Grammatical Gender in Language Production: Psycholinguistic Evidence from Greek

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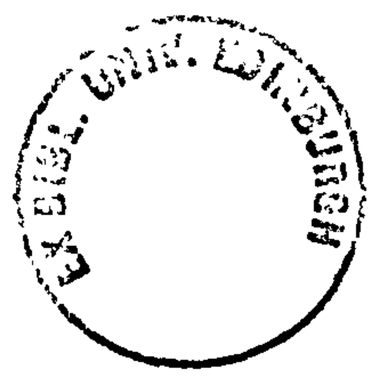

Declaration

I hereby declare that this thesis has been composed by myself, and that this work is my own and has not been submitted for any other degree or professional qualification.

Evangelia Plemmenou

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To my parents and to Klearchos

Abstract

This thesis is concerned with the representation and processing of grammatical gender in Greek. It addresses two issues. The first concerns the conditions under which gender priming can be obtained; the second concerns the relationship between gender and other nominal categories, particularly case and number. These two issues bear upon the more general question of how lexical-syntactic properties are stored, retrieved and used during grammatical encoding, and how various consequences of the grammatical make-up of words are evident in the fluency of speech. Furthermore, insofar as grammatical gender constitutes a point of divergence across different languages, the thesis uses Greek data to examine the scope of a particular production theory originally developed for typologically distinct languages.

The theoretical framework for this thesis is the production model of Levelt, Roelofs and Meyer (1999). A particularly attractive feature of this model is that it makes highly articulated proposals about the content and the mechanisms of access to lemma level representations, that is, of abstract representations of words and morphemes. The critical claims for this thesis concern the distinction between inherent grammatical properties and diacritic parameters, and the conditions under which these properties are selected or merely activated.

The empirical part of the thesis comprises two sets of experiments employing primed picture naming. The first set (Experiments 1-4), which focuses on gender alone, investigates the linguistic contexts in which gender priming can be obtained. These include bare noun or definite determiner + noun primes and colour adjective or indefinite determiner + noun targets. The picture of gender that arises from these experiments is largely compatible with the Levelt et al. treatment of gender insofar as it shows that gender refers primarily to an abstract lexical-syntactic property. Also in line with what has been previously observed for other languages, gender selection, which occurs when agreement has to be computed between a gender controller and an agreement target, proves to be a pre-requisite for gender priming.

The second set (Experiments 5-8) focuses on the relationship between gender and case on the one hand, and gender and number on the other. Two possible accounts of this relationship (independent features and feature clusters) provide plausible yet extreme hypotheses about the way gender, case and number may be interrelated. Experiments 5-8

show that when other nominal properties are varied, gender priming can be obtained only with a particular type of prime noun phrase (i.e., definite determiner + noun). Furthermore, the effect of gender relatedness is more readily apparent when a single selection process, namely gender selection, has to be carried out on-line during the retrieval of the target lemma. In all, the present results from Greek converge with related evidence in the language production literature insofar as they show that prior access to gender information affects subsequent word retrieval. More important, the conditions under which this effect is observed confirm two basic assumptions of the Levelt et al. model concerning first, the abstract nature of lexical-syntactic properties and second, the processing distinction between activation and selection, and thus strengthen the viability of this account. Finally, the apparent sensitivity of the production system to the coordination of different selection processes e.g., gender selection, case selection and number selection, suggests that although gender is independently represented, its effect on word production is determined, at least in part, by the relative effect of the other selection processes.

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Chapter 1 Introduction

1.1 Grammatical gender: a preliminary theoretical description

From a general linguistic standpoint, the category of grammatical gender reflects a classification of nouns which frequently corresponds to a real-world distinction of sex, but often too it does not. This category stands for and guides some general combinatorial properties of the nouns. For example, in the gender system of French, the class 'feminine' captures the grammatical generalisation that for the noun e.g., *maison* 'house $_{FEM}$', definite reference is denoted by *la* preceding the noun (*la maison*), indefinite reference is denoted by *une*, the appropriate pronoun selection for referring to either is *elle*, and so forth. By contrast, for masculine gender nouns e.g., *livre* 'book', the same contexts require the selection of *le* (definite reference), *un* (indefinite reference), *il* (pronoun), and so on. Therefore, the two genders condition two sets of distributional patterns which represent mutually exclusive alternatives in determining the appropriate determiner or pronoun form in various grammatical contexts.

Although there is still much divergence of opinion concerning the historical origin of gender, or its function in a particular language system (e.g., Bates & MacWhinney, 1989; Corbett, 1991; Zubin & Köpcke, 1981), there is almost no dispute as to its defining criterion, namely agreement. Thus, although "nouns may be classified in various ways, only one type of classification counts as a gender system; it is one which is reflected beyond the nouns themselves in modifications required of associated words" (Corbett, 1991, p. 4). In other words, saying that a language has two genders implies that there are two classes of nouns that can be distinguished syntactically by the agreements they take. While this is the generally accepted approach to gender, a question that is then raised is how native speakers of e.g., French know that, for example, the word for 'house' is feminine or the word for 'book' is masculine hence requiring distinct determiner or pronoun forms. Although it is commonly suggested (e.g., Corbett, 1991, Zubin & Köpcke, 1981) that more often than not, the gender of a particular noun can be determined analytically on the basis of meaning,

word-structure or sound-structure information, it is far from obvious that these regularities do indeed form part of the native speaker's competence and that they are used to assign nouns to genders and to compute gender agreement. This issue becomes even more intriguing with those languages in which all three-types of gender-assignment rules fail so that there are no criteria internal to the nouns for drawing a distinction between the different gender classes.

How then is the grammatical category of gender mentally represented and how does it become projected onto the syntax for the computation of agreement during grammatical encoding? Recent research in language comprehension and production has extensively addressed such questions since the study of gender is relevant to many core areas of human linguistic performance; thus for example, research in the representation of gender can shed light on the way lexical-syntactic information is stored in the brain, while research about the use of gender in comprehension can be informative about the role of prior grammatical cues in both grammatical decoding, i.e., parsing a sentence, and word recognition i.e., lexical access and selection.

1.2 Scope of the thesis

In the present work, the focus will be on the role of gender in lexical access in production: Is gender retrieval invariably implicated in the production of different types of noun phrases and, if so, what are the effects of repeatedly retrieving the same (or different) gender information on the time-course of the production of these noun phrases? In Dutch, for instance, people are slower at producing a gender-marked noun phrase when they are concurrently presented with a different-gender noun than when they are presented with a same-gender noun (e.g., Schriefers, 1993). This effect, typically called 'gender interference', is taken to reflect a particular processing characteristic of the production mechanism whereby the retrieval of a given gender value is inhibited and therefore slowed down when a competing gender value has been previously retrieved. The reverse effect, referred to as 'gender priming', should then reflect the facilitatory effect of having previously retrieved a particular gender value on the subsequent production of a same-gender utterance. Similarly, a number of studies carried out in languages other than Dutch (e.g., Akhutina, Kurgansky, Polinsky & Bates, 1999; Jacobsen, 1999; Jescheniak, 1999) have shown that prior gender information does have an effect on speakers' performance in laboratory tasks such as picture or word naming, tasks that are usually taken to reflect the workings of the language production system. Clearly however, since there are non-trivial differences in the gender

systems of different languages, as well as in the way system properties are incorporated in the various empirical studies, it is still far from obvious to what extent particular results, such as those from Dutch, generalise to other languages. Therefore, at a more general level, the present study will be concerned with the question of whether cross-linguistic differences in the formal realisation of gender have consequences for the way this category is represented and processed across languages. This in turn bears upon the fundamental question of whether it is feasible to assume a common cross-linguistic architecture for language production.

The target language of the study will be Greek. Greek is particularly well suited to detailed exploration of some of the issues noted above because of its three-gender system, its complicated formal system of gender assignment and gender agreement, and its pattern of interactions among the different nominal grammatical categories, most notably gender, case, and number. Unlike the two-gender systems of Dutch, French or Italian, which have been extensively examined, and in which gender can be treated as a binary feature with one gender value serving as the default value or form, three-gender systems pose more complex problems for mental representation and processing. Therefore, they constitute a substantial challenge to current production theories (which have been largely grounded on the investigation of two-gender systems) as well as to experimental design. Furthermore the interaction of gender with other nominal categories, via fusional morphophonology, raises the question of whether repeated access to fusionally realised categories also affects the way gender information participates in the production process. This issue will be pursued systematically in the empirical part of the thesis. To summarise, the two questions to be addressed in this study concern first the conditions under which gender priming can be observed, and second, the representational and processing relationship between gender and other nominal categories, particularly case and number.

1.3 Outline of the thesis

The thesis is organised as follows: Chapter 2 reviews the gender system of Greek. It includes a discussion of gender assignment, that is, the way in which native speakers of Greek allocate nouns to genders, and gender agreement. Following Corbett's (1991) account of gender assignment rules, we show that although semantics and phonology do sometimes provide the basis for gender distinctions, the determination of the gender of nouns in Greek relies heavily on morphological criteria relating to word structure, particularly to inflection and derivation. Yet morphological information is not always adequate to determine gender insofar as the match between gender classes and inflectional classes is not perfect. These

facts give rise to a number of questions about how gender information is stored in Greek and retrieved during lexical access in production.

Chapter 3 reviews the literature on the role of gender in language production. The first part of the chapter presents the Levelt, Roelofs and Meyer (1999) model, which will be taken as the theoretical framework for this thesis, and discusses two alternative proposals on how gender should be accounted for, namely Dell's (1986) and Caramazza's (1997). The second part presents recent empirical evidence from word production research, and to a lesser extent from comprehension research, and discusses the findings that are critical to the theoretical issues raised in the first part of the chapter.

Chapter 4 reports four primed picture-naming experiments in which different types of prime and target noun phrases are used. The aim is to examine whether gender priming can be obtained in Greek, that is, whether there is a reaction-time advantage for target responses following same-gender primes over those following different-gender primes, and to explore the linguistic contexts in which this effect can be obtained.

Following this, Chapters 5 and 6 investigate the relationship between gender and other nominal categories. Chapter 5 examines whether gender priming can be obtained when the case value of the prime and target response is manipulated, while Chapter 6 examines whether gender priming can be obtained when the number value is manipulated. The results from these two sets of experiments will be shown to have important implications for the way grammatical properties are organised and interrelated at the lemma level, and for the way different selection processes are carried out during grammatical encoding. The final chapter draws the different lines of empirical evidence together, and provides a unified account of how gender, case and number participate in lexical access in production.

