$	$p < 0.001$
ThemViol. vs. CatViol.	$t(78) = -3.84$	$p = 0.002$
CatViol. vs. Non-Ws	$t(78) = -3.01$	$p = 0.003$

The above results indicate that the same continuum observed in the error rate analysis is also found for RTs. This means that subjects take longer to process Novel-Ws, followed by Pseudo-Ws with thematic violations, then Pseudo-Ws with categorial violations and, finally, Non-Ws. These results support Hypothesis 3, which predicted the same across category continuum for RTs as for error rates. Focusing exclusively on Pseudo-Ws with violations, we see that Pseudo-Ws with thematic violations take significantly longer to process than those with categorial violations. Thus, Hypothesis 4 was supported. Finally, a one-way ANOVA comparing RTs across the suffixes *-tis*, *-tos*, *-simos* and *-tikos* for Pseudo-Ws with thematic violations (see the third column of Table 14) failed to yield any significant differences⁵⁴. Thus our results did not support Hypothesis 5, which predicted longer processing times for Pseudo-Ws with thematic violations formed with *-simos* and *-tikos* than for those formed with *-tis* and *-tos*.

6.3.3.2.4 Experiment 4: Discussion

Our previous on-line experiments, as well as the results of the off-line grammaticality judgment task in Experiment 3, contributed substantially to the design of Experiment 4. Our main goal was to examine whether native speakers differentiate between Pseudo-Ws which violate different types of constraints, focusing particularly on their behaviour towards Pseudo-Ws with thematic violations. This would enable us to isolate the effect of TFs in deverbal word formations. Both error rate and RT analyses indicated that subjects not only differentiated between possible and not possible words, but also between Pseudo-Ws which violate different types of constraints (according to Hypotheses 2 and 3). If we focus solely on error rate, we see that thematic constraints appeared to be more violable than categorial ones, since subjects accepted more Pseudo-Ws with thematic violations than Pseudo-Ws with

⁵⁴ This analysis actually mirrored a similar finding for the error data that was not reported above.

categorial violations (as per Hypothesis 1). Finally, based solely on RTs, we saw that Pseudo-Ws with thematic violations demonstrated a higher processing cost than those with categorial violations (Hypothesis 4). In this section we will consider what might account for these results.

Let us examine our stimuli against the background of a stage-like recognition process, as proposed by Libben (1993a, 1993b, 1994a, 1994b). If Stage 1 exposes all lexicalized substrings, then it is during this stage that Non-Ws with the form of *Stem* (non-existing) + *suffix*, such as **kapaktitis* ‘*conperor’, are rejected. Pseudo-Ws with categorial violations are rejected in Stage 2, where morphological processing takes place. In this stage, a Pseudo-W of the type **kareklatis* ‘*chairer’ is decomposed into *stem* + *suffix*, making the categorial mismatch apparent and forcing the participant to reject the word formation as not possible. However, my data suggest that there is a Stage 2a between Libben’s Stages 2 and 3 where thematic computation takes place. Although both the *stem* (e.g. *orimas-* ‘mature’) and the *suffix* (*-tis*) are already activated in Stage 2, it is not until Stage 2a that thematic processing occurs. Finally, Stage 3 yields interpretation, and it is here where Novel-Ws are processed.

If the above description of the lexical access of our stimuli is valid, then it seems that thematic processing constitutes a distinct part of word recognition for deverbal Pseudo-Ws. In other words, we must assume that after morphological computation, which is a common process for every type of derived Pseudo-W, thematic computation occurs as an obligatory process, specific to deverbal formations. This is a further indication that thematic constraints exist.

However, the findings with respect to Hypothesis 5 do not seem to support our initial predictions. The suffixes *-simos* and *-tikos* did not have a different effect on the processing of Pseudo-Ws than that of *-tis* and *-tos*. Thus, despite our initial assumption that *-simos* and *-tikos* are supposedly responsible for the increased verbal character of the nominals they form, as well as for the subsequent processing of their TFs, these factors do not appear to be reflected in processing times, at least for Pseudo-Ws. In other words, although the ‘thematic gravity’ of the suffixes would lead one to expect thematic violations with these suffixes to be more evident, participants did not show a distinct behaviour towards them. Rather, evidence

from the present research converges towards the view that processing of TFs takes place independently of the particular suffixes.

The results of Experiment 4 contrast with those of Manouilidou (2004) and Experiment 1, where existing nominals with *-tis* (e.g. *xoreftis* ‘dancer’) and *-tos* (e.g. *skalistos* ‘engraved’) did not show evidence for the processing of TFs, although existing nominals formed with *-simos* (e.g. *katanoisimos* ‘comprehensible’) and *-tikos* (e.g. *vevaiotikos* ‘affirmative’) did. Thus, even if Experiment 4 indicates that TFs exist in every deverbal word formation, factors such as lexicalization may block their surfacing for some nominals formed with specific suffixes. In general, lexicalization is involved where a particular meaning component is found to be in regular association with a particular morpheme. The set of meaning components of the suffixes *-tis* and *-tos* also include their thematic specifications. These specifications are only apparent in the processing of pseudo and novel words and not in the processing of existing words. Although the meaning of whole words can be described as being composed from the set of meanings associated with their parts, the thematic specifications of the suffixes *-tis* and *-tos* are overshadowed when they combine with a verbal root to produce a deverbal word formation.

6.3.4 General discussion of Experiments 3 and 4 and further implications

The results of the off-line rejection/acceptance rates as well as the on-line error rates and RTs in Experiments 3 and 4 demonstrated significant differences in participants’ performance on thematic versus categorial violations in all types of Pseudo-Ws. These results clearly suggest that the processing of TFs constitutes a necessary step in the lexical access of Pseudo-Ws, independently of the particular suffix. Although these findings suggest that the effects of TFs are visible in every type of Pseudo-W, this does not appear to be the case across the board for existing words. This issue will be addressed in the following chapter. Our results also have a number of implications for deverbal word formation and for the morphological theory of constraints, as well as for the psycholinguistic theory of lexical access. These latter issues are briefly addressed in the following sections and are fully developed in Chapter 7.

6.3.4.1 Implications for deverbal word formation and the application of constraints

One basic finding of the experiments described above is that the processing of thematic features plays an essential role in accessing deverbal Pseudo-Ws. Pseudo-Ws with thematic violations differed significantly from Pseudo-Ws with categorial violations and from Novel-Ws. This pattern was observed with all suffixes used in the study. Moreover, the present study has also shown that the processing of TFs takes place at a different/late stage of word recognition. The above psycholinguistic facts provide important clues regarding the nature of thematic constraints in deverbal word formation. First of all, it is clear that thematic constraints exist. In other words, thematic features are prominent enough to impose constraints on the creation of a new deverbal formation. Secondly, these constraints are distinct from other types of constraints. Their divergence is indicated by the fact that they are more easily violable than categorial ones and that their effect is detected at a later stage of processing.

More generally, the results of the present study suggest that while many constraints apply to derivational processes, each type of constraint has a different status in word formation. For instance, the fact that there are different patterns of rejection/acceptance for the different types of Pseudo-Ws suggests that even within strong constraints there are stronger and weaker ones, in terms of violability. For instance, for all the suffixes used in the present study, both their thematic and categorial constraints are traditionally classified as strong. However, in every case, the thematic ones appeared to be more violable. As we will see in Chapter 7, there seems to be a correlation between violability, late processing and late application of a constraint in word formation. When a constraint applies at a later stage (such as a thematic constraint), it seems to be more violable.

6.3.4.2 Psycholinguistic theory of lexical access

As shown earlier, lexical access of Pseudo-Ws and Novel-Ws is hypothesized to take place in stages. More specifically, Libben (1993b) has claimed that morphological processing is a distinct part of this process. If we accept this claim, then the results of Experiments 3 and 4 suggest that Libben's staged access model should be modified to reflect not only morphological processing of Pseudo-Ws, but also processing of features specific to each morphological operation, such as thematic processing for deverbal Pseudo-Ws. This further

implies that features might not be processed simultaneously, a notion that has already been discussed in this chapter when presenting the results of experiments 1 and 2 with real words. If this is the case, then we have an indication that the various properties of Pseudo-Ws exist at different levels, which would account for why they are not accessed at the same time during word recognition. As we have already suggested, this layering is not unique to the processing of Pseudo-Ws. Instead, we believe it to be a more general organizational attribute of the lexicon. This issue is discussed in greater depth in Chapter 7.

6.4 General conclusion for chapter 6

Based on a review of the experimental and theoretical literature, I formulated specific hypotheses regarding the status of TFs in deverbal word formation. These hypotheses were examined in the present chapter through a series of experiments investigating the status of TFs in DVNs, DVAdjs and Pseudo-Ws. The findings of each experiment led naturally to further questions that were investigated in subsequent experiments. While the results of each study have been briefly discussed, in the following chapter, I present an extensive discussion of the findings in terms of current issues in psycholinguistics and morphological theory that were introduced in earlier chapters of the thesis.

Chapter 7 DISCUSSION

The primary goal for the experimental research reported in the present dissertation was to investigate the status of thematic features (TFs) in deverbal nominals (DNs). This was done by exploring two independent issues. The first one was whether the processing of TFs of DNs constitutes a necessary step in accessing their mental representation. The second concerned the status of thematic constraints in deverbal word formation. To address these issues, three on-line lexical decision tasks and one off-line grammaticality judgment task were carried out. These tasks looked at deverbal nouns (DVNs), deverbal adjectives (DVAdjs) and Pseudo-Ws violating thematic constraints.

A review of the relevant literature demonstrated that DNs exhibit complex morphological structure and mixed categorial properties. Although they belong to the nominal class, they exhibit TFs, which are primarily considered verbal properties. The present experimental research was designed to determine whether TFs of DNs are processed, thus providing evidence as to whether the processing of nominal or verbal properties of DNs is reflected in performance during lexical access. By incorporating Pseudo-Ws and Novel-Ws into the stimulus set, particularly Pseudo-Ws with thematic violations such as *fall*>**faller*, the research was able to address the role that TFs play in accessing deverbal Pseudo-Ws, their effect on word formation in general, and the constraints they impose. The results of the experiments indicated that TFs appear to influence the lexical access of only those DNs with increased eventive properties or a more ‘verb-like’ character (e.g. *plysimo* ‘washing’, *kladema* ‘pruning’, *katedafisimos* ‘demolishable’). In contrast, TFs do not appear to be processed in the case of DNs with a less ‘verb-like’ character⁵⁵ (e.g. *kataktitis* ‘conqueror’, *skalistos* ‘engraved’). This result has further implications for the role that the particular suffix may play in determining the event properties of the specific items. Furthermore, the processing of TFs appears to interact in an interesting way with derivational processes, since the decomposition access route seems to have a facilitatory effect. Moreover, the results of the experiments dealing with Pseudo-Ws and Novel-Ws have shown that individuals react differently to Pseudo-Ws with thematic violations than to Pseudo-Ws with other types of violations, such as lexical categorial violations. We have thus been able

⁵⁵ As described on page 77, footnote 33.

to demonstrate that the effect of TFs can be clearly isolated during the on-line processing of pseudo and novel word formations independently from the specific suffixes they bear.

Based on the above findings, we will try to provide a comprehensive account of the status of TFs in deverbal nominals. In addition, the results of these experiments allow us to make certain generalizations regarding broader organizational issues of the lexicon, such as the representation of various features and their role during lexical access. Finally, there exist a number of implications for our understanding of deverbal word formation and the morphological theory of constraints that are discussed in detail in the following sections.

7.1 TFs in deverbal nominals

Based on theoretical proposals, such as the one by Baker & Bobaljik (2002), that the TFs of the verbal root are passed on to DNs via the derivational suffix, and taking into account previous psycholinguistic evidence which indicated that the TFs of verbs add to their processing complexity, we sought to determine the status of TFs in DNs. After having completed a series of experiments addressing this issue, we are able to propose an account of TFs in DNs.

Our initial assumption was that the representation of DNs is composed of separate types of information. Besides the various aspects of semantics and syntax which are common to every type of noun/adjective, the mental representation of DNs also appears to involve thematic information, which is essentially information about participants in the event described by the verbal root. Thus, the main difference between denominal and deverbal word formations is that the representation of the latter includes thematic properties in addition to the core meaning. Although this makes the representation of DNs more complex overall and adds to their processing load, it does not necessarily follow that thematic information *per se* is more difficult to process than other features of the lexical representation. There is certainly no such indication in the literature on the processing of thematic features of verbs, although they may be processed independently of other features.

Thematic features are clearly an essential part of a verb's representation and research has shown that they are invariably accessed together with other semantic and syntactic information as soon as the verb is encountered (e.g. Maurer & Koenig, 1999; Bencini & Goldberg, 2000; Friederici & Frisch, 2000). Interesting evidence about the mental

representation of verbs comes from the literature on aphasia. For instance, Marshal et al. (1997) report on a patient who made errors with thematic aspects of verb meaning, but no semantic errors with core aspects of verb meaning. Conversely, other patients have problems with core meaning, but not with thematic information (Marshall et al., 1996). Although such dissociations cannot be used to support differences in degree of difficulty for these aspects of verbal meaning, they can imply the existence of independent representations for core meaning and thematic information. This independence is usually taken as support for the view that core features, such as manner or direction of an action (for verbs like *kick*, *run* etc.) and whether or not a particular instrument is involved (e.g. *stir*, *sturb*), reside in the **concrete** domains of the semantic system. In contrast, a verb's thematic information is more likely to reside in the **abstract** domains⁵⁶ of the semantic system (Marshall et al., 1997). For instance, the verb *chase* encodes some perceptual features, such as speed and action. Such features are part of the core meaning of the verb, and can be accommodated in the concrete domains of the semantic system. The verb also encodes crucial thematic information, in that it describes an event involving an agent and a goal. Such information is more abstract in nature, and therefore, likely to be encoded in the abstract domains (in Marshall et al.'s terminology) of the semantic system. The implication would be that abstract semantic domains are severely impaired in those patients with problems in dealing with thematic information, whereas concrete domains are less so.

Likewise, we could assume a similar representation for DNs, such that representations of deverbal word formations would be composed of distinct, specialized domains (or *components*) containing different types of information. One such component would contain the thematic information of deverbal nominals. This component would not be present for denominal word formations, as they do not carry thematic information. Hence, when we observe increased RTs in lexical access of deverbals over denominals, we can attribute this increase to the accessing and processing of this extra component. This view is not only compatible with the fact that the processing of thematic information increases the processing load of verbs, but it also neatly accounts for the difference in RTs between deverbal and denominal word formations reported in the present research.

⁵⁶ Although the terms concrete and abstract may appear rather vague and arbitrary, the distinction between the two components is still valid.

The dissociation *within* the representations of deverbal word formations, as implied by the findings of Experiments 1 and 2, is less easily interpretable. If every deverbal word formation carries a specific domain devoted to thematic information, and if, as with the verbs, this domain is accessed during word recognition, then why do only some DNs demonstrate increased processing load? A possible explanation, suggested by the results of Experiment 1, is that this component becomes visible only when the nominal is decomposed into its constituents. Thus the viewing of the verb following a decomposition access route might facilitate the surfacing of the component which carries the TFs. The DVAdjs-*tos* in Experiment 1 were the only DVAdjs accessed as whole words and the only ones which did not differ in RTs from their denominal controls. We observed similar results with DVNs-*si* in Experiment 2. However, a further complication was introduced by the results for DVNs-*tis*. Although DVNs-*tis* were accessed after decomposition, no processing of TFs was detected in their RTs.

The results for DVNs-*tis*, as well as those for DVAdjs-*tos* and DVNs-*si*, led us to two possible inferences. Either the representation of these DNs does not include a component that carries thematic information or this component is there but was not accessed during the experiment. If the first inference is correct, then we would have to conclude that no feature percolation takes place when deriving a nominal in -*tis*, -*si* or -*tos* from a verbal base. If this is the case, then we must find theoretical reasons to justify it. For instance, we could assume a mechanism of *blocking* which prevents feature percolation from the verb to the nominal. This would require an explanation as to why two of these nominals can take complements in a sentential context (the cases of -*si* and -*tis*) and why an unexpressed argument/participant is still semantically present (in the case of -*tos*)⁵⁷, as shown in (47).

- (47) a. *i diorthosi ton grapton se pende lepta*
the correction theGEN papersGEN in five minutes
‘The correction of the papers in five minutes/for an hour’

⁵⁷ The phenomenon of unexpressed participants is common with verbs too. Maurer & Koenig (2000) and Koenig, Maurer & Bienvenue (2002, 2003) demonstrate that, depending on the verb form, a *semantically obligatory participant* (in other words what is usually called an *argument*) can be unexpressed in syntax. This is the case with the agent argument of passives, but not with middle verbs. For instance, in the phrase *the vase was sold to collect money for the charity* the agent is still syntactically active but not explicitly mentioned in syntax. In contrast, in the middle construction **the vase sold to collect money for the charity* the agent is not syntactically active and thus cannot license a control sentence.

- b. *o diorthotis ton grapton itan afstiros*
 the corrector theGEN papersGEN bePAST/SING strict
 ‘The corrector of the papers was strict’
- c. *to parathyra einai skalista*
 the windows are engraved
 ‘The windows are engraved’

We could also assume that the NP *ton grapton* ‘of the papers’ in (47a) and (47b) are not real complements, but rather argument adjuncts. However, as shown in Alexiadou (2001), these are indeed complements of the NPs *diorthosi* ‘correction’ and *diorthotis* ‘corrector’ in (47a) and (47b) respectively. Alexiadou (2001: 137) observes that both nominals of the type *correction* and *corrector* can license internal arguments, since both of them contain little *v* (see also section 3.4.2.2), although of different types. Moreover, a nominal such as *correction* also contains AspectP, which guarantees the presence of internal arguments.

On a semantic basis, Koenig et al. (2002, 2003) propose two criteria for distinguishing between arguments and adjuncts. The first one has to do with *semantic obligatoriness* and the second with *verb specificity*. Semantic obligatoriness selects participant categories that are both present in all situations described by a verb lemma and likely to be activated when a verb is recognized. Verb specificity selects participant categories that are most relevant to the meaning and syntactic properties of a verb lemma and also likely to be activated when a verb is recognized. For instance, in a sentence like *Mary peels two apples for her children in the evening*, the fact that somebody peels something is obligatorily present in every instant of the verb *peel*. In other words, an agent and a theme are always involved whenever the verb *to peel* is encountered. This is not the case with the PPs *for her children* and *in the evening*. Of course, when somebody peels something, this action must occur at a particular interval of time. Similarly, it is also possible that there is a beneficiary, such as the one implied by the PP *for her children*. In this case we would have to assume that both the temporal PP and the beneficiary PP constitute part of the semantic

obligatory arguments of the verb to *peel*. Here is where the second criterion, the one of verb specificity applies.

The criterion of *verb specificity* states that most temporal, locational and beneficiary PPs co-occur with most event denoting verbs (Koenig et al., 2003: 73). However, PPs expressing recipients, for example, co-occur with a smaller class of verbs. Also, participant roles corresponding to arguments take additional properties for particular event types. For instance, the agent of *sing* is a person who has to adduct his vocal cords, while this is not the case for the agent of *write*. These additional properties are obligatory for a singing event as opposed to the properties of location for the singing event. The location of the *singing* event is not crucial to determining the verb meaning. Therefore, we are entitled to state that the agent is an obligatory semantic participant (an argument) for the verb to *sing*, while a locational PP is not. Likewise, for DNs, we can say that the NP *ton grapton* ‘of the papers’ in examples (47a) and (47b) is not an adjunct, but is either, in Koenig’s terminology, a *semantically obligatory participant* or an *argument*. Both nominals *corrector* and *correction* describe a correcting event. In both cases, as with the verbs, an agent and a theme bearing certain semantic specifications are always involved. For instance, the agent of a correction event needs to have certain qualifications, such as being knowledgeable in the particular topic, in order to be qualified as a corrector. The theme, conversely, needs to be in a certain state which can receive correction. However, this is not the case for the temporal PP *in five minutes*, which does not have any particular connection to a correcting event. Every event can presumably be completed within a span of five minutes, and this time interval is not specific to a correcting event. Therefore, it cannot be qualified as *argument* of the *correction* and *corrector* nominals. This is how the verb specificity criterion is satisfied. Thus, according to this approach of distinguishing adjuncts from arguments, the NP *ton grapton* qualifies as an argument of the deverbal nouns *correction* and *corrector*, while the PP *in five minutes* does not.

The case of the *-tos* adjectives is slightly different. In section 3.4.1.3 we saw that these nominals might lack the agent argument (Markantonatou et al., 1996: 200). This is obvious from examples such as the one in (48).

- (48) **Ta parathyra itan skalista apo ton texniti*
 The windows were engraved-TOS by the craftsman

However, the fact that *-tos* nominals do not tolerate a *by*-phrase in syntax does not necessarily preclude their lexical entry from containing information about an agent participant. In any case, the example *ta parathyra itan skalista* ‘the windows were engraved’ does not describe an unaccusative event. The windows were engraved because somebody engraved them. In contrast, it is the speaker who chooses to ignore the involvement of an agent and focus on the event itself⁵⁸. Moreover, upon testing the processing of passive and intransitive forms of verbs, Maurer & Koenig (2000) found that it was the form of the verb that determined whether all semantic arguments are syntactically active arguments. Using the same reasoning, we can say that the same situation holds for nominals. Whether all semantic participants are syntactically active depends on the form of the nominal. It seems that those adjectives formed with *-tos* do not allow syntactic realization. However, the semantic participants are still part of their lexical entry. If we accept the argument that even those DNs which did not demonstrate increased processing load are still associated, in multiple ways, with semantic participants, we must conclude that the representation of all DNs includes a component with the thematic information of these nominals. The fact remains, however, that this information is not always accessed during word recognition. In the remainder of this section we will try to account for this apparent discrepancy.

So far we have seen that, in theory, the representation of DNs is organized into components. One of these components includes the thematic information associated with the specific nominal. In experimental settings, lexical access consists of the incremental identification of components until the participant is ready to make the lexical decision and

⁵⁸ In fact, verbs sometimes demonstrate similar behaviour. Goldberg (2001) shows that patient object omission is possible when the patient argument is not topical (or focal) in the discourse and the action is particularly emphasized. For instance, we know that the verb *kill* is a strictly transitive verb, although the sentence *tigers kill at night* is perfectly grammatical. Moreover, that verbs are able to appear in a much wider variety of argument structure frames while retaining their core meaning was demonstrated in a number of studies (Jackendoff, 1990, 1997; Goldberg, 1992; Grimshaw, 1993).

press the button to identify the word as an existing word of a given language. In the case of DVNs-*si*, DVNs-*tis*, and DVAdjs-*tos*, their identification takes place before the individual accesses the component with the thematic information. It is for this reason that there is no difference between RTs for DVNs-*tis*, DVNs-*si* and DVAdjs-*tos* and their denominal controls. Thus we could assume that accessing the TFs of these particular nominals is not a necessary prerequisite to identifying them. This also seems to suggest that thematic information is not as prominent as the other types of information constituting their mental representation.

However, we are still left with the question of whether this component could be prominent only for some DNs, and consequently accessed during word recognition. Earlier we saw that this component is immediately accessed for verbs, leading us to assume that it constitutes an integral part of their representation. In contrast, the very same component is absent from denominal nominals. In the case of DNs, it may be that some of them behave similarly to verbs, while others are closer to nouns. Indeed, what triggers the processing of TFs in some DNs, but not in others, is that they demonstrate verb-like behaviour. This verb-like behaviour is evident from the fact that they receive aspectual modification denoting repetition, *by*-phrase complements, and manner adverbials, as illustrated in section 3.4.1. Thus, the more eventive the DN is, the more prominent the status of the thematic component in its mental representation and the more likely that component is to be accessed. Evidence of this has been shown in the longer RTs for some nominals, but not for others.