Chapter 2 The gender system of Greek

2.1 Introduction

Gender is a grammatical category that reflects a classification of nouns and, partly, a distinction of sex. This chapter provides an account of grammatical gender in Modern Greek (hereafter Greek) from a theoretical linguistic perspective. Particularly, it examines gender assignment, that is, the way in which nouns are allocated to gender classes, and the types of agreement targets, namely the parts of speech that can show agreement in gender[1]. On the assumption common in recent psycholinguistic research that the human language processor can be tuned in a variety of different ways to meet the ecological demands of a speaker's native language, the present treatment of gender in Greek, although from a theoretical linguistic perspective, could offer insights into the way this information is stored and retrieved during language use. Our aim therefore in this chapter is to determine how certain descriptive facts about gender in Greek may relate to assumptions underlying psycholinguistic gender research.

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[1] From the perspective of psycholinguistic research, one of the most interesting things to know about the gender classes in a language is their relative size: How many nouns are masculine, how many are feminine, and how many are neuter? Unfortunately, the lack of publicly available computerised lexical databases for Greek makes it very hard to get a reliable estimate of the relative distribution of nouns in the three gender classes. A count by Mirambel (1959; quoted in Mackridge, 1985) gives the following figures for gender out of a random sample of about 600 nouns: 240 neuter, 195 feminine and 149 masculine. A similar picture of the gender distribution of nouns in Greek is given by Stephany (1997) who, on the basis of research on language acquisition, points out that neuter nouns are more frequent than feminine nouns which in turn are more frequent than masculine nouns. One should note however, that although by these estimates, it seems that Greek has more neuter words than feminine or masculine words, the probability of encountering a neuter word rather than a masculine word in e.g., a dictionary does not say by itself anything about the probability of encountering a neuter word in a corpus of sampled texts, because the latter also depends on how often every masculine, feminine and neuter word is actually being used in the language. Likewise, due to the lack of lexical-statistical analyses we cannot be precise about the extent to which semantic, morphological or phonological properties of nouns are responsible for gender assignment. It is thus possible to make only a few statements about general principles (as will be done in sections 2.2.2.- 2.2.4), and to suggest that with the exception of feminine nouns in *-ος*, the gender of a noun in Greek is largely determined by the inflectional class to which it belongs.

2.2 Gender assignment

2.2.1 A working definition of gender

Our starting point in the linguistic analysis of the Greek gender system is by the definition of gender. Thus, according to Householder, Kazazis and Koutsoudas:

> Gender in Greek is somewhat special. Nouns are said to 'have' it, but are not inflected for it; pronouns and adjectives (and the article) are inflected for gender. The gender of nouns however, can very often be determined from knowledge of one or two cases. When we say that a noun 'has' or 'belongs to' or 'is of' a certain gender, this means that all the words which are grammatically required to agree with it in gender must be inflected for that gender. (1964; quoted in Panara, 1998, p. 76)

The above definition, which immediately sets grammatical gender apart from natural gender, is in line with most other accounts of gender (see e.g., Corbett, 1991; Hockett, 1958) insofar as it identifies agreement as its defining criterion. Thus, although grammatical gender is a property of individual nouns, this property shows up in the behaviour of syntactically associated words. This means that in Greek, we can tell that for example, the word *κήπος* 'garden' belongs to the class of masculine nouns because it takes the singular nominative definite article *ο*, while the word *σημαία* 'flag' belongs to the class of feminine nouns because it takes the singular nominative definite article *η*, as in *η σημαία*. This systematic covariance between the gender of a noun and some formal property of an associated word is referred to as agreement. Given the above, it becomes clear that the agreement patterns exhibited by associated words, or else the agreement classes, are used both to infer the gender of a particular noun, and to establish the total number of genders in a language. Apart from being construed only as a syntactic phenomenon because of the syntactic relationship between the controller noun and the associated words (hereafter agreement targets), gender also refers to a morphological phenomenon insofar as gender agreement is realised by inflectional markers. In Greek, although gender is typically marked by suffixes e.g., *ωραί-ος κήπος* 'beautiful garden' versus *ωραί-α σημαία* 'beautiful flag', it can also be realised by means of suppletion as in the definite articles *ο*, *η*, *το*, or the indefinite articles *ένας*, *μια*, *ένα*.

Having established how the number of genders in a language as well as the gender of a particular noun are typically inferred, we turn to a different, yet fundamental aspect of gender systems, namely the question of how nouns are distributed over the available genders of a language. In short, the issue at hand is whether gender reflects an essentially random or arbitrary classification of nouns or whether there is some systematicity to it. Contrary to

earlier claims such as that of Bloomfield whereby "there seems to be no practical criterion by which the gender of a noun in German, French or Latin could be determined" (Bloomfield, 1933; quoted in Corbett, 1991, p. 7), several linguists have recently claimed that gender categorisations, although not as simple as once hoped for, do in fact exhibit a considerable degree of regularity. For example, with respect to the allegedly arbitrary gender system of German, Zubin and Köpcke (1984) concluded that gender could be predicted for a large proportion of German nouns on the basis of a complex interplay of overlapping semantic, morphological and phonological factors. Pursuing systematically the study of assignment systems of several gender languages around the world, Corbett (1991) also reached the conclusion that gender assignment is essentially systematic. He argued that:

> Assignment may depend on two basic types of information about the noun: its meaning (semantics) and its form. Information about form may in turn be of two types: word-structure, comprising derivation and inflection (morphology), and sound-structure (phonology). Languages may use different combinations of these factors and may also permit varying numbers of exceptions. (p. 8)

The question of arbitrariness versus systematicity in gender assignment although typically approached at a purely descriptive linguistic level as a question about systematicity in language, has important implications for attempts to determine the structure and the processing characteristics of the mental lexicon. For example, if as originally hypothesised the gender of a noun is entirely arbitrary, then this property would have to be stored in some way in memory together with the gender of all the other nouns in the language, and retrieved from memory during language use. If however, the gender of that noun were predictable on the basis of semantic or formal criteria (or some combination of the two), then it would be plausible to assume that the language user exploits this regularity in order for example, to compute the gender of the noun on-line each time the noun has to be used. In what follows, we consider how nouns are assigned to the three gender classes in Greek. The role of semantic, phonological and morphological information is examined in turn.

2.2.2 Gender and semantics

Semantics plays an important role in determining gender in Greek. When nouns have animate referents, their gender usually corresponds to the sex of the denoted entity. A form for males and a form for females is generally distinguished in the default or citation form of the nominative singular. Masculine nouns typically end in *-ος*, *-ας* and *-ης* whereas feminine nouns end in *-α* and *-η* as shown in the examples in (2.1).

(2.1)

a. *άνθρωπος* 'man, human being'
b. *πατέρας* 'father'
c. *εργάτης* 'worker'
d. *μητέρα* 'mother'
e. *κόρη* 'daughter'

It is not the case however, that the remaining nouns are neuter. Consider for example, the nouns in (2.2).

(2.2)

a. *φάρος* 'lighthouse $_{\text{MASC}}$'
b. *κουβάς* 'bucket $_{\text{MASC}}$'
c. *χάρτης* 'map $_{\text{MASC}}$'

d. *κάθοδος* 'descent $_{\text{FEM}}$'
e. *σημαία* 'flag $_{\text{FEM}}$'
f. *μάχη* 'battle $_{\text{FEM}}$'

g. *μέρος* 'place $_{\text{NEUT}}$'
h. *πράγμα* 'thing $_{\text{NEUT}}$'
i. *δάκρυ* 'tear $_{\text{NEUT}}$'

It is possible to trace further broad generalisations underlying the semantic aspect of gender assignment in Greek. Thus for example, most abstract concepts are referred to by feminine nouns e.g., *ειρήνη* 'peace', *ελπίδα* 'hope', *ελευθερία* 'freedom' etc. Names of fruit trees are more often than not feminine e.g., *πορτοκαλιά* 'orange tree', *λεμονιά* 'lemon tree' etc. "suggesting that the feminine may have connotations of fecundity" (Mackridge, 1985, p. 49), whereas their fruit is neuter e.g., *πορτοκάλι* 'orange', *λεμόνι* 'lemon' etc. Names of rivers are masculine whereas names of boats are conventionally assigned to the neuter gender class. In sum, while semantics generally provides a gender distinction for humans and gives rise to regularities of the type noted above, it does not cover a large proportion of nouns.

2.2.3 Gender and phonology

According to Corbett (1991), in phonological systems "gender can be established by reference to a single form" (p. 51). In Greek, gender is predictable from phonology, that is, from the form of the ending in the nominative singular, which is typically used as the citation

form, in some nouns only. Thus, as shown by the examples in (2.3), nouns with the nominative singular ending *-ος* may be masculine, feminine or neuter. Similarly nouns with the nominative singular ending *-ας* may be masculine or neuter etc. The potentially classificatory role of phonological properties is further undermined when oblique-case forms of the noun are referred to.

(2.3)

a. *φακός* 'torch $_{\text{MASC}}$'
b. *έξοδος* 'exit $_{\text{FEM}}$'
c. *μέρος* 'place $_{\text{NEUT}}$'

d. *γιακάς* 'collar $_{\text{MASC}}$'
e. *κρέας* 'meat $_{\text{NEUT}}$'

Furthermore, a gender assignment system which would be based on the phonological properties of the stem rather than on the properties of a particular case form, particularly on the form of the inflectional suffix, also has to be rejected. As illustrated by the examples in (2.4), stems ending in a particular vowel or consonant may belong to words of either of the three gender classes.

(2.4)

a. *φακ-ός* 'torch $_{\text{MASC}}$'
b. *φακ-ή* 'lentil $_{\text{FEM}}$'
c. *σακ-ί* 'sack $_{\text{NEUT}}$'

d. *πάτ-ος* 'bottom $_{\text{MASC}}$'
e. *κοίτ-η* 'river bed $_{\text{FEM}}$'
f. *κουτ-ί* 'box $_{\text{NEUT}}$'

Thus, phonology is not a conditioning factor of gender distinctions in Greek. To cover a larger proportion of nouns, phonological rules have to be supplemented by other criteria.

2.2.4 Gender and morphology

Given the inadequacy of semantic and phonological criteria to determine gender assignment, we now consider the role of morphological information. In principle, morphologically conditioned gender assignment may be achieved by reference to inflectional properties of more than one word form of a given noun, that is, to its inflectional class, or by reference to

word formation processes such as derivation and compounding. The former point captures the systematic relationship that is often observed between gender classes and inflectional classes, but also the relationship between gender and the two other nominal categories, number and case, with which gender is fusionally marked. We use here the terms 'inflectional class' or 'declension' to refer to "a set of lexemes which share a paradigm and whose word forms are alike in respect of the realisation of the morphosyntactic properties in every cell" (Carstairs-McCarthy, 1998, p. 323). They are not to be confused with the notion of 'paradigm' which refers to the entire set of morphosyntactic properties or property combinations associated with actually or potentially distinct word forms. Two words may share a paradigm and an inflectional class, or a paradigm only. Interestingly, the number of inflectional classes that have been proposed for the nominal system of Greek has ranged from three to eight depending each time on the criteria employed for their formulation. Some of these criteria have been first, gender, second, a distinction between two case-form versus three case-form types of nouns, third, the presence or absence of a vocalic thematic element etc. Thus for example, by assuming Ralli's (1994) division of Greek nouns into eight inflectional classes, nouns of inflectional-class type 1 are masculine, nouns of inflectional-class types 3 and 4 are feminine, and nouns of inflectional-class types 5, 6, 7 and 8 are neuter.