To sum up, the mental representation of deverbal word formations is organized into separate components or separate levels. One of these carries the thematic information associated with these nominals. However, this is a necessary part of lexical access only for those nominals with an increased eventive character. Hence, although there is uniformity regarding the number of components which form the mental representation of these nominals stemming from the percolation mechanism, there is no uniformity when it comes to their prominence and their significance for a particular nominal. As a result, accessing a DN with an eventive character requires going through its thematic component, while accessing a DN with a diminished verbal character does not.

There is one final point still to be addressed. Throughout this section, we have argued that DNs with increased verb-like properties have similar mental representations to those for

verbs. However, there is a crucial difference. While the number of a verb's arguments seems to be part of its mental representation, this is not the case for deverbal nouns. Various studies have shown that native speakers are sensitive to the number of arguments a verb carries (e.g. Shapiro et al., 1993). Also, evidence from double dissociations in aphasia supports a similar conclusion (e.g. Shapiro et al., 1993; Kim & Thompson, 2000). However, as we saw in Manouilidou et al. (2004), as well as in Experiment 1, the number of arguments associated with a DVN does not seem to affect RTs in lexical access. Therefore, although the lexical entry of a DN may be specified for semantic participants, as is the case for verbs, the number of participants is not prominent enough to be reflected in RTs for deverbal nominals. This may be related to the fact that syntactic realization of the semantic participants is less obligatory in DNs than in verbs.

The following section examines the broader implications that the findings of the studies presented here might have for psycholinguistic theories of lexical access, the nature of mental representations and the organization of the lexicon.

7.2 Psycholinguistic implications of the present research

To understand a word, native speakers must be able to access several types of mentally represented information, most importantly its meaning or *central representation* (see McQueen & Cutler, 1998). The access of a word's meaning is not an all-or-none event that happens at a specific moment in the time course of word recognition. Accounts of central representation in which word meanings are distributed over a number of smaller units (semantic features or other properties) allow for some of these properties to be accessed more rapidly than others, thereby becoming available at an earlier point in the course of lexical access (see Schreuder & Baayen, 1997).

Despite the general acceptance of the overall staged character of lexical retrieval, the nature of processing relations between the stages remains an active focus of debate both in language production and language comprehension in sentential context, as well as in words in isolation. Whereas most experiments have been restricted to the investigation of semantic and phonological word properties, relatively few researchers have tackled lexical properties that touch upon syntactic issues, and still fewer have tackled timing issues regarding the processing of these properties.

The present investigation has tackled syntactically-related issues by examining the processing of thematic features in deverbal word formations and how such processing interacts with grammatical class. As I mentioned in section 2.2.4, I consider thematic features to be syntactic in nature, in the sense that they are closely related to the argument structure of a particular item. One aim of this research was to determine whether effects of TFs are obtained in visual word recognition of MG deverbal nominals. The experiments reported here have shown that even though TFs are inherited features, and despite the fact that they are not typical for the grammatical class of nominals, the information associated with them is accessed. A second aim of the present research was to delineate any specific characteristics associated with the processing of TFs throughout the process of visual word recognition. Our results have shown that there are two factors that particularly affect the processing of TFs. The first is the lexical access route. Processing of TFs was facilitated when a morphologically complex DN was accessed after being decomposed into its constituents. The second factor is the specific nature of the DN. DNs with eventive properties are more likely to favour the processing of TFs in their access, despite their membership in the class of nominals, which would normally disfavour the processing of TFs.

Taken together, the results of the experiments reported in the present thesis support a stage-like process both for existing words and pseudo/novel words. Moreover, they also indicate that membership in one grammatical class does not necessarily preclude the processing of information typically associated with another grammatical class. These two issues are further developed in the following sections with particular reference to the findings regarding the processing of TFs in deverbal nominals and in Pseudo-Ws.

7.2.1 Lexical access: a stage-like process

As mentioned above, the fact that lexical access takes place in stages is well documented in the literature and is postulated by a variety of models in language production (e.g. Caramazza, 1997) and language comprehension (e.g. Marslen-Wilson & Tyler, 1987; Tanenhaus & Carlson, 1989). It is also clearly delineated in dual route models of lexical access such as Schreuder & Baayen's (1995). Finally, a number of studies (e.g. Feldman, 2000; Rastel, Davis, Marslen-Wilson & Tyler, 2000; Tsapkini et al., 2002) have provided

clear experimental evidence in favor of the differential time course of activation for various lexical properties.

The majority of the evidence that supports differential time course of activation for various features comes from priming studies. For instance, Rastle et al. (2000) report two sets of visual priming experiments in which the morphological, semantic, and orthographic relationships between primes and targets varied in three stimulus onset asynchrony (SOA) conditions (43 ms, 72 ms, and 230 ms). Results showed distinct priming effects for each set of primes (orthographic, morphological, semantic) in different SOAs. For example, it was shown that morphological structure plays a significant role in the early visual recognition of English words independently of both semantic and orthographic relatedness. Moreover, semantic priming was observed only in long SOAs, suggesting that semantic information emerges at later stages in lexical access. Orthographic relatedness was shown to elicit facilitation at short SOAs, namely in the beginning of lexical access, whereas it elicited inhibition at longer SOAs after the prime was perceived.

Tsapkini et al. (2002) demonstrated similar results in a masked priming study investigating the issue of whether morphological relatedness can affect processing independently from the confounding factor of differential orthographic similarity in the lexical access of regular and irregular verbs in MG. Their studies showed that processing in a short SOA (35ms) masked condition was not sensitive to underlying morphological structure, but only to orthographic similarity. In contrast, morphological processing emerged in longer SOAs (150ms), a fact that the authors interpreted as an indication that an 'abstract' morphological level is reached at a later stage of lexical access.

The findings of the experiments presented in this thesis indicate that the class of DNs is not homogenous in terms of lexical access, possibly reflecting differences in the organization of their mental representation (see section 7.1). For instance, TFs seem to be an integral part of lexical access and representation only for a subgroup of DNs with an increased verbal character, but not for those with a diminished verbal character. Although we did not use a priming paradigm, our results also suggest a different time course of activation for various features. As we saw in sections 6.1.3 and 6.2.3, longer RTs were observed for DVAdjs and DVNs when compared to denominal adjectives and denominal nouns respectively. To make this a valid comparison, we only compared groups of DVAjds and

DVNs that were accessed in the same way, either after being decomposed into their constituents or as whole words (as determined through previous comparisons with their non-derived controls). Thus, in Experiment 1 (see section 6.1.3) we compared DNAdjs-*eros* to DVAdjs-*menos/simos/tikos* (accessed after decomposition) and DNAdjs-*ikos* to DNAdjs-*tos* (accessed as wholes), rather than grouping all the DVAdjs and all the DNAdjs together. A similar approach was adopted for Experiment 2 as well. In both studies, processing of TFs was clearly detected for those DNs accessed after being decomposed into their constituents. In light of these findings, we can speculate that the lexical access of these nominals has taken place in the following way: At an initial stage the parser had to decompose both the DNs and their denominal controls. For instance, *diorthotis* ‘corrector’ was decomposed into *diortho-* ‘correct’ + *tis* and *sfouggaras* was decomposed into *sfouggar-* ‘sponge’ + *as*⁵⁹. After decomposition had occurred, there was more information necessary to access in the case of DNs with increased verbal character. This was the thematic information, the accessing of which further increased RTs for those DNs.

Hence, it appears that TFs of those DNs with increased verbal character are accessed at a later stage, after they have been decomposed. Thus, although TFs may constitute part of the lexical entry of DNs, their access, made available through decomposition, suggests that TFs are not accessed immediately, and consequently, they do not surface in the access representation for these nominals, at least in visual word recognition. In the light of the similar RTs obtained for DNs with diminished verbal character and their denominal controls, we surmise that the processing of TFs never materializes for those DNs with a diminished verbal character. In other words, their recognition takes place before their thematic component can be accessed. If this is the case, then we have an indication that not all features of a word are immediately accessible, with some features possibly never being accessed. It further suggests that the accessing of lexical features occurs in stages, with some of them being accessed in earlier stages of processing and others later on, if at all.

A stage-like process is even more evident for Pseudo-Ws. Prior to the studies presented here, Libben (1993a, 1993b) had already postulated the existence of a stage-like process in accessing Pseudo-Ws. His model was exclusively focused on the isolation of

⁵⁹ If we had the means to detect them, at this stage we would likely find similar RTs for both DNs and their denominal controls.

morphological processing. As we saw in section 6.3.3.2.4, the results of Experiment 4 probing the lexical access of Pseudo-Ws also support such a stage-like process for more abstract features, such as TFs. The longer RTs reported for the Pseudo-Ws which violate thematic constraints clearly indicate that thematic computation takes place and that this occurs at a different/later stage than the processing of the categorial and morphological features of the base. We take this as strong evidence that lexical access is a staged process, arriving incrementally at the discrete levels of representation which contain the various features of a word.

A remaining question is why TFs are consistently processed during the lexical access of Pseudo-Ws, but not always during the lexical access of existing words. As Pseudo-Ws do not have an established mental representation, the parser will use whatever information is available in order to achieve successful access. Firstly, it is forced to decompose the Pseudo-W into its constituents. Once decomposition has taken place, the parser still proceeds cautiously with a step by step identification of the various components of the Pseudo-W. Thus, the parser is unlikely to skip the thematic component in its attempt to identify a Pseudo-W. In contrast, when the parser is processing existing words in a visual lexical decision paradigm, it may skip decomposition altogether and overlook some features since other ones take precedence and facilitate or accelerate lexical access.

We must also consider the possibility that the consistent processing of TFs in Pseudo-Ws, but not in all real words, could be an artifact of the lexical decision task itself. The object in a lexical decision experiment is for participants to identify real words and reject non-real ones, of which Pseudo-Ws are one type. Thus the task requirements for the stimulus types differ in the sense that positive responses are required for real words, while negative responses are required for Pseudo-Ws. A number of studies suggest that there are different mechanisms involved in the generation of positive and negative responses which could have impacted the results of the present experiments. For example, negative responses likely require a more effortful and extensive “search” to exclude a possible matching lexical–semantic representation (Binder et al., 2003). Supporting this assumption are behavioural measures from many previous lexical decision studies (Grainger & Jacobs, 1996; Forster & Shen, 1996; Sears, Hino & Lupker, 1995; Andrews, 1989, 1992; Coltheart, Davelaar, Jonasson & Besner, 1977), which clearly indicate that Non-Ws are more difficult and take

longer to process than real words. Further supporting the notion that greater effort is required to generate negative responses was a study in which different brain activation patterns were generated when participants classified filtered speech sounds as nonspeech relative to when they classified the same sounds as speech (Scott, Holmes, Friston & Wise, 2000). On the basis of these findings, it could be argued that the greater effort expended in the search for Pseudo-Ws during lexical access allows sufficient time for the processing of their TFs. In contrast, the relative speed of the lexical access process for real words does not leave sufficient time for the processing of TFs in those items for which they have relatively little prominence.

In any event, despite possible task specific effects, both existing words and Pseudo-Ws appear to be accessed in stages.

7.2.2 Grammatical class vs. thematic features

One of the underlying research questions motivating the present investigation concerned the interaction of two types of features that are thought to influence lexical access. These are grammatical class and thematic features. In section 2.2.4.1 we saw that the grammatical class of a word may determine how it is stored and how it is related to other words. We also saw that the difference between nouns and verbs is usually attributed to the presence of a thematic component associated with verbs, which increases their representational complexity. Although there are compelling theoretical arguments for the existence of a thematic component in DNs, it was not clear whether this component would play a role in accessing them or whether the role of the thematic component would be overshadowed or obscured by other category-related properties of these nominals.

The results of the present studies suggest that information related to the grammatical class of a specific nominal does not appear to preclude accessing of other features in lexical access. If grammatical class had precedence over semantic/syntactic features, then all DVNs and all DVAdjs would yield similar RTs to all DNNs and DNAdjs respectively. However, this was not the case. Only those DVNs/DVAdjs without a prominent thematic component had RTs similar to those of DNNs. This difference cannot be attributed to factors such as imageability, familiarity, length and number of syllables, since the stimuli were controlled for them.

The fact that we do not have evidence of processing of TFs in DNs with diminished verbal character, this suggests that the mental representation of the class of DNs may not be as uniform as has been generally assumed. In terms of their lexical access, and more specifically with respect to the processing of their thematic information, DNs with increased verbal properties appear to pattern with verbs, while those with diminished event properties pattern with (simple or denominal) nouns. Considering lexical access to be suggestive about mental representation, we inferred that the mental representation of DNs with increased verbal properties is similar to the mental representation of verbs, with both including a prominent thematic component that is processed during lexical access. In other words, despite the volume of research supporting grammatical class as an organizing principle of the lexicon, our finding that accessing of DNs, which belong to the same restricted grammatical class does not proceed in a uniform way suggests that the grammatical class of the end-product of the derivation of a complex word may not be as absolute an organizing property of the lexicon as previously thought. In some instances, there may be other properties that unite items from separate lexical categories. Thus, the present research underlines the importance of taking into consideration not only obvious features such as overall grammatical class of a complex lexical item, but also the other properties inherited from its individual constituents.

This conclusion by no means diminishes the role of grammatical class in the organization of the lexicon. Rather, it adds a new perspective on how grammatical class might interact with other features by suggesting that lexical items are not blindly accessed based on their grammatical class. Instead, the parser is sensitive enough to retrieve other more defining features.

7.2.3 The nature of the mental representations and the organization of the lexicon

In section 7.2.1 we argued that lexical access seems to take place in stages. By assuming that the layers of access correspond to layers of representation or that units of access correspond to units of representation, we can make a number of claims about the organization of the lexicon based on the evidence from lexical access obtained through the present investigation. These claims lead to certain generalizations regarding the nature of the mental

representations and the organization of the lexicon to be discussed in the following paragraphs.

The results obtained in the present study converge to support the idea that there is no uniform representation for DNs. Rather, DNs appear to be divided into two categories, based on whether or not their TFs are accessed during word recognition. Consequently, we cannot maintain the position that lexical access and the organization of the lexicon is primarily based on information stemming from the grammatical class of each lexical item. It seems that grammatical class gives precedence to other features which might be more defining for the particular items than their class membership.

Based on linguistic theory, we can assume that TFs are stored in the central representation of both categories of DNs. However, TFs appear to be accessed only for those nominals with increased verbal character. Even though the accessing of this component is mediated by decomposition and so does not happen at an initial stage, it is still an essential component for the identification of DNs with an increased verbal character. This is not the case for those DNs with a diminished verbal character. Although the thematic component is part of their mental representation, there is no evidence of it being accessed. This difference between the two types of DNs, as well as the fact that lexical access of TFs is facilitated by decomposition⁶⁰, suggests that TFs are probably part of a separate level which is between access and central representation. This component, which we could call the *feature representation component*, includes all features specific to each lexical item, such as TFs for DNs. *Feature representation* is further organized into subcomponents, with the most prominent features surfacing during processing of the primary subcomponents of the representation and the less prominent features appearing during processing of the secondary subcomponents. Therefore, we can say that the thematic component is in a prominent position in the *feature representation* of DNs with verb-like character, whereas it is not in a prominent position and therefore not accessed in the *feature representation* of those DNs with a diminished verbal character.

⁶⁰ The interaction of decomposition and processing of TFs is not obligatory. Whether a nominal is accessed after being decomposed or not is related to its *access representation*. However, the processing of TFs is independent of the access representation, as suggested by the case of DVNs-*tis* (accessed after decomposition, but with no processing of TFs detected). This provides additional evidence for the fact that TFs are not accessed at an initial stage and that they are not part of the access representation of a DN.

The type of representation described in the preceding paragraph is in accordance with both linguistic and psycholinguistic theories positing an organizationally layered lexicon characterized by levels of representation. Most psycholinguistic models of the lexicon incorporate units of activation for these levels, either in terms of phonological, graphemic, morphological, and/or semantic features (e.g., Schreuder & Baayen, 1995). The results of the present study give some credence to this view by providing evidence that access representation, feature representation and central representation are accessed sequentially. However, the same findings also allow us to focus on another aspect of lexical organization which does not postulate a fixed order for the subcomponents of each layer of representation. Instead, we have argued that the various subcomponents are accessed or not according to their prominence for the specific item and not according to a fixed order.

In summary, our findings suggest that the word recognition system appears to be structured in a much more fluid manner than was originally anticipated by the various models of lexical access (e.g. Schreuder & Baayen, 1997). In this system, various features can be accessed via distinct operations and at distinct points of time. Furthermore, the encoding and stage of access of specific feature information may vary from word to word. In other words, the processor may or may not reach some components within the specific time frame we measure. Thus, our findings support a layered mental representation for certain lexical items in which their various properties exist at different levels and are not accessed at the same time, or at all, during the recognition process. Unless further research proves otherwise, we could assume that such layering is not unique to the processing of DNs, but is a more general organizational attribute of the lexicon. If this is the case, then it suggests that linguistic features do not have a direct one-to-one correspondence to “mental” features, at least in terms of organization (see also McQueen & Cutler, 1998). For instance, while the linguistic framework adopted in the present thesis postulates that TFs, at least for those DNs formed in an identical way, should be equally prominent, without any predicted variability among them, the data from on-line processing reported in the present study have shown that there is variability which can be attributed to organizational specifications of the mental lexicon.

In the following section I discuss the implications of the findings of the present study with respect to theoretical proposals about deverbal word formation and word formation in general.

7.3 Deverbal Word Formation

We saw in Chapter 6 that although the processing of thematic features plays an essential role in accessing deverbal Pseudo-W formations, its role for existing DVNs is limited only to those with an increased eventive character. Furthermore, we noted that the processing of TFs does not occur at the initial stage of word recognition. This psycholinguistic evidence, which describes language performance, can be used to inform linguistic theory, which describes language competence. Thus, we consider that our findings, taken together, allow us to make a specific proposal regarding both the role of thematic constraints in word formation and the nature of Deverbal Word Formation (DWF) within the general framework of feature percolation. These two issues are discussed in detail in the following sections.

7.3.1 Constraints in Word Formation

As we saw in section 6.3.1, theories of word formation (Bauer, 2001; Plag, 1999; Ralli, 2005) postulate the existence of interaction constraints which derive from various components of the grammar, such as the phonological, syntactic, semantic etc. These constraints seem to apply universally whenever a morphological operation takes place. In addition to these general constraints, the results of the present experiments suggest that there are constraints specific to particular morphological operations, such as thematic constraints for DWF. Furthermore, the general constraints interact with each other and this interaction does not yield a uniform result for each type of word formation. Thus, not only can thematic constraints be considered as distinct from other constraints that apply to DWF, they can also be viewed as a special by-product of the interaction of semantic and syntactic constraints when applying to various types of DNs. Future research could help to determine whether such interaction between general constraints is unique to DWF or whether there are other constraints similarly specific to different morphological operations. To date, this issue has been largely ignored by theories of word formation which acknowledge the existence of general constraints.

There are two further issues related to thematic constraints in DWF. The first one is that these constraints appear to be processed at a later stage in word recognition. If processing specifications are a reflection of word formation processes, then we will have to assume that word formation also involves the *sequential application* of different constraints. For instance, for all the suffixes used in the present study, both their thematic and categorial constraints are traditionally classified as strong. However, in every case, the thematic ones appeared to be processed after the categorial ones. Viewed from the perspective of word formation, thematic constraints would appear to apply after the application of categorial constraints⁶¹.

This would have further implications for word formation, suggesting a stage-like process similar to one for lexical access. The idea of a stage-like organization in word formation is not new. Within the framework of Lexical Morphology and Phonology, the lexicon is divided into various *levels* (Kiparsky, 1982) or *strata* (Mohannan, 1986), which classify and group together the application of morphological and phonological processes of word formation. These levels or strata span between the lexicon and syntax and divide lexical structure into sublevels, each of which includes a morphological and a phonological part.

The levels of lexical structure are arranged in a particular order. The processes taking place at a sublevel closer to syntax are more predictable, more productive and more regular than the processes taking place at a sublevel closer to the lexicon, which contains lemmas with non-predictable features. Figure 15, as presented in Ralli (2005: 220) illustrates the lexical structure for MG in accordance with Lexical Morphology/Phonology.

⁶¹ The notion that linguistic rules apply in a strict order is in sharp contrast with the ‘fluidity’ of the organization of the mental lexicon as described in section 7.2.2. One way to accommodate the notion of ordering is to consider that each rule equips a lexical item with certain features, which can then be organized into a variety of configurations.

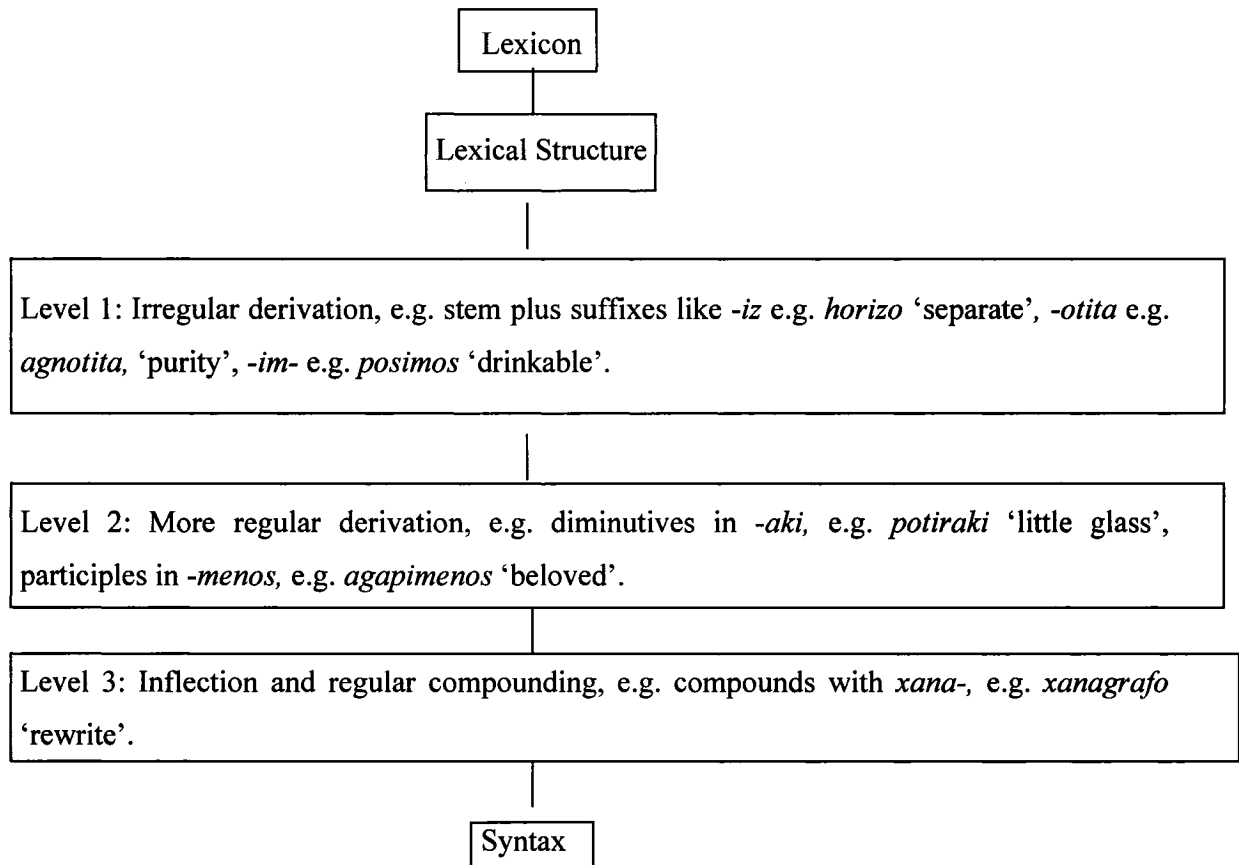


Figure 15: *Level Model in Word Formation* (Ralli, 2005: 220)

Although there is no temporal assumption in a model such as the one illustrated above, we can similarly propose the existence of *sequential stages* in the application of constraints as equivalent to Ralli's levels of lexical structure. Thus, if we apply the same schema to DWF, while leaving the notions of regularity and productivity aside, we can make similar inferences regarding the application of constraints. For instance, categorial constraints would apply at a higher level, closer to the verbal root, while thematic constraints would surface at a lower level. As our RT data suggest that TFs are accessed at a later time in both existing and Pseudo-Ws, we could introduce a temporal dimension to account for the sequential application of constraints, with thematic constraints applying at a later stage in DWF. Thus we can imagine that the Schema in Figure 16, which illustrates DWF with respect to the application of thematic and categorial constraints, reflects sequential stages in word

formation. Unfortunately, the present investigation does not allow us to place other constraints that might apply, such as phonological constraints, in the hierarchy.