The role of morphological criteria in gender assignment is further attested in derived words whose gender value is inherited from the derivational affix through headedness and percolation. Thus, for example, deverbal nouns in *-της* (e.g., *φοιτητής* 'student') and *-μος* (e.g., *γυρισμός* 'return') are masculine, deverbal nouns in *-τρια* (e.g., *μαθήτρια* 'female student') and *-εια* (e.g., *βοήθεια* 'help') are feminine, and so are denominal nouns in *-ινα* (e.g., *γιατρίνα* 'female doctor') and *-ισσα* (e.g., *μάγισσα* 'sorceress'). Deverbal nouns in *-μα* (e.g., *γράμμα* 'letter') and denominal ones in *-ακι* (e.g., *παιδάκι* 'little child') are neuter. As heads of the respective structures, the suffixes given above transmit their gender value to the derived word. Note that such an account assumes independent, grammatically specified representations for suffixes, similar to the ones typically assumed for stems. Compounds also inherit their gender value from the head constituent that is usually the right-hand member, as illustrated by the examples in (2.5).

(2.5)

a. *φρουτοσαλάτα* 'fruit salad $_{FEM}$' < φρούτ- $_{NEUT}$ σαλάτα $_{FEM}$

b. *τσιμεντόλιθος* 'cement block $_{MASC}$' < τσιμέντ- $_{NEUT}$ λίθος $_{MASC}$

c. *παγοκύστη* 'ice bag $_{FEM}$' < παγ- $_{MASC}$ κύστη $_{FEM}$

d. *τοματοχυμός* 'tomato juice $_{MASC}$' < τομάτ- $_{FEM}$ χυμός $_{MASC}$

Kinship terms in Greek exhibit considerable regularity in the morphological marking of gender distinctions. The male-female contrast is realised inflectionally rather than with the use of suppletive forms as is the case in English. Some examples are given in (2.6).

(2.6)

a. *αδερφός / αδερφή* 'brother / sister'

b. *ξάδερφος / ξαδέρφη* 'cousin'

c. *θείος / θεία* 'uncle / aunt'

d. *ανηψιός / ανηψιά* 'nephew / niece'

The morphological criteria however, are found wanting when it comes to the nouns in *-ος* that belong to the second inflectional class, and that can be either masculine or feminine. Importantly, the many-to-one mapping between gender classes and inflectional classes suggests that the two nominal properties are independent. This claim is also warranted by syntactic considerations. Gender is 'visible' to syntax since it is checked in the computation of agreement between nouns and other agreeing elements. Inflectional class by contrast, which also provides a classification for nouns, is solely morphological; it does not condition any type of agreement between words.

In sum, the gender of a noun in Greek does not show up only in the morphology of its agreement targets, but also in the morphology of the noun itself. Greek therefore has a fairly 'overt' gender system. This descriptive observation about regularity in gender assignment can be seen to have several psycholinguistic implications. For instance, as argued extensively by Van Berkum (1996), it could be the case that native speakers exploit regularity to derive the gender of known words as they speak, in the same way that they assign a gender to invented words or to words borrowed from other languages, and therefore do not explicitly store gender in their mental lexicon. The presence and the type of systematicity (that is, whether semantic or formal) in gender assignment may have implications not only for the way gender information is stored, but also for the way it is retrieved in different linguistic contexts. If for example, masculine gender information has to be explicitly retrieved for the production of e.g., the agreement target *κόκκινος* 'red' in the

phrase *κόκκινος κουβάς* 'red bucket', does this information also have to be retrieved for the production of the noun *κουβάς* alone which also 'shows' its gender in its form? In other words, does gender have to be invariably retrieved whenever it surfaces in the eventual form of a target utterance or is its retrieval conditioned by some other factor? This question will be addressed extensively in the subsequent chapters of the thesis; it will be shown to have important implications for theories of lexical representation and access during language production.

2.3 Gender agreement targets

We noted earlier that agreement constitutes the defining property of gender and the way in which the latter is realised in language use. It is defined as "systematic covariance between a semantic or formal property of one element and a formal property of another" (Steele, 1978; quoted in Corbett, 1991, p. 105). Gender agreement in Greek is largely realised through suffixation. In this respect, Greek follows the pattern observed in most of the world's languages. Different suffixes may mark the same gender contrasts so that on purely formal grounds gender congruency can be rendered opaque. Apart from suffixation, some gender distinctions are marked through suppletive forms. In what follows, we consider the lexical categories which show agreement as well as the forms through which agreement is instantiated. These are presented in Table 2.1 below.

Table 2.1

Agreement targets in the Greek gender system

	Masculine	Feminine	Neuter	English approximation
Definite article	ο	η	το	the
Indefinite article	ένας	μια	ένα	a
Demonstrative pronoun	αυτός, τούτος, εκείνος, τέτοιος, τόσος	αυτή, τούτη, εκείνη, τέτοια, τόση	αυτό, τούτο, εκείνο, τέτοιο, τόσο	this, that, such
Interrogative pronoun	ποιός, πόσος	ποιά, πόση	ποιό, πόσο	who, how much
Indefinite pronoun	ένας, κανένας, κάποιος, καθένας, άλλος, μερικοί, κάμποσοι	μια, καμία, κάποια, καθεμία, άλλη, μερικές, κάμποσες	ένα, κανένα, κάποιο, καθένα, άλλο, μερικά, κάμποσα	one, no one, someone, everyone, another, some
Relative pronoun	ο οποίος, όποιος, όσος	η οποία, όποια, όση	το οποίο, όποιο, όσο	who, such
Personal pronoun	αυτός	αυτή	αυτό	he
Possessive pronoun	(δικός) μου	(δική) μου	(δικό) μου	mine
Definite pronoun	ο ίδιος, μόνος	η ίδια, μόνη	το ίδιο, μόνο	oneself
Adjectives	μικρός	μικρή	μικρό	small
Participles	κουρασμένος	κουρασμένη	κουρασμένο	tired
Some Numerals	τρεις, πρώτος	τρεις, πρώτη	τρία, πρώτο	three, first

Note that several of the formal gender distinctions shown in Table 2.1 are present in the singular nominative only; they are lost in the plural or in oblique case forms in the singular. For example, the two definite article forms *ο* $_{\text{MASC}}$ and *η* $_{\text{FEM}}$ are collapsed in the plural in a single form *οι*. Similarly, the two nominative adjective forms *μικρός* $_{\text{MASC}}$ and *μικρό* $_{\text{NEUT}}$ are collapsed in the accusative in a single form *μικρό*. As a result, there is considerable syncretism within the system. Furthermore, alongside the adjectives which typically distinguish between the three genders, there is a class of adjectives which only marks the neuter versus non-neuter distinction e.g., *διεθνής* $_{\text{MASC, FEM}}$ / *διεθνές* $_{\text{NEUT}}$ 'international'.

2.4 Summary

This chapter dealt with the linguistics of grammatical gender in Greek. It examined the regularities in the distribution of nouns over the three gender classes, and the agreement patterns of associated words. Morphological information was shown to be instrumental to gender assignment. A potential psycholinguistic implication of this observation was pointed out concerning the way gender information is retrieved in the production of different types of target utterances. This issue will be taken up in the remainder of the thesis, and will be discussed in the context of current theories of language production.

Chapter 3 The psycholinguistics of grammatical gender: models and empirical data

3.1 Introduction

The description of the gender system of Greek suggested that gender relates, in different ways, to two levels of linguistic analysis: the syntactic and the morphological. The former (referring here to agreement) provided the basis for its definition. The latter (inflectional class information) often determined the distribution of nouns to gender classes. In this chapter, several psycholinguistic aspects of the representation and marking of gender in language production will be dealt with. Gender retrieval is inextricably intertwined with lexical access. Particularly, it pertains to the nature of the representations, syntactic and morphological, that mediate conversion from an auditory signal to a meaning in speech perception, and from a message to signals to the motor system in speech production. The chapter comprises two parts. The first part is devoted to models of language production. Extensive reference will be made to the Levelt, Roelofs and Meyer model (1999), which will function as the theoretical framework for the following chapters. Several other proposals on how gender is represented and retrieved during lexical access, and on how it relates to the other nominal categories of Greek will also be reviewed. The second part is primarily concerned with the experimental findings on the role of gender in production, although brief reference will also be made to its role in comprehension.

3.2 Psycholinguistic perspectives

3.2.1 Gender in models of language production

Implicit in current models of language production is the assumption that gender is not computed on-line on the basis of the semantic and/or formal regularities which were shown to underlie assignment systems. Instead it is stored as an inherent property of nouns. This

way the process of gender retrieval is rendered fast, effortless and less prone to error: the relevant information simply has to be looked up. How is then, gender represented? The most detailed proposal concerning the representation of lexical syntactic information in general, and of gender in particular, is first found in Roelofs (1992), and developed in Levelt et al. (1999). The details of this model are discussed in the next section. It will become clear however, that most of the components assumed in this model will be similar to what is also assumed in the other production models, reflecting the strong implicit consensus that has developed among psycholinguists with respect to many important phenomena. In particular, production models converge on the assumptions first, that semantic, syntactic and morphophonological information constitute distinct levels of linguistic representation, second, that these levels are probably accessed sequentially, and third, that lexical access involves two broad stages of processing. They disagree on the actual number and organisation of representations, on whether processing is initiated in later levels before it has been completed in earlier levels, and on whether processing across levels is strictly feedforward or involves feedback.

3.2.1.1 The Levelt, Roelofs and Meyer (1999) model

In this model, four main levels of processing are distinguished, each corresponding to a characteristic output representation (Figure 3.1). These are lexical concepts, lemmas, morpho-phonological words and phonetic gestural scores, respectively. Lexical access refers to the spreading of activation along links connecting the nodes of the different levels. The top level or 'conceptual stratum' is where the speaker formulates the pre-linguistic message of the sentence. The message must be specified in terms of lexical concepts, which are language-specific. Lexical concepts are non-decompositional, that is, they are not represented by 'clusters' of semantic features. Instead, they are represented by unitary concept nodes. Levelt et al. distinguish between two types of nodes: lexical concept nodes, that point to specific words in the language, and concept classification nodes, which are interpreted in conjunction with lexical nodes and extend or modify the meaning of the latter. They express properties like mood, number, social distance etc. The conceptual stratum also contains labeled links which specify conceptual relations. A word's sense is represented by its lexical concept's labeled links to other concept nodes.