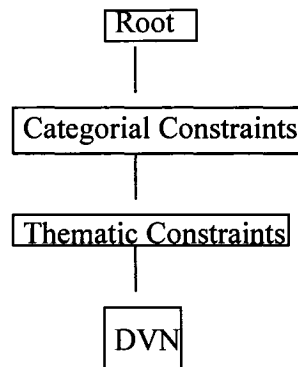


Figure 16: *Sequential application of constraints in DWF*

The second issue related to thematic constraints in DWF that we must address here derives directly from the results of the error analysis in both the off-line and on-line tasks with Pseudo-Ws. The different patterns of rejection/acceptance for the two types of Pseudo-Ws suggest that thematic constraints appear to be more *violable* than categorial ones. Morphological theories (Bauer, 2001; Plag, 1999; Ralli, 2005) postulate the existence of strong and weak constraints, depending on the strictness of their application in certain environments. As we saw in section 6.3.1, both the categorial and thematic constraints that we studied are considered to be strong in MG. However, the results of the present research suggest that even within “strong” constraints there are degrees of distinction. Namely, strong constraints can be further divided into “stronger” and “weaker”, in terms of their “violability”. The evidence provided by the present experiments makes a case for a more complex view of constraints than was discussed previously (see section 6.3.1). Although individual constraints were initially presented as either being *absolute* (attaching only to a particular base) or *flexible* (preferring a particular base but attaching to other bases as well), our findings suggest that even strong constraints may be gradient. This is something that needs to be incorporated into theoretical accounts of constraints on morphological operations.

Finally and more importantly, there seems to be an *interaction* between the level of application and the violability of the particular constraint. The closer we are to the root, the

stricter the constraint appears to be. Conversely, when a constraint applies at a later stage (such as a thematic constraint), it appears to be more violable. When they approach the word level, constraints relax and more easily allow violations. By relating lateness of application to violability, we can account for both the RTs and error rates we obtained for Pseudo-*Ws* with thematic and categorial violations.

7.3.2 Implications for Distributed Morphology and Percolation Theories

Although the present studies were not designed to test the predictions of various theories of word formation, their outcome is, nonetheless, suggestive about them. We will focus our discussion here on two competing theories, Distributed Morphology (DM) (e.g. Halle & Marantz, 1994; Marantz, 1997; Embick & Noyer, 2001, 2004) and Lexicalist Percolation Theories (Selkirk, 1982; Lieber, 1980/1990; DiSciullo & Williams, 1987).

As mentioned in section 1.1, DM views the lexicon in a very narrow sense, including only a list of atomic, category-neutral roots (sound-meaning pairings) and abstract (bundles of) features but no lexicon-specific computational operations. In DM, the morphosyntactic information associated with a derived item is distributed across various components of the grammar (narrow lexicon, syntax, post-syntactic phonology) and the creation of a word from another word does not presuppose the existence of an autonomous morphological component of the grammar (distinct from the syntax and the PF). Every word (whether traditionally ‘derived’ or ‘non-derived’) is a non-atomic object with at least *some* syntactic structure, while the ‘root’ of a word is underspecified in terms of part of speech. Grammatical category and other morphosyntactic features are specified after the addition of a category-defining head, such as a nominalizer or a verbalizer (cf. Arad, 2003; Embick & Noyer, 2004). It is this category-defining head that determines the traditional part-of-speech properties. This is in accordance with the *Categorization Assumption* proposed by Embick & Noyer (2004: 5), which postulates that “Roots cannot appear without being categorized; Roots are categorized by combining with category-defining functional heads.” Thus, what traditional morphology considered a bare root could, within a DM framework, could be seen as a complex syntactic object combining a category-neutral root and a null verbalizer or nominalizer.

In Experiment 2 (see section 6.2.3) we found that viewing of the suffix (and not of the verbal root) seemed to play a determining role in the processing of TFs. It appeared that

the verbal root was not prominent enough to trigger the processing of TFs. Rather, this processing seemed to occur only in cases where the nominal demonstrated increased verb-like properties, which were determined by the suffix, as shown in section 6.2.4. Consequently, we could say that it is the suffix which is ultimately responsible for the TFs of the nominal. This finding appears to be compatible with a theory of word formation like DM as it is in accordance with the basic assumptions behind DM regarding the existence of a category-neutral root and the increased role of a category-defining head, such as a nominalizer, for the stimuli of Experiment 2. Also, the idea that word formation takes place in stages, as illustrated in the previous section, is also compatible with DM, which assumes that word formation can be spread over different components, each of which makes its own contribution.

While these facts appear to be compatible with DM, the same cannot be said for the design and outcome of Experiments 3 and 4 (section 6.3.3), which dealt with Pseudo-Ws and Novel-Ws. In Experiments 3 and 4, manipulating the lexical category of the base resulted in different RTs as well as different acceptance and rejection patterns for the two groups of Pseudo-Ws employed as stimuli. The basic assumption behind this design was that the interaction of the suffix with the class-membership-derived properties of the base would allow us to draw conclusions about the role of the specific TFs associated with both the base and the suffix. This experimental design is at odds with one of the basic premises of DM, namely, the existence of category-neutral roots. As formulated, Experiments 3 and 4 are not compatible with the existence of a category-neutral root, since they crucially assume that the bases to which the suffixes were attached are either verbal or nominal. However, in a DM account, they could be either category-neutral roots, with the suffix acting as the phonological realization of the category-defining head, or they could be made up of a category-neutral root embedded under a phonologically null category-defining head, with the suffix acting as the phonological realization of a second category-defining head. In this case, Experiments such as 3 and 4 cannot provide evidence either for or against DM, because we cannot know whether the bases of the Pseudo-Ws were category-neutral roots or whether they carried a null category-defining head.

In contrast, both the design and the outcome of Experiments 3 and 4 are compatible with lexicalist theories of word formation, which accept the existence of conventional

grammatical categories listed in the lexicon together with further specifications. However, taken together, the findings of the experiments reported in Chapter 6 do not provide unequivocal support for the lexicalist theories of percolation, which base their analysis of DNs almost exclusively on the verbal properties of the base. The results suggest that although the verb might be the source of the TFs for a deverbal item, the suffix has an equally important role. Therefore, theories of percolation should be modified to reflect the increased role of the suffix when it comes to thematic specifications. The following section deals with deverbal word formation and feature percolation in more detail.

7.4. Implications for word formation: percolation revisited

7.4.1 Feature percolation: the basic mechanism

The models of word formation proposed by Lieber (1980/1990), Selkirk (1982) and DiSciullo & Williams (1987) assume a percolation mechanism which is responsible for the features of the new word. According to this mechanism, the features of the new word depend on the features of its parts. The basic principle of feature percolation as described in section 3.2.2 states that in a morphological construction X, which is constituted from Y and Z, the grammatical category and the rest of the morphosyntactic features of X come from the particular features of Y and Z. Furthermore, when a form includes an affix, the affix's features have priority. For instance, for the creation of the word *helpless*, the suffix *-less* is responsible for the grammatical category and the morphosyntactic features of the new word.

Feature percolation from the nonhead takes place only when the head needs additional information in order to fulfil its requirements. In Selkirk's terminology, such cases of interference from the features of the non-head are known as the 'revised percolation principle'. The revised percolation principle states that where the new word is underspecified for certain features, these are inherited from the non-head constituent. For instance, in the creation of *helpless*, percolation of the grammatical category comes from *-less* and percolation of semantic features comes from *help*. The observation that the new word can also inherit features from the non-head has led DiSciullo & Williams (1987) to introduce the term 'relativized head'. They accept that the head is responsible for attributing features of lexical category, but that sometimes the same constituent may behave as a non-head when it

comes to other features (usually morphosyntactic, semantic etc.). In such cases, a non-head (with respect to the lexical category) takes over the role of head (with respect to another feature). This is called the ‘relativized head percolation principle’. The notion of ‘relativized head’ implies that a constituent can be the head with respect to one particular feature, but a non-head with respect to another. In the following section, we will illustrate how the relativized head percolation principle appears to apply in Deverbal Word Formation (DWF).

7.4.2 Feature percolation in DWF

In the previous section, we saw how the percolation mechanism is responsible for deriving the features of a new word formation from those of its parts. With respect to deverbal word formation and, more specifically, to the features of argument structure (AS), we necessarily assume a more prominent role for either the *relativized-head percolation* or *revised percolation principle*. The non-head constituent, in our case the verb, transmits its AS features to the deverbal nominal. Thus, even though the suffix as head determines the lexical category of the new word, the verb is actually responsible for its AS properties. The English suffix *-er* provides a clear example of this. The suffix creates nouns which denote an animate entity. When *-er* attaches to a verb, the new word formation inherits the verb’s TFs and has the potential for developing AS. This is the case for *writer*, *teacher*, *builder* etc. On the other hand, when the suffix *-er* attaches to a noun, the new word formation does not have the potential to develop AS. For instance, the nouns *villager*, *Londoner* etc. do not have AS. In both cases, and according to the percolation principle, it is the suffix which determines the morphosyntactic features of the new nominal. However, in the case of DVNs, the revised percolation principle has also applied, accounting for why DVNs with *-er* have AS features inherited from the verb. We have shown that the revised percolation principle is responsible for transmitting the AS properties of the verbal root to the new DVN. However, the various percolation theories tend to ignore other operations beyond simple transmission of AS properties that also appear to take place during derivation. These are discussed in the following section.

7.4.3 Re-revised percolation principle

According to the *revised percolation principle*, AS features are transmitted to a new DVN from the verb base. If we accept that DWF is a process similar to the one described in the previous section, then we might presume that all AS properties associated with the new word formation are associated with the verb. For example, to form the derivations *diorthotis* ‘corrector’, *diorthosi* ‘correction-SI’, and *diorthoma* ‘correction-MA’, the same verbal base *diorthono* ‘correct’ combines with three different suffixes. The verb *diorthono* ‘correct’ has an argument structure of the type <Ag<Th>>, which is obligatory in every environment in which the verb *diorthono* might appear. According to Selkirk’s (1982) model, percolation transmits this AS to all three nominals (*diorthotis*, *diorthosi*, *diorthoma*), giving them the possibility of having an AS of the <Ag<Th>> type. However, the AS properties of these three nominals are distinct from one another (see section 3.4.2.4). Moreover, they also yield distinct RTs in the visual word recognition experiments reported here. Thus, while it appears that the source of their AS is clearly the verbal base (the non-head constituent), it is the suffix which determines the extent to which this potential AS actually materializes. Thus the role of the suffix (the head) is crucial in determining the final AS properties of these nominals. Current percolation theory does not account for this.

The role of the suffix is also apparent when it comes to the creation of pseudo and novel words. As with real words, a percolation mechanism should be active in the creation of pseudo and novel words. However, Pseudo-Ws remain Pseudo-Ws because, at some point during the derivational process, percolation fails to apply completely. This is not due to the verb; it is active and available to transmit whatever features it has. Percolation fails because the suffix is not compatible with the verb’s features. This incompatibility either blocks the creation of a new, well-formed lexical item or it leads to the creation of a Pseudo-W. In either case, it is the suffix which apparently selects whether and how many features will transmit to the new word formation. This observation should lead us to re-establish the role of the head in DWF as the determiner of non-categorical, morphosyntactic features, including AS properties. In the following section, I will present a detailed proposal of the percolation mechanism as it applies to DVNs. I will also propose a new principle which re-establishes the role of the suffix and distinguishes the ‘morphosyntactic’ features transmitted by the head from those transmitted by the non-head.

7.4.4 Re-establishing the effect of the head

We have argued that the derivation of a DVN involves feature percolation both from the head and the non-head constituent. Previous authors have claimed (Selkirk, 1982; Lieber, 1980/1990) that the verb is the main source of AS features for the new word or, put another way, that relativized head percolation takes place. However, if this were the case, then every nominal derived from a verb would have the exact AS properties of its base verb. As the following examples show, this is clearly not the case.

- (49) a. *O Jiannis diorthonei ta grapta edo kai mia ora*
The Jiannis correctSING the papers here and an hour
'Jiannis has been correcting the papers for an hour'
- b. **O Jiannis einai diorthotis grapton edo kai mia ora*
the Jiannis is corrector papersGEN here and an hour
'Jiannis has been the corrector of the papers for an hour'
- c. **I diorthosi ton grapton apo to Gianni edo kai mia ora*
the correction theGEN papersGEN by the Jiannis here and an hour
'the correction of the papers by Jiannis for an hour'
- d. *To diorthoma ton grapton apo to Gianni edo kai mia ora*
the correcting theGEN papersGEN by the Jiannis here and an hour
'the correcting of the papers by Jiannis for an hour'
- (50) a. *O Jiannis kapnizei 20 tsigara tin imera*
The Jiannis smokes 20 cigarettes theACC dayACC
'Jiannis smokes 20 cigarettes per day'
- b. **O Jiannis einai kapnistis 20 tsigaron tin imera*
the Jiannis is smoker 20 cigaretteGEN theACC dayACC
'Jiannis is a smoker of 20 cigarettes per day'

- c. **To kapnisma 20 tsigarou tin imera apo to Gianni*
 the smoking 20 cigaretteGEN theACC dayACC by the Gianni
 ‘the smoking of 20 cigarettes per day by Gianni’

Examples (49a) and (50a) illustrate sentences where all the verb arguments are present. The remaining examples (49b, c, d and 50b, c), illustrate that the nominals derived from the verbs in (49a) and (50a) do not tolerate the same arguments as the base verb. There are considerable differences not only between the AS of the verb and the nouns, but also between the nouns, as the difference between (49c) and (50d) indicates. Instead of the verb being fully responsible for transmitting the thematic features and, consequently, the AS properties to the newly derived noun, the properties of the particular suffix intervene to determine to what extent the verb’s features finally reach the product of derivation. It is as if a balance is achieved between the contributions of the verb and the suffix regarding the inheritance of AS features. The verb supplies the TFs and the suffix selects which ones will be part of the nominal’s final AS.

The above analysis motivates a further revision to the *revised percolation principle*, as it applies to deverbal word formations. While the revised percolation principle stresses the verb’s contribution to the AS properties of the DVN, the goal of the re-revision is to reinstate the crucial role of the head as the final determiner of the AS properties of the nominal. Thus the *re-revised percolation principle* for DWF postulates that while the non-head constituent is the source of the AS properties for the new DVN, it is still the head which determines the final AS properties of the nominal. In addition to accounting for the psycholinguistic facts, this formulation provides a more precise meaning to the rather vague statement that the head transmits morphosyntactic features in DWF.

7.5 Conclusion

The goal of the present thesis was to investigate the processing of TFs in the lexical access of DNs and of Pseudo-Ws which violate thematic constraints. By providing evidence from previously untested word formations, such as DNs, a secondary goal was to contribute to our understanding of the mental lexicon and, more specifically, to how the various linguistic

features of a complex lexical item interact during lexical access. Based on the empirical evidence of the present thesis, we have been able to readdress issues of grammatical class in lexical access and its interaction with other semantic/syntactic features of complex lexical items. The thesis has also provided insight regarding theories of word formation by showing that complex word formations, such as DNs comprise a diverse class with defining characteristics that result from the interaction of the specific properties of their constituents. Most importantly, these properties constitute an integral part of the mental representation of DNs, which the human parser is sensitive enough to detect and process under certain conditions during word recognition.

Although the present thesis provides considerable evidence regarding the lexical access and representation of DNs, as well as insights into how various lexical features interact with grammatical category, all of the evidence has been gathered during the on-line visual recognition of single words within the lexical category of derived nominals. Much could be learned from pursuing related research on different lexical categories in both single word and sentential context, as well as in seeking out neurological correlates to aspects of lexical processing through electrophysiological, neuroimaging and lesion studies. These possible directions for future research would expand upon and enrich the findings of the present study. By adding the results of such methodologically diverse studies to the findings of the present investigation, we may arrive at a clearer understanding both of the status of thematic features and AS in defining DNs and of their role in retrieving these nominals. A comparison between the recognition patterns of verbs, DNs and (simple and denominal) nouns would be particularly helpful in elucidating the role of grammatical category, as opposed to specific features, in word recognition and in sentence processing. We would then be in a privileged position to further refine currently held views of the role of various lexical properties of complex words in word recognition and in the organization of the lexicon.

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APPENDIX A (Experiment 1)

The first column presents the stimuli in Greek as appeared on the computer screen for the lexical decision task. The second column provides the transliteration in the Latin alphabet, and the third one the English translation.

	<u>Greek Script</u>	<u>Transliteration</u>	<u>Translation</u>
DVAdjs-menos	καλυμμένος κεντημένος θρεμμένος σφιγμένος σκαλισμένος στεφανωμένος στολισμένος τριμμένος	kalymenos kentimenos thremmenos sfigmenos kalismenos stefanomenos stolismenos trimmenos	covered embroidered bred squeezed engraved crowned decorated grated
DVAdjs-simos	αμφισβητήσιμος αναστρέψιμος εφαρμόσιμος εκπαιδεύσιμος επισκευάσιμος κατεδαφίσιμος προσαρμόσιμος συγκρίσιμος	amfisvitisimos nastrepsimos farmosimos kpaideusimos episkeuasimos katedafisimos prosarmosimos sygkrisimos	doubtful reversible applicable trainable repairable demolishable adjustable comparable
DVAdjs-tikos	ανασταλτικός χαλαρωτικός διεγερτικός επενδυτικός επιβαρυντικός εξοργιστικός καταθλιπτικός παρηγορητικός	anastaltikos xalarotikos diegertikos ependytikos epibaryntikos eksorgistikos katathliptikos parigoritikos	suspensive relaxing stimulating investive damaging infuriating depressing comforting
DVAdjs-tos	αντιληπτός επιτρεπτός κατανοητός λατρευτός μισητός ποθητός σκαλιστός υποφερτός	antiliptos epitreptos katanoitos latreutos misitos pothitos skalistos yποfertos	detectable permissible comprehensible beloved hateful desirable engraved bearable

	<u>Greek Script</u>	<u>Transliteration</u>	<u>Translation</u>
DNAdjs-ikos	αδελφικός ειρηνικός εμπορικός επιστημονικός γεωργικός κομματικός παιδικός σφαιρικός	adelfikos eirinikos emporikos epistimonikos georgikos kommatikos paidikos sfairikos	fraternal peaceful commercial scientific agricultural political partying childish spherical
DNAdjs-eros	βροντερός βρωμερός φαρμακερός φλογερός καρπερός παγερός θανατερός σιχαμερός	vronteros vromeros farmakeros flogeros karperos pageros thanateros sixameros	thundering dirty poisonous flaming fructuous frosty deadly disgusting
NAdjs -menos	βέβαιος επιτήδειος γενναίος μαλακός νηστικός πανούργος παρθένος σκούρος	vevaios epitideios gennaios malakos nistikos panourgos parthenos skouros	certain dexterous brave soft hungry sly virgin dark
NAdjs-eros	αριστερός αυστηρός φαλακρός πονηρός σταθερός στυγερός τρυφερός ζωηρός	aristeros afstiros falakros poniros statheros stygeros tryferos zoiros	leftist strict bald cunning stable heinous tender vivid

	<u>Greek Script</u>	<u>Transliteration</u>	<u>Translation</u>
NDAjs-ikos	αυθεντικός ελαστικός εντατικός φανατικός παθητικός πλασματικός πραγματικός συμβατικός	afthentikos elastikos entatikos fanatikos pathitikos plasmatikos pragmatikos symvatikos	authentic flexible intensive fanatic passive imaginary real conventional
NDAjs-simos	φρόνιμος ώριμος γόνιμος κρίσιμος μόνιμος νόστιμος πρώιμος στάσιμος	fronimos orimos gonimos krisimos monimos nostimos proimos stasimos	wise mature fertile critical permanent tasty premature static
NDAjs-tikos	βιοτικός δυνητικός ιδιωτικός πρακτικός θετικός ρομαντικός σημαντικός τακτικός	viotikos dynitikos idiotikos praktikos thetikos romantikos simantikos taktikos	biotic potential private practical positive romantic important regular
NDAjs-tos	αφόρητος αμείλικτος αυθόρμητος άθικτος άτακτος άξεστος εφικτός εξάίρετος	aforitos ameiliktos afthormitos athiktos ataktos aksestos efiktos eksairetos	unbearable merciless spontaneous intact naughty rude doable excellent

APPENDIX B (Experiment 2)

	<u>Greek Script</u>	<u>Transliteration</u>	<u>Translation</u>
DVNs-<i>ma/-simo</i>			
	αφηνίασμα	afiniasma	bolting
	βούρκωμα	vourkoma	filling with tears
	δείλιασμα	deiliasma	cowardice
	κορύφωμα	koryfoma	climax
	ορφάνεμα	orfanema	the state of becoming orphan
	δάνεισμα	daneisma	lending
	γαργάλισμα	gargalisma	tickling
	γιάτρεμα	giatrema	healing
	γυάλισμα	gyalisma	polishing
	μάντρωμα	mantroma	fencing in
	τρόχισμα	trocisma	grinding
	ζούλιγμα	zouligma	squeezing
	γνέψιμο	gnepsimo	waving
	τσούξιμο	tsouksimo	tingle
	φτιάξιμο	ftiaksimo	fixing
	σμίξιμο	smiksimo	blending
DVNs-<i>si</i>			
	αγαλλίαση	agalliasi	elation
	αγόρευση	agorefsi	oration
	αναρρίχηση	anarrixisi	ascent
	ανάρρωση	anarrosi	recovery
	διάρρευση	diarrefsi	leakage
	ευδοκίμηση	efdokimisi	thriving
	μεσίτευση	mesitefsi	interceding
	μετανόηση	metanoisi	repenting
	αθέτηση	athetisi	infraction
	αθώωση	athoosi	exculpation
	αραίωση	araiosi	dilusion
	άθροιση	athroisi	summation
	βεβήλωση	vevilosi	profanation
	διευθέτηση	diefthetisi	settlement
	επούλωση	epoulosi	cicatrization
	σχεδιάση	sxediasi	design
DVNs-<i>tis</i>			
	ακροβάτης	akrovatis	acrobat
	αναχωρητής	anaxoritisi	someone who departs
	βουτηχτής	voutixtis	diver
	κωπηλάτης	kopilatis	rower
	πολιτευτής	politeftisi	politician

<u>Greek Script</u>	<u>Transliteration</u>	<u>Translation</u>
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θριαμβευτής	thriamveftis	triumphant
στασιαστής	stasiastis	insurgent
ξενιτευτής	kseniteftis	migrator
χλευαστής	xlevastis	jeerer
διώκτης	dioktis	persecutor
εκτιμητής	ektimitis	estimator
περιγηγής	periigitis	sightseer
πεταλωτής	petalotis	blacksmith
πολιορκητής	poliorkitis	besieger
θεραπευτής	therapeftis	healer
θεριστής	theristis	harvester

DNNs-*adiko*

επιπλάδικο	epipladiko	furniture shop
κουλουράδικο	koulouradiko	bagel shop
λουλουδάδικο	louloudadiko	flower shop
ποδηλατάδικο	podilatadiko	bike shop
πουκαμισάδικο	poukamisadiko	shirt shop
τσαντάδικο	tsantadiko	bag shop
ψωμάδικο	psomadiko	bakery
φαναρτζίδικο	fanartzidiko	lantern shop
γιαουρτάδικο	giaourtadiko	yogurt shop
καλαθάδικο	kalathadiko	basket shop
κασετάδικο	kasetadiko	tap shop
κεραμιδάδικο	keramidadiko	tile shop
τζαμάδικο	tzamadiko	glass shop
τυροπιτάδικο	tyrpidadiko	cheese-pie shop
σιδεράδικο	sideradiko	smithy
ρεμπετάδικο	rebetadiko	music hall