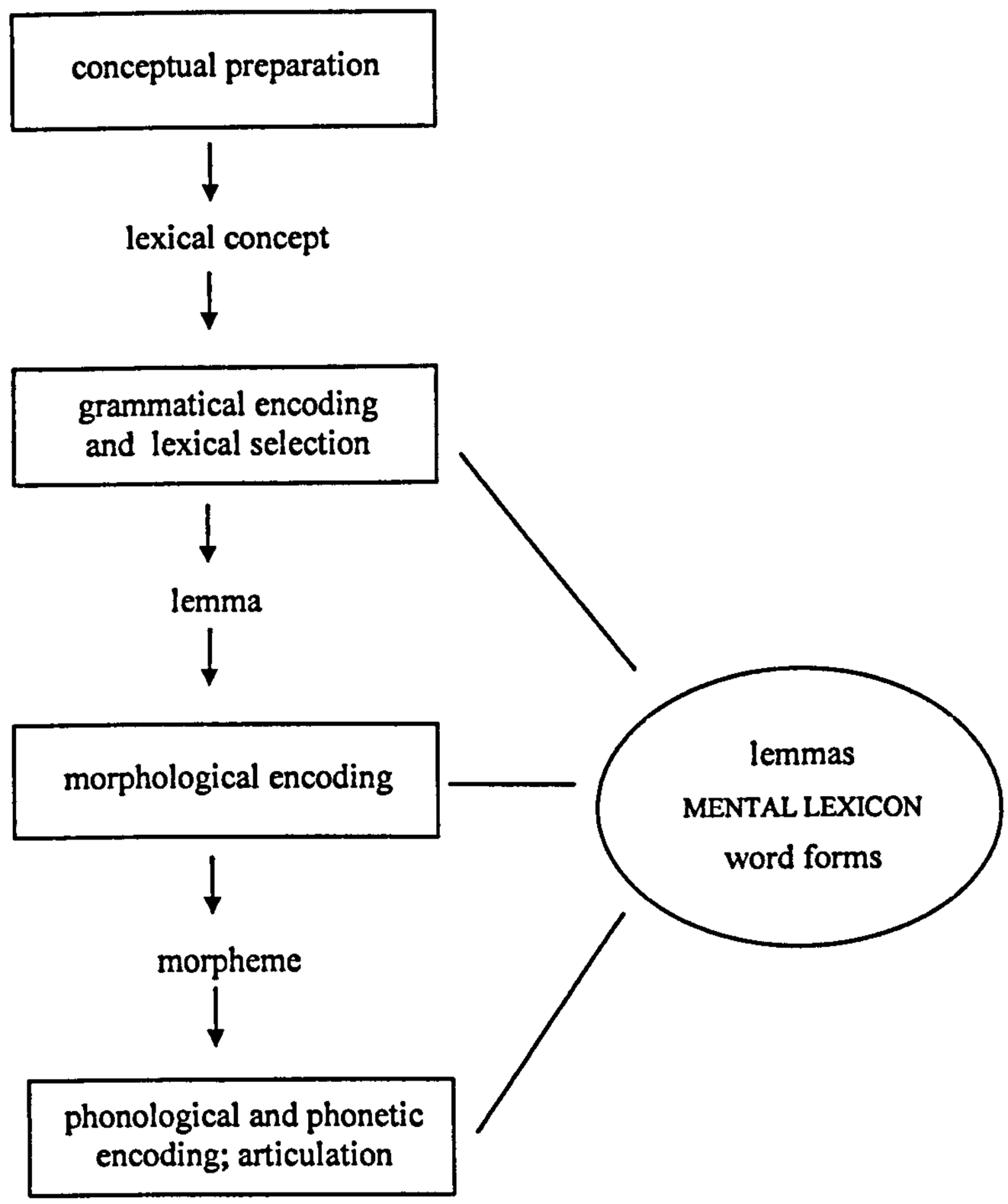

Figure 3.1. Outline of the Levelt, Roelofs and Meyer (1999) model.

3.2.1.1.1 Representational assumptions

The syntactic stratum

The pre-verbal message triggers the generation of a syntactic structure. This leads to the first stage of lexical access in language production, the so-called lemma selection. Lemmas are modality-independent, hence abstract, lexical entries, which contain all the syntactically relevant properties of a word. Although in Levelt (1989), lemmas also contained the semantic specification of a word, in the present model as we have just seen, semantic specifications are represented by the connection of lemmas to lexical concepts. Every word in the mental lexicon, simple or complex, content or function word, is represented at this level by a lemma node. The assumption of such an intermediate level between conceptual and word form representations is central to the Levelt et al. model. Its proposal has been motivated by a number of findings including speech error data, studies of the availability of

grammatical information in tip-of-the-tongue states and in anomic performance, naming experiments using extensions of the picture-word interference paradigm, and naming experiments measuring event-related brain potentials (e.g., Badecker, Miozzo, & Zanuttini, 1995; Garrett, 1988; Jescheniak & Levelt, 1994; Van Turennout, Hagoort, & Brown, 1997; Vigliocco, Antonini, & Garrett, 1997). From a theoretical viewpoint, the proposed encapsulation of syntactic information in the form of lemmas supports the notion of modularity. Syntactic rules can operate only on syntactically specified elements, and no morphophonological properties of the word can play a role at the syntactic level.

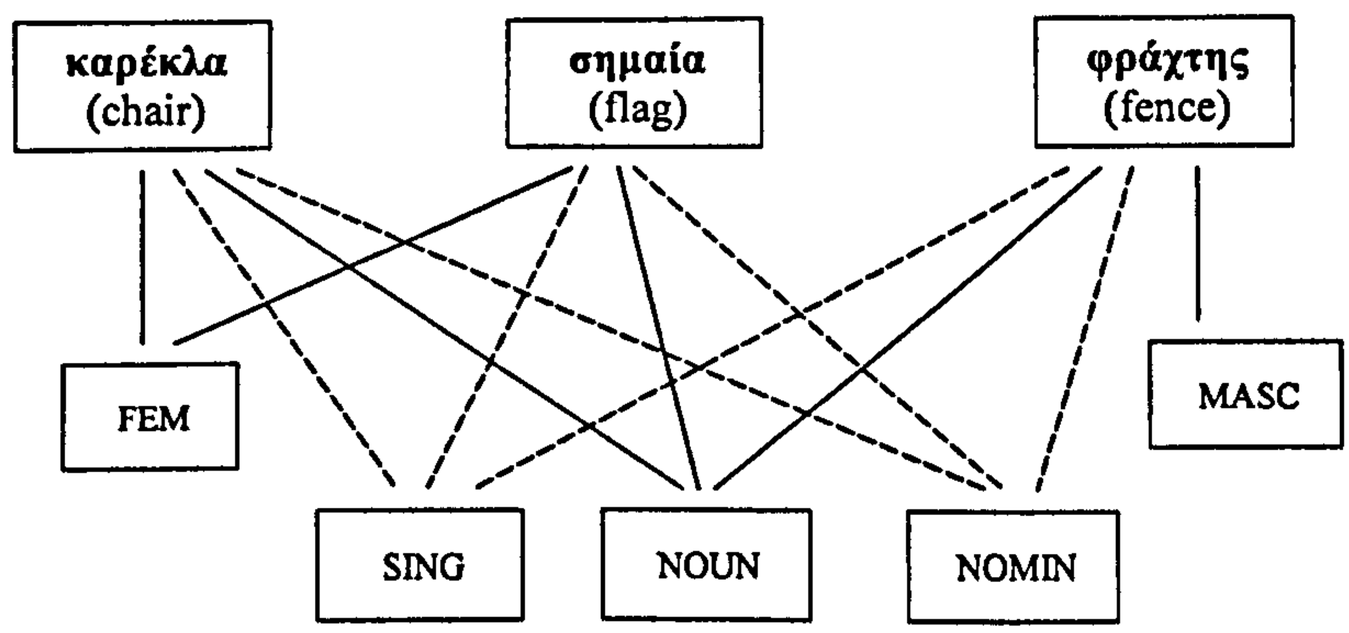

Figure 3.2. Fragment of the syntactic (lemma) stratum in the Levelt, Roelofs and Meyer model.

Within the syntactic stratum each lemma node connects to nodes representing the word's syntactic properties (Figure 3.2). These include category information (e.g., noun, verb), feature information (e.g., a gender value) and combinatorial information. Lemmas are also connected to diacritic parameters or diacritics. These are slots for the specification of parameters which are valid only in the current context of speaking. Their value is set by semantics or syntax. For example, the number of a noun typically depends on the intention of the speaker to talk about one or more entities. By contrast, the number of a verb depends on the number of the sentence subject, and is set by agreement.

The model assumes a single node for each category or feature. Lemmas corresponding to different words of the same category or sharing a feature, are connected to one shared category or feature node. Furthermore, each lemma is connected to a so-called lexeme node at the word form level, which specifies the word's morphophonological form. The grammatical gender of nouns is represented at the syntactic stratum as a fixed property of the corresponding lemmas. In line with the above, all nouns of a given grammatical gender are

connected to one gender node specifying that grammatical gender. For agreement targets, like adjectives and determiners, gender is not lexically specified. Rather, it constitutes a diacritic whose value is set each time by agreement rules. Given the above, a question that then arises is whether both agreement controllers (nouns) and agreement targets are connected to one shared gender node specifying their grammatical gender. Although this is plausible, it is not explicitly stated in the model. An alternative possibility would be to assume distinct representations for those properties that are lexically and those that are contextually specified. In that case, adjectives or determiners, and nouns would not be connected to the same gender node.

The word form stratum

The output of the syntactic stratum is fed into the next level of representation, where word forms are specified. Each lemma has one or more links to morphemes at the word form stratum. In turn, each morpheme has pointers to its metrical structure and to the segments that make up its form. A set of procedures at the morpheme/segment level is responsible for the generation of the phonological word's syllabification, given the syntactic and phonological context. Morpheme nodes correspond roughly to roots and affixes. The model assumes morphologically decomposed form entries; morphological structure is necessary since morphemes usually define domains of syllabification within words. Four types of morphological complexity are distinguished in the model: the degenerate type, the single-lemma-multiple-morpheme type, the single-concept-multiple-lemma type and the multiple-concept type. These types do not exhaust all possibilities in the generation of morphologically complex words. In the second type, with which we will be concerned here, a word form such as *dogs* is generated from the single lemma *dog*, with the number diacritic valued as plural. Therefore, a single lemma happens to map onto more than one morpheme. Regular inflections are probably all of this type. The model assumes numbered pointers from the lemma to morphemes, to account for the serial order in the production of the latter.

Recently Janssen, Roelofs and Levelt (2001) proposed an extension to Levelt et al.'s claims about the representation of morphological information, in the slots-and-fillers tradition of language production. Specifically, they argued for the presence of inflectional frames, used to guide the process of combining the stem with the inflectional affixes. A frame contains one slot for the stem and one slot for every inflectional affix that occurs with the stem. For regular words, the number of affixes may be predicted by the word class of the stem, in particular by the diacritics specified for that stem. The frame serves as an error-checking

mechanism, that is, it checks whether all required inflectional affixes are inserted in the appropriate slots. Furthermore, the morphological encoding component is assumed to be subdivided into a stem encoding component and an inflectional encoding component. The former is responsible for the retrieval of stems from the lexicon but also for the assembly of constituent morphemes in the cases of derived or compound stems. An inflectional frame becomes available upon retrieval of the stem, on the basis of the word class information of the corresponding lemma. The output of this component is fed into the inflectional encoding component, which takes care of the retrieval of the appropriate inflectional affixes.

Gender at the word form stratum

Does gender information appear in word structure? Particularly, does gender correspond to a morpheme node at the word form stratum in the same way that it corresponds to a feature node at the syntactic stratum? Although this is what is largely assumed by Janssen et al., it is not clear how it is realised in inflectionally richer languages, and especially in the morphological encoding of fused categories. Some of the issues which arise can be illustrated with reference to Greek nouns. For example, in the noun form *φράχτης* 'fence', a single inflectional suffix *-ης* expresses jointly the diacritics of number and case, and the feature of gender. Thus, properties that were independently represented at the syntactic stratum are realised as 'clusters' at the word form stratum. More importantly, a single inflectional suffix may express different syntactic property clusters. The suffix *-ης* in *φράχτης* marks the features masculine, singular, nominative, whereas the same suffix in *στάχτης* 'ash' marks the features feminine, singular, genitive. Such cases of affixal homonymy are common in the inflectional system of Greek. They resemble lexical homonymy in that they can be distinguished at the conceptual and lemma level, while exhibiting complete form overlap. One possible representation of affixal homonymy would be a single affix node with multiple pointers to the different feature clusters. Alternatively, different representations of the same affix (with different frequencies of occurrence and distributional properties) would be uniquely associated with distinct sets of syntactic features. Which option is preferred by speakers of a particular language is an empirical question.

In theoretical linguistic studies of Greek nominal inflection, a detailed account of affixal homonymy has been proposed within the framework of feature theory (see e.g., Ralli, 2000). Following this account, constituents of a morphological structure (here nominal stems and inflectional affixes) are represented as feature bundles. Features are in turn, represented as

attribute-value pairs. The attribute part determines the type of the feature, whereas the value part determines its content. The features proposed for noun stems are category, gender, case, number and inflectional class, whereas the features proposed for nominal suffixes are case, number and inflectional class. Note that on this account, gender is taken to belong only to the stem. Examples of the stem and affix entries for the noun *πίνακας* 'blackboard', and of the notational conventions employed are given below (3.1).

(3.1)

Πίνακ:	category: n	ας:	case: nom
	gender: masc		number: sing
	case: X		infl. class: 1
	number: Y		
	infl. class: 1		

As can be seen in the example, not all stem attributes have a specific value. The attributes of case and number have their values set during the word formation process. Affixal homonymy corresponds, in this framework, to instances of disjunctive feature specification. Neuter nouns e.g., *βιβλί-ο* 'book' have the same form in the nominative, accusative and vocative case. On the assumption that there is a single entry for the suffix *-ο*, rather than three distinct ones, this is represented as:

(3.2)

o:	case: {nom acc voc}
	number: sing
	infl. class: 5

Multi-valued, as opposed to binary valued, features and disjunctive feature specification are strongly motivated in Greek, given its rich inflectional system on the one hand, and its high degree of syncretism on the other. It is argued however, that disjunctive feature specification should be restricted to those features "which do not have a distinct semantic interpretation, that is, to inflectional class, case and gender which has lost its relation to sex and animacy" (Ralli, 2000, p. 210). Although the present theoretical linguistic analysis refers to morphological entities in word formation, there is a striking similarity between the representations it assumes and the type of information associated with the lemma level in Levelt et al. Particularly, grammatical information is lexically specified, that is, it is pre-associated with lexical entries. It is represented by features (nodes), which, in a sense, define slots for the required pieces of information. Some slots correspond to inherent lexical

properties e.g., the gender of nouns, and have a fixed value, whereas other slots correspond to properties whose values are contextually defined. Although the Levelt et al. model incorporates the distinction between inherent and non-inherent grammatical information (as category, featural and combinatorial information on the one hand, and diacritics on the other), it does not account adequately for the latter. Thus, for example, how is gender information represented for adjectives? Gender feature underspecification would require an 'empty' gender node to which the adjective lemma would be connected, with disjunctive links to the three 'valued' gender nodes. At present the model only assumes fully specified gender nodes, one for each gender class, and some type of link between all words of the same gender to that single gender node. Fully specified nodes are also assumed for the other grammatical categories.

In the Levelt et al. model these features are associated with word lemmas. Inflectional affixes are not represented at this level, that is, as abstract lexical entries, and do not have featurised grammatical information associated with them. They are morphological entities, incorporated only at the level of word form encoding. Thus, whereas there is a certain degree of 'isomorphism' between the syntactic and the word form level with regard to stems, this is not the case for inflectional affixes, which do not have a lemma (level) correlate. By contrast, in the linguistic analysis of Greek word structure outlined above, nominal stems and inflectional affixes were treated in a uniform manner. In particular, both were represented as feature bundles, the unification of which drove word formation. For example, inflectional class information, specified both in the stem and the suffix, operated as a matching device, responsible for the association of a given stem with the appropriate inflectional affix. Interestingly, lexically-specified grammatical information is thus shown to pertain to two levels of linguistic analysis, the syntactic and the morphological, driving in the former, constituent assembly, and in the latter, word formation.

Concluding this section on word form representation, a final point is noted. Although Levelt et al. assume decomposition of form entries, morphology in the model is word-based. That is, the meaning of a complex word is not derivable from the meaning of its constituent morphemes, but from the word as a whole. This is achieved through the postulation of the lemma level, where not only simple but also compound and derived words are represented. Morphemes are thus construed in a broader sense and are taken simply to refer to the building blocks of word form. Evidence for the fact that morphemes may be devoid of meaning and still contribute to word structure, comes from empirical studies which show

that morphological priming is obtained with morpheme repetition, in the case of opaque and transparent compounds alike.

3.2.1.1.2 Lexical selection: some processing assumptions

In the Levelt et al. model lexical selection refers to the process of retrieving a word, more specifically a lemma, from the mental lexicon. It is a statistical mechanism based on the spreading of activation, and favouring the selection of the highest activated lemma. Typically, the process of lemma selection is initiated upon selection of the node of the target lexical concept. Activation spreads from the conceptual to the lemma level, with each node sending a proportion of its activation to its direct neighbours. Regarding the selection of gender information, two related processing assumptions of the model will be discussed. The first concerns the discreteness of stages, and the second, the unidirectionality in the flow of information.

Discreteness refers to a strict temporal succession of processes. In word production, this means that the morphophonological form of a word becomes activated only after its lemma has been selected. That is, processing at a later stage is initiated only upon completion of processing at an earlier stage. Discreteness contrasts with cascaded processing, a term used to refer to multiple processes that are not strictly ordered with respect to one another, and that can be mutually influenced as they carry out their computations. Therefore, discrete and cascaded processing accounts differ in the following: Although the former assume that only after the target lemma has been selected will it start spreading activation to the associated morphemes, thus restricting morphophonological activation to the target element, the latter assume that a lemma will send activation to its associated word form as soon as it has received some amount of activation itself. Thus, cascaded processing enables lexical candidates, that is, words that are at least partly compatible with the meaning to be expressed, to activate their phonological forms before any single candidate has been selected. Since multiple lemmas spread activation to the word form level, phonemes corresponding to the target's semantically related neighbours become candidates for selection i.e., competitors, at the word form level. Without cascaded processing, as in the discrete account, non-selected candidates of the lemma level cannot influence events at the level of morphophonological encoding. Although the benefit from cascaded processing is assumed to be speed of processing, which begins at each level as soon as possible, a related drawback is increase in the possibility of error as lower level representations may be activated by higher level representations which subsequently get ruled out.

The second processing characteristic of the Levelt et al. model, that is, the unidirectionality in the flow of information, concerns the vertical but also the lateral connections in the model. It assumes that there is unidirectional flow of activation from lemmas to word forms as well as from lemmas to lexical syntactic properties. The process of lemma selection is thus, encapsulated in that it cannot be modulated either by the phonological form of the word or by its syntactic content. As will be shown later (section 3.2.1.2.1), the issue of the directionality in the flow of information constitutes one of the major points of divergence among competing models of language production.

Thus, contrary to Levelt et al.'s assumption of feedforward connections only, interactive models assume bi-directional connections between nodes. Particularly, for each top-down connection, such as that from a lemma to a morpheme, there is a corresponding bottom-up connection. The latter delivers feedback from the later to the earlier level. Importantly, feedback allows phonological neighbours of the target, to influence processing during lemma selection. This occurs as follows: phonemes receive activation not only from the target word but also from the target's phonological neighbours, which have become activated. Feedback from these phonemes to the lemma level increases the activation of the target lemma, but also activates lemma nodes corresponding to any words sharing any of the activated phonemes (consider, for example, *fox* and *fog*) regardless of their semantic or syntactic resemblance to the target. The activated lemmas send activation to associated phoneme and concept nodes. In sum, feedback together with cascaded activation allow semantic and phonological neighbours of the target to be active at all levels of the system. Note here that evidence against cascaded activation constitutes evidence against interactivity, whereas evidence in favour of cascaded activation provides evidence against discreteness, while being neutral with respect to interactivity. The latter is achieved with the added mechanism of feedback.

The unidirectionality assumption has important consequences for the processing of grammatical gender; it entails that the selection of the gender of a noun and the computation of gender agreement with some agreement target e.g., an adjective, cannot be affected by form properties of the noun. It also entails that gender selection can only indirectly affect lexical access. The explanation for this is fairly straightforward: given that all connections in the model are unidirectional, enhancing the level of activation of a gender node cannot affect the level of activation of the associated lemma node. Thus, lemma selection cannot be affected (facilitated or inhibited). Enhancing the activation level of a gender node can only affect lexical access if the same gender node has to be reselected. Consider for example, the

production of the words *κήπος* 'garden $_{MASC}$' and *μεγάλος* 'big $_{MASC}$' after the production of *φράχτης* 'fence $_{MASC}$'. We assume that *φράχτης* enhances the activation level of the masculine gender node. Subsequent production of a masculine bare noun such as *κήπος* does not require gender selection, for the reasons outlined earlier. Therefore, lexical access of *κήπος* will not be affected. By contrast, subsequent production of a masculine gender agreement target such as *μεγάλος*, does require gender selection. Since the activation level of the masculine gender node was enhanced by the production of *φράχτης*, this would affect selection of the same gender node, and by extension, lexical access of *μεγάλος*. The issue of the nature of the connection between lemmas and syntactic properties is pervasive in most studies of lexical access. It is central in the understanding of findings about the way gender information contributes to word production. It will be therefore taken up in the review of the empirical findings on gender priming.