DNNs-*si*

αμορφωσιά	amorfosia	lack of education
χωριατιά	xoriatia	gaucherie
κατεργαριά	katergaria	craftiness
μαλαγανιά	malagania	cajolery
μπαμπεςιά	mpampesia	treachery
παγαποντιά	pagapontia	vagapontage
παραξενιά	paraxenia	bizarreness
ζητιανιά	zitiania	beggary
τεμπελιά	tebelia	laziness
λεβεντιά	leventia	manfulness
ανθρωπιά	anthropia	humaness
τσιγκουνιά	tsigounia	stinginess
αρχοντιά	arxontia	nobleness
παληκαριά	palikaria	bravery

	πονηριά	poniria	foxiness
	<u>Greek Script</u>	<u>Transliteration</u>	<u>Translation</u>
DNNs-tis	φουστανελάς	foustanelas	evzone
	γιαουρτάς	giaourtas	yogurt seller
	καρβουνάς	karvounas	coal seller
	παντοφλάς	pantoflas	slipper seller
	παπλωματάς	paplomatas	mattress carder
	παπουτσάς	papoutsas	shoe maker/repairer
	σφουγγαράς	sfouggaras	sponge diver
	ποδηλατάς	podilatas	bike mechanic
	ωρολογάς	orologas	horologer
	λουλουδάς	louloudas	florist
	λαμαρινάς	lamarinas	iron worker
	πορτοφολάς	portofolas	pickpocket
	καστανάς	kastanas	chestnut seller
	κλειδαράς	kleidas	locksmith
	περιπτεράς	peripteras	kiosk owner
NDNs-ma/-simo	αίνιγμα	ainigma	enigma
	άγαλμα	agalma	statue
	χάραμα	xarama	dawn
	διάταγμα	diatagma	edict
	εξάνθημα	eksanthima	outburst
	κάταγμα	katagma	fracture
	όραμα	orama	vision
	βάλσαμο	valsamo	balm
	ένζυμο	enzymo	ferment
	κάρδαμο	kardamo	cardamon
	οικόσημο	oikosimo	coat of arms
	ορόσημο	orosimo	landmark
	σύνθημα	synthima	slogan
	έγκλημα	eglima	crime
	πείραμα	peirama	experiment
	φάντασμα	fantasma	ghost
NDNs-si	αίρεση	airesi	heresy
	αμφίεση	amfiesi	costume
	διάσειση	diaseisi	concussion
	φυματίωση	fymatiosi	tuberculosis
	πρόποση	proposi	toast
	σύνεση	synesi	wisdom
	ύδρευση	ydrefsi	water supply
	πρόφαση	profasi	pretext

μήνυση
έκταση
κατάνυξη
λοιμωξη
συνέντευξη
σύρραξη
περίληψη
πρόσοψη

mynisi
ektasi
katanyksi
loimoksi
synentefksi
syrraksi
perilipsi
prosopsi

appeal
amplitude
devoutness
infection
interview
conflict
summary
facade

NDNs-tis

αντάρτης
ασβέστης
δεσπότης
γρανίτης
κομήτης
μαγνήτης
πειρατής
εφιάλτης
γκαντέμης
μπακάλης
καθρέφτης
σατράπης
μπαμπέσης
ντερβίσης
πλανήτης

antartis
asvestis
despotis
granitis
komitis
magnitis
peiratis
efialtis
gademis
bakalis
kathreftis
satrapis
mpampesis
dervisish
planitis

partisan
asbestos
lord
granite
comet
magnet
pirot
nightmare
unlucky
grocer
mirror
autocrat
sneak
dervish
planet

Length Controls

βουτυράς
βραχνάδα
γουνάρας
καθισιό
μουντάδα
θαμπάδα
σβελτάδα
ζωηράδα
ασπρίλα
χτύπος
καπνίλα
λεφτάς
φρεσκάδα
εξυπνάδα
ξενώνας
αγριάδα

boutyras
vraxnada
gounaras
kathisio
mountada
thampada
sveltada
zoirada
asprila
xtypos
kapnila
leftas
freskada
exyprnada
ksenonas
agriada

butter seller
hoarseness
furrier
inaction
dullness
mistiness
agility
briskness
whiteness
clack
smokiness
rich
freshness
smartness
guest house
roughness

APPENDIX C (Experiment 3 = off-line)

Thematic Violations –*simos*

Greek Script	Transliteration	Possible translation
ανεβάσιμος	anevasimos	ascent-able
μεθύσιμος	methysimos	intoxicate-able
αποτυχήσιμος	apotyxisimos	fail-able
διψάσιμος	dipsasimos	thirst-able
ακροβατίσιμος	akrovatisimos	equilibrate-able
θριαμβεύσιμος	thriamvefsimos	triumph-able
τρέξιμος	treksimos	run-able
λαλίσσιμος	lalisimos	crow-able
απολαμβάσιμος	apolamvasimos	enjoy-able
δουλεύσιμος	doulefsimos	work-able
χαϊρέσιμος	xairesimos	joy-able
εμβαθύσιμος	emvathysimos	deepen-able
αγρυπνήσιμος	agrypnisimos	stay awake-able
χορεύσιμος	xorefsimos	dance-able
καθίσσιμος	kathisimos	sit-able
κοιμίσσιμος	koimisimos	sleep-able
μεγαλώσιμος	megalosimos	grow-able
πηδήσιμος	pidisimos	hop-able
κελαϊδήσιμος	kelaidisimos	tweet-able
παινέσιμος	painepsimos	praise-able
διαγωνίσσιμος	diagonisimos	compete-able
ξεφαντώσιμος	ksefantosimos	disport-able
πέσιμος	pesimos	fall-able
ονειρεύσιμος	oneirefsimos	dream-able
πετάξιμος	petaksimos	fly-able
γεράσιμος	gerasimos	age-able
φοιτητίσιμος	foititisimos	study-able
καταφτάσιμος	kataftasimos	arrive-able
χαμογελάσιμος	xamogelasimos	smile-able

Thematic Violations –*tis*

Greek Script	Transliteration	Possible translation
αηδιαστής	aidiastis	disgust-er
ωριμαστής	orimastis	mature-er
διαφεριστής	diaferistis	differ-er
περιμενωτής	parimenotis	wait-er
αργηστής	argistis	be late-er
επιθυμητής	epithymitis	desire-er
κατρακυλιστής	katrakylitis	roll-er
αιμορραγητής	aimorragitis	bleed-er
ζηλευτής	zileftis	envy-er
δακρυστής	dakrystis	tear-er

ναυαγιστής	navagistis	wreck-er
πλημμυριστής	plimmyristis	flood-er
υποφερτής	yprofertis	suffer-er
ανθιστής	anthistis	bloomer
αρεστής	arestis	like-er
ξυπνηστής	ksypnistis	awake-er
πεινωτής	peinotis	[be hungry]-er
ξεχαστής	ksehastis	forget-er
θελητής	thelitis	want-er
ευτυχιστής	eftyxistis	be happy-er
υπαρκτής	yparktis	exist-er
κακιωστής	kakiostis	sulk-er
ξενυχτηστής	kseyuxtistis	[spend-the-night-out]-er
ξεχειλιστής	ksexeilistis	overflow-er
ξεφτιστής	kseftistis	unravel-er
ανατριχιαστής	anatrixiastis	[have goose bumps] -er
αντιπαθητής	antipathitis	dislike-er
θυμωτής	thymotis	[get angry]-er
στεναχωρεστής	stenoxorestis	[get worried]-er
μισητής	misitis	hate-er

Categorial Violations –*simos*

Greek Script	Transliteration	Possible translation
αχύριμος	axyrimos	straw-able
αδελφίμος	aderfimos	brother-able
αγγούριμος	aggourimos	cucumber-able
αλεύριμος	alevrimos	flour-able
αμπέλιμος	ampelimos	vine-able
βαρέλιμος	varelimos	barrel-able
βυσσίνιμος	vyssinimos	[sour cherry]-able
χαλίκιμος	xalikimos	pebble-able
ελάτιμος	elatimos	fir-able
γαϊδούριμος	gaidourimos	donkey-able
γυναίκιμος	gynaikimos	woman-able
καμπάνιμος	kampanimos	[church bell]-able
καρβούνιμος	karvounimos	coal-able
κεφάλιμος	kefalimos	head-able
ποτάμιμος	potamimos	river-able
ζαχάριμος	zaxarimos	sugar-able
βρόντιμος	vrontimos	thunder-able
φαρμάκιμος	farmakimos	poison-able
φλόγιμος	flogimos	flame-able
κάρπιμος	karpimos	fruit-able
πάγιμος	pagimos	ice-able
ειρήνιμος	eirimimos	peace-able
κουτάλιμος	koutalimos	spoon-able

εμπόριμος	emporimos	trade-able
μπουκάλιμος	boukalimos	bottle-able
τσάντιμος	tsantimos	bag-able
γλάστριμος	glastrimos	planter-able
παίδιμος	paidimos	child-able
σφαίριμος	sfairimos	sphere-able
τραπέζιμος	trapezimos	table-able

Categorial Violations –*itis*

<u>Greek Script</u>	<u>Transliteration</u>	<u>Possible translation</u>
βιβλιατής	vivliatis	book-er
χαρτονιτής	xartonitis	carton-er
φουστανατής	foustanatis	dress-er
καβουριτής	kavouritis	crab-er
καραβιτής	karavitis	boat-er
καρεκλατής	kareklatis	chair-er
καστανατής	kastanatis	chestnut-er
κουλουριτής	koulouritis	bagel-er
λουλουδατής	louloudatis	flower-er
μαγαζατής	magazatis	shop-er
ντουλαπατής	ntoulapatis	closet-er
παιχνιδιτής	paixniditis	toy-er
ποτηριτής	potitritis	glass-er
σαπουνιτής	sapounitis	soap-er
σκουπιδιτής	skoupiditis	garbige-er
τραπεζατής	trapezatis	bank-er
παντοφλατής	pantoflatis	slipper-er
γιαουρτατής	giaourtatis	yogurt-er
φορεματής	forematis	dress-er
καρβουνιτής	karvounitis	coal-er
παπουτσατής	papoutsatis	shoe-er
ποδηλατατής	podilatis	bike-er
περιβολιτής	perivolitis	garden-er
ρολογιτής	rologitis	watch-er
σφουγγαριτής	sfouggaritis	sponge-er
λαμαρινιτής	lamarinitis	[steel sheet] -er
πορτοφολιτής	portofolitis	wallet-er
επιπλατής	epiplatis	furniture-er
κλειδιτής	kleiditis	key-er
περιπτεριτής	peripteritis	kiosk-er

Appendix D (Experiment 4: on-line)

Novel-Ws –*simos*

<u>Greek Script</u>	<u>Transliteration</u>	<u>Possible translation</u>
αναγκάσιμος	anagkasimos	force-able
διαβάσιμος	diavasimos	read-able
γεμίσιμος	gemisimos	fill-able
βλέψιμος	vlepsimos	see-able
διανεμίσιμος	dianemisimos	distribute-able
παίξιμος	paiksimos	play-able
πιέσιμος	piesimos	press-able
ποτίσιμος	potisimos	(to) water-able
ραντίσιμος	rantisimos	spray-able
σφραγίσιμος	sfragisimos	seal-able
σκαλίσιμος	skalisimos	dig-able
σκορπίσιμος	skorpisimos	disperse-able
στολίσιμος	stolisimos	decorate-able
τινάξιμος	tinaksimos	jerk-able
τραβίξιμος	traviksimos	pull-able
ζυγίσιμος	zygisimos	weigh-able