To sum up, in the Levelt et al. model processing stages are strictly serial; there is neither parallel processing nor feedback between lexical selection and form encoding (with the one still restricted exception of self-monitoring). There is no free cascading of activation through the lexical network. Given that gender information is connected to the lemma, one could assume that it becomes selected each time the corresponding lemma is selected. In fact, there are two positions on that issue. One interpretation of the model holds that selection of a lemma automatically implies the selection of the syntactic property nodes to which the lemma connects. This is in line with the claim that lexical selection is conceived of as the selection of the syntactic word, but also with the rationale for postulating the lemma level in the first place. Caramazza (1997) also favours this interpretation of the model and refers to the centrality of syntactic information as the 'syntactic mediation' (SM) hypothesis. Particularly, he notes that "the selection of a word's lemma node is tantamount to the selection of the syntactic nodes/features that define that word, and that the selection of a lexeme is mediated by the selection of the word's grammatical features" (p. 181). Thus for example, selection of the noun lemma *κήπος* 'garden' would entail selection of the nodes noun, masculine, singular, nominative.

The alternative interpretation, more clearly articulated in recent versions of the Levelt model, assumes that the syntactic properties of a selected lemma only become selected when actually needed in the local syntactic environment of the word. Thus for example, gender need not be selected in the production of the bare noun *κήπος* 'garden', although it should be selected in the production of the noun phrase *μικρός κήπος* 'small garden', in order to compute gender agreement between the adjective and the noun.

Given the above, there appears to be a discrepancy between the centrality of lemma node selection on the one hand, and the non-centrality of syntactic property selection on the other. An adequate account of this issue has been provided by the distinction between activation and selection. A node is selected when its activation level is higher than that of competing nodes in the response set by some critical amount. Otherwise, it is merely activated. Whereas a single node becomes selected at the end of each stage, multiple nodes may be, partly, activated. To produce a bare noun, the lemma must be activated and selected; gender information will be activated but not selected. The activation-selection distinction is extensively drawn upon to accommodate various findings on word production. More importantly, it provides a way of dealing with the 'dispensability' of syntactic information in various contexts, without rendering superfluous the notion of lemmas.

In the subsequent chapters, this distinction will become critical in accounting for the effect of gender in word production. However, certain aspects in its formulation warrant further consideration. Thus for example, in terms of activation levels, what precisely is the difference between activation and selection? Is a selected node always more highly activated than a merely activated but non-selected node? And does the act of selection boost activation to a particular level such that for example, the selected node gets an activation level of say 1.0 set, and the competitors are then set to 0? Furthermore, how does activation subsequently decay in an activated versus a selected node? On the assumption that priming arises from residual activation, the latter question is particularly relevant in the understanding of priming effects. Thus, if a feature has been activated in prior use, then, presumably it should prime. But is that irrespective of whether or not it has been selected? There appear to be at least three possibilities here. First, selection may involve a higher degree of activation than mere activation, in which case a selected node and an activated node might both prime, but the former might prime more. Second, both a selected and an activated node might involve the same degree of activation and decay, in which case both would prime equally. Third, perhaps only a selected node retains residual activation-activation in a non-selected node might decay entirely at the end of a processing stage –in which case only a selected node would prime. Given the above, the critical issue in selection versus mere activation with respect to whether priming occurs, would be associated with the decay of activation rather than with the initial activation level. These issues will be taken up in the discussion of the empirical findings, in the second part of the thesis.

3.2.1.2 Two alternative accounts of word production

Some of the components and processing assumptions of the Levelt et al. model are not shared by other psycholinguistic models of word production. In this section we consider two influential alternative accounts of lexical access in production, with emphasis on their assumptions about the representation and processing of grammatical information. These are Dell's (1986) interactive activation model, and Caramazza's (1997) Independent Network model.

3.2.1.2.1 Dell (1986)

The overall architecture of Dell's model is very similar to that of Levelt et al. in the assumptions it makes about the representation of lexical information. It distinguishes between semantic, syntactic (lemma), morphological and phonological word properties, which are represented in hierarchically ordered levels. At the semantic level, word meaning is decomposed rather than unitary as argued by Levelt et al. Syntactic information, although lexically specified and assigned to a distinct level of representation, is not adequately accounted for. A lemma node, through its connection to conceptual structure, represents a word as a semantic and syntactic entity. We assume that gender information is specified at the syntactic level. At the morphological level, morpheme nodes are marked for both morphological and syntactic category. Thus for example, *listen* is specified as S_v, for verb stem, *chair* as S_n, for noun stem etc. Derivational and inflectional affixes are represented independently of stem morphemes, but are specified in the same way. For example, the *-s* in *chairs* is specified as 'Suffix Plural'. Note that this notation assumes morphologically decomposed form entries. Morpheme nodes connect to phonological segments.

In terms of processing, Dell's model provides an interactive account of lexical access. Information that is relevant primarily to later stages of processing can nonetheless, influence decisions made in earlier stages. This is achieved through cascading activation and bottom-up feedback. The lemma level sends activation to the word form level even before the target lemma has been selected. Furthermore, there is backward flow of activation not only from the level of phonemes to that of morphemes, but also from morphemes to lemmas and from lemmas to semantics. Evidence in support of these processing assumptions comes from speech errors, such as anticipations, perseverations and exchanges, which are largely attributed to the spreading of activation and the concurrent construction of multiple representations. The lexical bias effect, that is, the tendency for sound errors to create actual words or morphemes, is also viewed as the result of positive feedback between letters and

words. The semantic bias effect, that is, the tendency for sound errors to create words that are semantically related to other words in their vicinity, is explained along the same lines. Apart from accounting for a great deal of speech error data, this model has been successful in leading to quantitative predictions regarding error patterns and in implementing these predictions in computer simulations.

Regarding the selection of gender information and its role in lexical access, the model is less explicit than the Levelt et al. model. It does not specify whether the connection from lemmas to syntactic property nodes is unidirectional or bidirectional. However, the bidirectional flow of activation from the lemma to the word form level would in principle allow the processing of morphemes or phonemes to affect gender selection. This prediction is particularly relevant to studies of lexical access in morphologically rich languages, which exhibit complex patterns of matching between gender classes and gender marking devices. As we showed for Greek, a gender class can be associated with more than one inflectional class, and an inflectional class can be associated with more than one gender class. Assuming that there are differences in these associations, for example, in their connection strength, it would follow from the bidirectional nature of activation flow in the model that different gender markings differentially affect gender selection. We will return to this issue in the review of the empirical findings.

3.2.1.2.2 Caramazza (1997)

Caramazza's Independent Network model (IN model) retains the basic tripartite architecture of the previous two models i.e., it distinguishes between semantic, syntactic and word form information, but drops the assumption of a certain ordering of stages, from conceptual representations through lemmas to word form representations. Specifically, the IN model assumes that lexical knowledge is organised in sets of independent networks. The lexical-semantic network represents word meanings in a decomposed form, as bundles of semantic properties, features or predicates. The grammatical properties of a word are represented within the lexical-syntactic network; they are organised in sub-networks corresponding to the different grammatical categories or properties. Thus, there is a sub-network containing word category nodes e.g., for Noun, Adjective, Verb, a sub-network containing gender nodes e.g., for Masculine, Feminine and Neuter etc. Nodes within a given sub-network have inhibitory links since they are in competition. The phonological (P-) and orthographic (O-) lexeme networks contain modality-specific representations of lexical items, particularly of lexical stems. The terms phonological and orthographic lexeme are used to capture the modality-specific nature of these representations and to distinguish them from the a-modal lemmas of

Levelt et al. and Dell. Note however, that phonological and orthographic lexemes are both semantically and syntactically specified. By dispensing with the level of a-modal lemma nodes, the IN model assumes a direct mapping of word meaning onto word form.

The main processing assumptions of the model are outlined below. Activation is feedforward only, and cascading. It spreads from a selected semantic representation simultaneously and independently to the syntactic and lexeme networks. Note that semantic representations have direct connections to phonological or orthographic representations, as opposed to mediated ones through lemmas. As a result, there is no structural or temporal ordering in the processing and selection of the two types of information. The syntactic network also receives input from outside the lexical system, particularly, from sentence generation mechanisms. Not all syntactic features can be activated by semantic representations. For example, gender features, with the exception of natural-gender marked words such as *γυναίκα* 'woman', do not receive activation from the semantic network. By contrast, features with a semantic reflex, such as number and tense, do receive activation. Normally, the activation of a grammatical property from the semantic network is not sufficient for that property to be selected. Rather, the effect of the activation propagated from the semantic to the syntactic network can be viewed as a form of priming of the target property that will eventually be selected when additional activation is provided by the lexeme network. Thus, selection of the full set of the grammatical features of a word requires prior activation and selection of the corresponding lexeme node. This assumption allows, at least in principle, for the possibility that gender selection be bypassed if there is a gender agreement target for which the gender information does not have an explicit reflex in the phonological form of the utterance.

The IN model is particularly interesting in the present context as some of its main assumptions derive from observations about the availability of grammatical and phonological information in tip-of-the-tongue states (TOT). The latter refer to a "momentary inability to utter an intended word, accompanied by the feeling that the target word is known and that it is on the verge of being available" (Miozzo & Caramazza, 1997, p. 1411). TOT states can be experimentally induced through picture-naming tasks, definition-naming tasks or a combination of the two. Thus for example, Miozzo and Caramazza (1997) showed that Italian subjects in this state, were able to retrieve both the grammatical gender and the initial phoneme of words with above chance level accuracy, but that performance for the two features was uncorrelated. This finding was taken to demonstrate that, contrary to claims about the centrality of syntactic information, access to a word's phonological form is not contingent upon prior retrieval of the word's syntactic features (in line with the assumptions

of the IN model). Caramazza's interpretation of the zero correlation between initial phoneme and gender guesses has not remained unchallenged (see e.g., Roelofs, Meyer & Levelt, 1998), while concerns have also been expressed with respect to the validity of the task used. Particularly, it has been pointed out that TOT states, like speech error data, do not reflect normal production processes, while the types of response required, that is, guesses of grammatical and phonological information, are off-line judgments and, as such, cannot tap on the issue of the temporal ordering and organisation of lexical retrieval processes. Note however, that the evidence that Caramazza provides for his proposal, is not restricted to the findings from TOT states. Other evidence comes from the neuropsychological literature, primarily concerning instances of modality-specific grammatical class deficits (e.g., Badecker, Miozzo, & Zanuttini, 1995; Caramazza & Hillis, 1989). As our present focus is on gender, we will not consider these other arguments here.

3.2.1.3 Summary

In this section we discussed Levelt et al.'s model of language production, and provided an overview of two of its most influential alternatives: Dell's interactive activation model, and Caramazza's Independent Network model. The emphasis was on their assumptions regarding the representation and processing of grammatical gender. Given that most of the components postulated by Levelt et al. were the same or similar to what was postulated by the other two models, it follows that differences in the way grammatical gender is implicated in lexical access will be largely attributed to differences in the processing assumptions of the models. In the next section we return to Levelt et al.'s model and consider in some detail the conditions under which gender is held to be selected, but also the nature of the information that a gender node is held to encode.

3.2.2 What triggers gender selection?

According to Levelt et al. (1999; see also Roelofs et al., 1998) the selection of a target lemma does not automatically imply the selection of its associated gender feature. Rather, the gender feature is selected only when it determines some gender agreement target in the noun's local syntactic environment. Empirical evidence in line with this position comes from studies such as that of La Heij, Mak, Sander & Willerboordse (1998) which demonstrated that, in Dutch, a gender-interference effect is obtained only in the production of NPs with a gender marked definite determiner, but not in naming the same pictures with bare nouns; this was taken to indicate that gender selection is implicated in the former type of NP only. It follows from the above that on Levelt et al.'s account, gender selection is syntactically

conditioned, and as such, it occurs outside the lexicon. It is triggered by the presence of an underspecified feature (diacritic) e.g., the gender of an adjective or a determiner, which has to be given a value. This is most commonly done by agreement, that is, by copying the noun's (agreement source) inherently specified gender feature to the gender diacritic of the adjective or the determiner (agreement target).

Interestingly, Dell's model of lexical processing (Dell, 1986; Dell, Schwartz, Martin, Saffran, & Gagnon, 1997) provides a similar account of selection processes insofar as these are taken to occur outside the lexicon. Here the selection of features (or of lexical items) is triggered by frames. Each frame consists of categorised slots generated by the rule system that corresponds to each level of processing (syntactic, morphological, phonological). In order to fill in these categorically labeled slots, the lexicon must be addressed. At each level a lexical selection process occurs; words are selected at the syntactic level, morphemes at the morphological level, and phonemes and/or features at the phonological level. At each level the most highly activated element is selected. Note however, that in Dell's terms gender selection refers to the selection not of an abstract node, but of a gender marking lexical element. Nevertheless, the two accounts converge on the assumption that gender marking elements (particularly, their gender diacritics) beyond the noun per se are responsible for gender selection. In the case of bare nouns, since their gender is inherently specified for their stems, the relevant property is merely activated.

Although this formulation of the activation-selection distinction (which largely corresponds to the distinction between bare noun-gender agreement target production) may account for what is empirically observed in Dutch (as seen earlier), it is problematic for those cases where noun stems appear to be disjunctively specified for their gender feature. We consider three such classes of nouns from Greek.

3.2.2.1 Inflectionally-specified noun gender

Unlike most nouns in Greek, the nouns given in (3.3) exhibit variation in form, specifically in their inflectional ending, depending on the gender value they assume. They resemble adjectives or other agreement targets insofar as gender induces a set of word forms from a single stem. Regarding the lexical-syntactic representation of the noun pairs in (3.3), two accounts seem plausible. On one account, the nouns in each pair should correspond to distinct lemmas with different syntactic (gender) specifications each. This account is clearly in line with Levelt et al.'s claim that lemmas are purely abstract lexical entries which are blind to the morphophonological properties of words. Therefore, even if two nouns have the

same stem as for example, is the case for *αδερφ-ός* 'brother' and *αδερφ-ή* 'sister', they should still be dissociated, hence represented by two distinct lemmas, at the syntactic stratum. Notice here however, an apparent discrepancy in the way adjectives and nouns that exhibit form variation are treated by Levelt et al.: Although a set of word forms (induced by different gender values) from a single adjective stem is represented by a single lemma, a set of word forms from a single noun stem is assumed to be represented by different lemmas. Therefore, an alternative account of the representation of the noun pairs in (3.3) could be one whereby for example, the words *αδερφός* and *αδερφή*, would be represented by a single lemma that is disjunctively associated with two gender nodes, the masculine and the feminine. However, disjunctive specification (or underspecification) of gender values typically characterises agreement targets, and as pointed out earlier, triggers gender selection. The noun pairs in (3.3) have human referents, and reflect primarily a distinction of sex. They constitute therefore, instances of semantically-conditioned gender selection: information from the conceptual level is 'copied' to the syntactic level, in order for a property to be given a value. The specification of the noun lemma's gender diacritic will then drive the process of word form encoding, particularly the selection of the appropriate inflectional suffix, here *-ος* or *-η*. Given the above, it could be claimed that not only gender activation but also gender selection is implicated in the production of nouns as in (3.3), that is, when at the form level a single stem selects for more than one inflectional suffix.

(3.3)

a. *αδερφ-ός*	*αδερφ-ή*	'brother' – 'sister'
b. *φίλ-ος*	*φίλ-η*	'friend $_{\text{MASC/FEM}}$'
c. *νον-ός*	*νον-ά*	'godfather' – 'godmother'
d. *θεί-ος*	*θεί-α*	'uncle' – 'aunt'
e. *θε-ός*	*θε-ά*	'god' – 'goddess'
f. *αστ-ός*	*αστ-ή*	'townsman' – 'townswoman'

3.2.2.2 Derivationally-specified noun gender

The nouns in (3.4) resemble the class of nouns in (3.3) in that they also exhibit variation in form, specifically in their derivational ending, depending on the gender value they assume. Here again a single noun stem is associated with more than one derivational suffix responsible for the gender value of the resulting word. Thus for example, the masculine suffix *-άκος* renders the word *ανθρωπάκος* 'little man' masculine, while the neuter suffix *-άκι* renders the word *ανθρωπάκι* 'little man' neuter. As argued in 3.2.2.1, there are two

possible accounts of the syntactic representation of the nouns whose gender value appears to be conditioned by their suffix. On Levelt et al.'s account, each noun in (3.4) should be represented by a distinct lemma connected to a single gender node. On the alternative account, a single lemma roughly corresponding to the stem could be disjunctively associated with more than one gender node, in which case the appropriate gender should be selected each time for the production of the noun. In the noun pairs in (3.4) with human referents, the difference of gender does not always correspond to a distinction of sex e.g., *γεροντάκος – γεροντάκι* 'nice old man' versus *γλωσσάς – γλωσσού* 'babbler' (male-female). In fact, in some of the pairs with human or with non-human referents, the difference of gender does not reflect any semantic distinction whatsoever e.g., *ανθρωπάκος – ανθρωπάκι* 'little man', *δρομάκος – δρομάκι* 'alley'. Therefore, the specification of the noun lemma's gender value is only partly conditioned by information from the conceptual level. However, regardless of the precise nature of the information that drives the selection process, what is important is that a gender value may have to be selected in order for the appropriate derivational suffix to be selected at the word form level. In sum, it could be claimed as above that gender selection, rather than mere activation, is implicated in the production of bare nouns like the ones in (3.4) on the ground that a single stem 'subcategorises' for more than one derivational suffix corresponding to more than one gender value.

(3.4)

a. *ανθρωπ-άκος* MASC	*ανθρωπ-άκι* NEUT	'little man'
b. *αλητ-άκος* MASC	*αλητ-άκι* NEUT	'guttersnipe'
c. *γεροντ-άκος* MASC	*γεροντ-άκι* NEUT	'nice old man'
d. *δρομ-άκος* MASC	*δρομ-άκι* NEUT	'alley'
e. *δουλευτ-αράς* MASC	*δουλευτ-αρού* FEM	'hard-working'
f. *υπν-αράς* MASC	*υπν-αρού* FEM	'sleepyhead'
g. *χορευτ-αράς* MASC	*χορευτ-αρού* FEM	'great dancer'
h. *καφε-τζής* MASC	*καφε-τζού* FEM	'coffeehouse keeper'
i. *γλωσσ-άς* MASC	*γλωσσ-ού* FEM	'babbler'
j. *πρωτ-άρης* MASC	*πρωτ-άρα* FEM	'novice'

3.2.2.3 Lexically-unspecified noun gender

Somewhat less clear is the case of nouns as in (3.5) where a disjunctive specification (or underspecification) of gender characterises not only the stem but also the full word form. Following the same reasoning as before, a single lemma corresponding to e.g., the noun

γεωλόγος 'geologist' could be connected to two gender nodes, the masculine and the feminine. Nouns of this class have human referents, and denote primarily profession e.g., *δικηγόρος* 'lawyer', but also familiarity e.g., *συγγενής* 'relative' and attributes e.g., *παιδοκτόνος* 'infanticide'. Their gender value appears to be specified outside the lexicon, at the level of syntax. For example, *γεωλόγος* 'geologist' is masculine in the NP *ο γεωλόγος*, by virtue of a feature co-occurrence restriction, that is, the masculine determiner *ο*, but feminine in the NP *η γεωλόγος*, by virtue of it co-occurring with the feminine determiner *η*. On the assumption that the lemmas of these nouns are associated with more than one gender value, it could be claimed that a gender selection process must be implicated in their production.

However, a further question which arises with respect to these nouns is whether gender selection could simply be bypassed since the category (or more precisely, the distinction) at hand does not surface in the eventual morphophonological form of the word. Levelt et al.'s model does not allow such a bypassing of gender selection when an agreement target has to be produced, even if the relevant information has no consequences for its phonological form. Empirical evidence in support of this claim was reported by Schriefers and Teruel (1998), who demonstrated that in French, a gender interference effect was obtained both when the target noun's gender had an explicit phonological reflex in the article and the (postnominal) adjective, e.g., *la maison blanche*, and when it did not, e.g., *l'enfant terrible*. On the basis of this, they concluded that gender selection is implicated in both types of target NPs, hence the resulting interference effect (see however, Schiller & Caramazza, 2000, for a different account). Regarding the nouns like those in (3.5), it is a matter of experimentation to decide whether a selection of the lemma's gender value needs to be made before the word form can be looked up, even when both genders correspond to the same word form.