Novel-Ws -*tikos*

<u>Greek Script</u>	<u>Transliteration</u>	<u>Possible translation</u>
ανακοινωτικός	anakoinotikos	announc-ive
αναθετικός	anathetikos	allocate-ive
δαγκωτικός	dagkotikos	bit-ive
ενθουσιαστικός	enthousiastikos	[cause enthusiasm]-ive
γκρεμιστικός	gkremistikos d	emolish-ive
λυγιστικός	lygistikos	bent-ive
πλησιαστικός	plisiastikos	approach-ive
σκαλιστικός	skalistikos	engrave-ive
σταφανωτικός	stefanotikos	crown-ive
τριφτικός	triftikos	rub-ive
αμφισβητικός	amfisvitikos	doubt-ive
επισκευαστικός	episkevastikos	repair-ive
κοιταχτικός	koitaxtikos	look-ive
πειραχτικός	peiraxtikos	tease-ive
μοιραστικός	moirastikos	share-ive
ρωτιστικός	rotistikos	ask-ive

Novel-Ws -*tos*

<u>Greek Script</u>	<u>Transliteration</u>	<u>Possible translation</u>
ακολουθητός	akolouthitos	follow-able
ανακαλυπτός	anakalyptos	discover-able
αποφασιστός	apofasistos	decide-able

δημιουργιτός	dimiourgitos	create-able
επινοητός	epinoitos	invent-able
κατασκευαστός	kataskevastos	manufacture-able
σχεδιαστός	sxediastos	design-able
σχηματιστός	sximatistos	formulate-able
ανεβαστός	anevastos	raise-able
χαρακτός	xaraktos	carve-able
δαμαστός	damastos	tame-able
φραχτός	fraxtos	fence-able
καυτηριαστός	kaftiriasstos	sear-able
σωριαστός	soriasstos	[knock down]-able
ταραχτός	taraxtos	disturb-able
ξαφνιαστός	ksafniasstos	surprise-able

Novel-Ws-tis

Greek Script	Transliteration	Possible translation
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ανεβαστής	anevastis	raise-er
χαιρετιστής	xairetistis	wave-er
ενοχλητής	enoxlitis	bother-er
γεμιστής	gemistis	fill-er
κατορθωτής	katorthotis	accomplish-er
κλωτσιστής	klotsistis	kick-er
ποτιστής	potistis	water-er
πριονιστής	prionistis	saw-er
ραντιστής	rantistis	spray-er
σηκωτής	sikotis	lift-er
σκαλιστής	skalistis	dig-er
σκλαβωτής	sklavotis	enslave-er
σουβλιστής	souvlitis	spike-er
τονιστής	tonistis	stress-er
χτυπιτής	xtypitis	hit-er

CatViol-simos

Greek Script	Transliteration	Possible translation
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αχύριμος	axyrimos	straw-able
αδέλφιμος	aderfimos	brother-able
αγγούριμος	aggourimos	cucumber-able
αλεύριμος	alevrimos	flour-able
αμπέλιμος	ampelimos	vine-able
βαρέλιμος	varelimos	barrel-able
βυσσίνιμος	vyssinimos	[sour cherry]-able
χαλίκιμος	xalikimos	pebble-able
ελάτιμος	elatimos	fir-able
γαϊδούριμος	gaidourimos	donkey-able
γυναίκιμος	gynaikimos	woman-able
καμπάνιμος	kampanimos	[church bell]-able

καρβούνιμος	karvounimos	coal-able
κεφάλιμος	kefalimos	head-able
ποτάμιμος	potamimos	river-able
ζαχάριμος	zaxarimos	sugar-able

Cat Viol -tikos

Greek Script	Transliteration	Possible translation
εισιτηρικός	eisitiritikos	ticket-ive
φαγωτικός	fagitotikos	food-ive
γραφειτικός	grafeitikos	office-ive
καραβιτικός	karavitikos	boat-ive
μαστοριτικός	mastoritikos	artisan-ive
μολυβιτικός	molyvitikos	pencil-ive
προβατοτικός	provatotikos	sheep-ive
πολογιτικός	rologitikos	watch-ive
βουνιτικός	vounitikos	mountain-ive
πευκοτικός	pefkotikos	pine-ive
σιδεροτικός	siderotikos	iron-ive
προσωποτικός	prosopotikos	face-ive
γελιοτικός	geliotikos	laughter-ive
δενδροτικός	dendrotikos	tree-ive
θρανιοτικός	thraniotikos	desk-ive
σχολειοτικός	sxoleiotikos	school-ive

Cat Viol. -tos

Greek Script	Transliteration	Possible translation
καντηλιτός	kantilitos	[vigil candle]-able
κουταλιτός	koutalitos	spoon-able
κρεβατιτός	krevatitos	bed-able
λιονταριτός	liontaritos	lion-able
μαχαιριτός	maxairitos	knife-able
μαντηλιτός	mantilitos	handkerchief-able
ντουλαπιτός	ntoulapitos	closet-able
παπουτσιτός	papoutsitos	shoe-able
λουτροτός	loutrotos	bath-able
ταμειοτός	tameiotos	cash-able
υπουργειοτός	ypourgeiotos	ministry-able
κοσκινοτός	koskinotos	sieve-able
λαχανοτός	laxanotos	cabbage-able
λειψανοτός	leipsanotos	corps-able
μαγουλοτός	magoulotos	cheek-able
συννεφοτός	synnefotos	cloud-able

CatViol.-tis

Greek Script	Transliteration	Possible translation
βιβλιατής	vivliatis	book-er
χαρτονιτής	xartonitis	carton-er
φουστανατής	foustanatis	dress-er
καβουριτής	kavouritis	crab-er
καραβιτής	karavitis	boat-er
καρεκλατής	kareklatis	chair-er
καστανατής	kastanatis	chestnut-er
κουλουριτής	koulouritis	bagel-er
λουλουδατής	louloudatis	flower-er
μαγαζατής	magazatis	shop-er
ντουλαπατής	ntoulapatis	closet-er
παιχνιδιτής	paixniditis	toy-er
ποτηριτής	potiritis	glass-er
σαπουνιτής	sapounitis	soap-er
σκουπιδιτής	skoupiditis	garbige-er
τραπεζατής	trapezatis	bank-er

Them Viol.-simos

Greek Script	Transliteration	Possible translation
αγρυπνήσιμος	agrypnisimos	stay awake-able
απολαμβάσιμος	apolamvasimos	enjoy-able
αποτυχήσιμος	apotyxisimos	fail-able
χαρέςσιμος	xairesimos	joy-able
χαμογελάσιμος	xamogelasimos	smile-able
διψάσιμος	dipsasimos	thirst-able
φοιτητίσιμος	foititisimos	study-able
γεράσιμος	gerasimos	age-able
καθίσιμος	kathisimos	sit-able
καταφτάσιμος	kataftasimos	arrive-able
κελαϊδήσιμος	kelaidisimos	tweet-able
κοιμήσιμος	koimisimos	sleep-able
πέσιμος	pesimos	fall-able
πετάξιμος	petaksimos	throw-able
υποκρίσιμος	ypokrisimos	pretend-able
ξεφαντώσιμος	ksefantosimos	disport-able

Them Viol -tikos

Greek Script	Transliteration	Possible translation
αιμορραγητικός	aimorragitikos	bleed-ive
αργηστικός	argistikos	[be late]-ive
δακρυστικός	dakrystikos	tear-ive
διαφεριστικός	diaferistikos	differ-ive
ευτυχιστικός	eftyxistikos	[be happy]-ive

ωριμαστικός	orimastikos	mature-ive
ξεχειλιστικός	ksexelistikos	overflow-ive
ξυπνιστικός	ksypnistikos	[wake-up]-ve
αναδυτικός	anadytikos	emerge-ive
κοκκινιστικός	kokkinistikos	blush-ive
χειροτερευτικός	xeiroterefistikos	deteriorate-ive
λαμπτικός	lambtikos	shine-ive
γλιστρικός	glistikos	slip-ive
τρεμιστικός	tremistikos	tremble-ive
χλωμαστικός	xlomiastikos	pale-ive
λιωστικός	liostikos	melt-ive

Them Viol-tos

Greek Script	Transliteration	Possible translation
χλωμαστός	xlomiastos	[get pale]-able
ευθυμίτος	efthymitos	cheer-able
φτερνιστός	fternistos	sneeze-able
κοιμιστός	koimistos	sleep-able
μουδιαστός	moudiastos	numb-able
υποχωρητός	ypoxoritos	recede-able
ωριμαστός	orimastos	mature-able
ξυπνιστός	ksypnistos	wake-able
γαυγιστός	gavgistos	bark-able
ποχαλιστός	roxalistos	snore-able
κολυμπιστός	kolybistos	swim-able
προσευχιστός	proseftistos	pray-able
αρκουδιστός	arkoudistos	crawl-able
επιπλευστός	epipleostos	float-able
αναπηδηχτός	anapidistos	bounce-able
συγκρουστός	sygroustos	crash-able

Them Viol.-tis

Greek Script	Transliteration	Possible translation
διαφεριστής	diaferistis	differ-er
περιμενωτής	parimenotis	wait-er
αργηστής	argistis	be late-er
αιμορραγητής	aimorragitis	bleed-er
ναυαγιστής	navagistis	wreck-er
πλημμυριστής	plimmyristis	flood-er
ξυπνηστής	ksypnistis	awake-er
ευτυχιστής	eftyxistis	be happy-er
κακιωστής	kakiostis	sulk-er
ξεχειλιστής	ksexelistis	overflow-er
ξεφτιστής	kseftistis	unravel-er
ανατριχιαστής	anatrixiastis	[have goose bumps] -er
αντιπαθητής	antipathitis	dislike-er

θυμωτής ωριμαστής	thymotis orimastis	[get angry]-er mature-er
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Non-Ws *tis*⁶²

<u>Greek Script</u>	<u>Transliteration</u>
απροβάτης	aprovatis
νολυμπητής	nolumpitis
πριαμβευτής	priamveftis
ρετανάστης	retanavstis
ρωπηλάτης	ropilatis
τιποτάκτης	tipotaktis
τροχαστής	troxastis
υκροβάτης	ykrovatis
αδηγητής	adigitis
βυντονιστής	vyntonistis
ετρελεστής	etrelestis
γοκιμαστής	gokimastis
κροσκυνητής	kroskynitis
νατάσχεση	natasxesi
ρατακτητής	rataktitis
ρεταφραστής	retafrastis

Non-Ws *-simos*

<u>Greek Script</u>	<u>Transliteration</u>
κεθοδεύσιμος	kethodefsimos
δετακινήσιμος	detakinisimos
ακφηλώσιμος	akfilotikos
κολιορκήσιμος	koliorkisimos
κημοσιεύσιμος	kimodiefsimos
ιφαρμόσιμος	ifarmosimos
ακπαιδεύσιμος	akpaidefsimos
οπισκευάσιμος	opiskevasimos
τρολαρμόσιμος	trolarmosimos
ναμεδαφίσιμος	namedafisimos
ρυστρίσιμος	rystrisimos
αφασκρέψιμος	afaskrepsimos
δαλοικήσιμος	daloikisimos
ζεπαπεύσιμος	zepapefsimos
παφιεργήσιμος	pafiergisimos
τροκλέψιμος	troklepsimos

⁶² Providing English translation for the Non-Ws was not possible.

Non-Ws -tikos**Greek Script Transliteration**

αδασταλικός	adastaltikos
φαλαρωτικός	falarotikos
τιεγερτικός	tiegertikos
εκενδυτικός	ekendutikos
ελιβαρυντικός	elibaryntikos
εροργιστικός	erorgistikos
ναμαθλιπτικός	namathliptikos
γακιγορητικός	gakigoritikos
ακτοιστικός	aktoistikos
αφυρωτικός	afyrotikos
αλαρορευτικός	alaroreftikos
αδαβεωτικός	adaveotikos
δεθυστικός	dethystikos
ριμητικός	rimitikos
κειωτικός	keiotikos

Non-Ws -tos**Greek Script Transliteration**

ατριληπτός	atriliptos
εδιτρεπτός	editreptos
δασανοητός	dasanoitos
ξατρευτός	ksatreutos
διβητός	divitos
ψοκητός	psokitos
σκαφιστός	skafistos
υροφερτός	yrofertos
βαδορθωτός	vadorthotos
νιδωτός	nidotos
κραστός	krastos
δαζωτός	dazotos
ρεμιστός	remistos
κιαβλητός	kiavlitos
τιαιρετός	tiairetos
νιακριτός	niakritos