(3.5)

a. *ο/η γεωλόγος*	'geologist'
b. *ο/η δικηγόρος*	'lawyer'
c. *ο/η συνεργός*	'accessory'
d. *ο/η δημοσιογράφος*	'journalist'
e. *ο/η μηχανικός*	'engineer'
f. *ο/η επιχειρηματίας*	'businessman'/'businesswoman'
g. *ο/η συγγενής*	'relative'
h. *ο/η οδηγός*	'driver', 'leader'
i. *ο/η παιδοκτόνος*	'infanticide'

The three classes of nouns examined above illustrate how, contrary to Levelt et al.'s claim, some noun lemmas may not be inherently specified for, or associated with a single gender value. Particularly, given that a specification of gender has to be made, for the choice of the appropriate inflectional as in (3.3), or derivational as in (3.4), suffix, it is hypothesised that gender selection may be implicated in the production of these nouns, in the same way that it is implicated in the production of agreement targets. In fact, it could be argued that a noun of the type exemplified in (3.3), (3.4) or (3.5) comprises both the source and the target of a gender agreement relation. For example, in *αδερφός* 'brother', the semantic specification 'male' triggers the selection of the masculine gender node, which in turn, conditions the selection of the inflectional suffix *-ος*. How is then bare noun production to be accounted for? Particularly, should a dual mechanism be postulated according to which the production of some nouns involves gender selection while the production of others does not, or should we assume a single mechanism (involving gender selection) responsible for the production of both types of nouns? This issue has not been addressed in empirical studies thus far. It will be taken up in our discussion of the findings of Experiment 4.

Related to the question addressed above is the issue of the type of information that actually constitutes a word's gender specification and therefore, becomes selected. In Levelt et al.'s account the relevant information, which is abstractly specified, corresponds to a node. Gender selection involves the selection of this node. A cross-linguistic investigation of the gender interference effect (Costa, Sebastian-Galles, Miozzo, & Caramazza, 1999; La Heij et al., 1998; Miozzo & Caramazza, 1999; Schriefers, 1993; Schriefers & Teruel, 2000; Van Berkum, 1997) however, demonstrated that gender selection does not necessarily presuppose the specific assumptions of the model proposed by Levelt et al. Particularly, it suggests that this process concerns not some abstract gender nodes but lexical nodes for the different gender marking devices e.g., determiners and adjectives. This process appears to be sensitive to the types of mappings between gender classes and gender marked elements between as well as within languages. The empirical findings which pertain to this issue will be examined in section 3.3.3.2.

3.2.3 Grammatical gender and nominal categories

We noted earlier that beyond a general agreement among psycholinguists, that the conversion of ideas into spoken words involves a semantic-syntactic and a phonological encoding component, there is still little consensus on how these stages operate, and on how they might interact during production. We also noted that regarding the relationship between these stages, the critical question is whether word form information can feed back to

influence the lemma selection process; that is, whether the availability, hence the properties, of a given word's morphological and/or phonological form can bias the probability that this word will be selected instead of some lexical alternative. Such an assumption is a common feature of interactive style models of production (e.g., Dell, 1986), not shared by serial, discrete models like the one adopted by Levelt et al. The issue of the temporal ordering and the relationship between processing stages relative to grammatical gender has been addressed in a number of empirical studies (e.g., Akhutina, Kurgansky, Polinsky, & Bates, 1999; Friederici, Steinhauer, & Frisch, 1999; Schriefers, Friederici, & Rose, 1998, for comprehension; Schriefers & Teruel, 2000; Vigliocco & Franck, 1999, for production).

Thus for example, Vigliocco and Franck (1999) examined the role of conceptual features (conceptual gender) and of syntactic features (grammatical gender) in the computation of gender agreement. Using a constrained sentence completion task in Italian and French, they showed that gender agreement errors between the subject and the predicate were more common when the subject head noun did not have any conceptual correlates, and that the advantage for conceptual gender could not be attributed to a mere difference in animacy. On the basis of these findings, Vigliocco and Franck argued that both conceptual and syntactic information contribute to the grammatical encoding process, contrary to claims about the encapsulation of processes and the purely syntactic nature of agreement operations. Similarly, the relationship between gender and phonological information has been addressed primarily in a series of studies which investigated certain characteristics of determiner selection, employing a variant of the picture-word interference paradigm (e.g., Alario & Caramazza, in press; Costa et al., 1999; Miozzo & Caramazza, 1999; Schriefers & Teruel, 2000). The critical observation in these studies concerned the variation of the mapping between gender classes and gender marking devices within as well as between languages, suggesting some type of interaction between the computation of agreement and the phonological encoding process.

However, a type of relationship which has not been examined in any of the above mentioned studies is that between grammatical gender and the other nominal categories (for Greek, number, case and inflectional class). NP production is driven by a combination of these different sources of information, which are thought to become available at different points in the course of lemma retrieval (see e.g., Caramazza, 1997). Therefore a complete account of the production process requires a specific description of how these sources of information contribute to the selection of nouns and of other lexical items with similar properties e.g., determiners, adjectives, pronouns. In principle, two accounts of the relationship between

nominal categories appear to be plausible. On one account, gender, case, number and inflectional class are independently represented and retrieved. As such they contribute independently to lexical access. Thus, if a noun is represented by means of a noun frame with specific slots which must be filled with feature values, before the corresponding phonological form can be activated and retrieved (Janssen, 1999), each kind of information will contribute independently to the specification of these values. This account also implies that the different nominal categories define equally the dimensions along which the inflected forms of nouns are organised. On a different account, the syntactic stratum exhibits internal structure so that the nominal categories are inter-related and possibly, organised in information chunks. This kind of hypothesis allows for interactions between syntactic features so that, for example, certain feature combinations may be easier to retrieve than others, or the retrieval of a given feature may prime the retrieval of another. The structuring of features in clusters will also have consequences for the organisation of a word's inflected forms. The issue of the relationship between nominal categories is particularly interesting in the present context given their fused status in Greek: gender, number and case are systematically expressed by one affix. In what follows, we consider the relation of gender to each of these categories.

3.2.3.1 Gender and inflectional class

Perhaps the most 'apparent' relationship is that between gender and inflectional class defined here as the set of lexemes which share a paradigm and whose forms are alike regarding the realisation of morphosyntactic properties. As shown in the description of the gender system of Greek, the gender value of a noun can, in most cases, be predicted on the basis of inflectional class information, with the exception of masculine and feminine nouns in *-oç*. Although both gender and inflectional class provide a classification to nouns, they do not usually coincide. Particularly, whereas the former provides a three-way distinction between masculine, feminine and neuter nouns, the latter provides a more variable classification. That is, the number of inflectional classes proposed for Greek has ranged from three to eight depending on the criteria which served each time as the basis for their formulation. Thus, more than one inflectional class may correspond to a single gender. Unlike gender, case and number, inflectional class information is not included in the Levelt et al. model as part of the noun's syntactic specification. In fact, it is not included in any level of lexical representation. However, beyond its classificatory role, this information is also central to word formation processes in that it ensures the correct matching between stems and inflectional suffixes. In line with this, Ralli (2000) for example, argues that the membership of a noun to a given

inflectional class is indicated by a special marker, the 'ic' feature, the specific value of which triggers the selection of the appropriate inflectional suffix for a stem bearing the same marker. For the matching to be achieved, the 'ic' feature must be assigned to both stems and suffixes. It seems therefore, that we are dealing with a type of agreement, in which the target and the source are conflated, that is, restricted to word-internal constituents. Inflectional class information is purely morphological; it is not visible to syntactic operations, nor can it be changed by them. In this respect it differs from gender, case and number, which are used by syntactic mechanisms such as agreement, case assignment and phrase structure rules, and thus percolate to different phrasal elements.

Given the above it is fairly easy to see how Levelt et al.'s model could be extended to include the 'ic' feature: by adding an 'ic' node at the lemma level with labeled pointers to the appropriate morphemes at the morphological level. In line with what is assumed for the other syntactic categories, there must be a single abstract node for each inflectional class, and all nouns of the same inflectional class must be connected to this shared 'ic' node. What is less clear however, is whether and, if so, how the systematic relationship between gender and inflectional class pointed to earlier, is mentally represented and how it contributes to the production process. It could be the case, for example, that frequently co-occurring feature values form sub-networks within the syntactic level or simply, that they have stronger connections, so that the selection of one such feature primes the selection of associated features. For instance, selection of the 'ic' node which corresponds to the class of masculine nouns in *-ης* and *-ας* e.g., *φράχτης* 'fence', *κουβάς* 'bucket', in Ralli's (1994) classification, could facilitate the selection of the masculine gender node. By contrast, selection of the 'ic' node which corresponds to the class of masculine and feminine nouns in *-ος* e.g., *κήπος* 'garden', *άνοδος* 'ascent', could inhibit the selection of the appropriate gender node, because of its association with two gender values. In sum, the notion of inflectional class, as defined here, has received very little attention from psycholinguists despite its prominence in the pedagogical grammars and dictionaries of many languages, and in linguistic debates on the interface between morphology and syntax.

3.2.3.2 Gender and Case

Case is a morphosyntactic property which marks the various relations that a noun phrase may bear to a governing head. Some such relations are fundamentally syntactic in nature (e.g., the subject, direct object and indirect object relations), whereas others are primarily semantic (e.g., the relations encoded by the instrumental, the locative or the ablative case). In the Levelt et al. model, noun case is represented at the lemma level by a diacritic, whose

current value is set by government by some other syntactic element. For example, in the prepositional phrase *για τον καινούργιο μαθητή* 'for the new student', the accusative case is imposed on the noun *μαθητή* by the governing member (typically, the head of a phrase) *για*. The same case value is then set for the adjective *καινούργιο* by agreement this time, with the noun head. In Greek therefore, both government relations, as that between preposition and object, and agreement relations, as that between adjective and noun, are sensitive to properties of case. If we extend Levelt et al.'s claims regarding the storage of gender to a word's diacritics, here to case (but also to number), we have to assume that each case value is represented by a single node, and that all words of the same case must be connected to one shared case node. Furthermore, because a word's case is not inherently specified, a case node has to be selected rather than merely activated, prior to morphophonological encoding. At the syntactic level therefore, gender and case do not appear to be related in any way.

Consider now the paradigm of the adjective *καινούργιος* 'new' in Tables 3.1 and 3.2, which illustrates how gender agreement interacts with case at the word form level. Since Greek marks gender distinctions in both numbers, we consider the singular as well as the plural forms here.

Table 3.1

Gender agreement in the singular forms of the adjective καινούργιος 'new'

	Masculine	Feminine	Neuter
Nominative	καινούργιος	καινούργια	καινούργιο
Genitive	καινούργιου	καινούργιας	καινούργιου
Accusative	καινούργιο	καινούργια	καινούργιο
Vocative	καινούργιε	καινούργια	καινούργιο

Table 3.2

Gender agreement in the plural forms of the adjective καινούργιος 'new'

	Masculine	Feminine	Neuter
Nominative	καινούργιοι	καινούργιες	καινούργια
Genitive	καινούργιων	καινούργιων	καινούργιων
Accusative	καινούργιους	καινούργιες	καινούργια
Vocative	καινούργιοι	καινούργιες	καινούργια

The three genders are clearly distinguished in the nominative and the vocative of both numbers and in the accusative of plural forms. In the other cases, the three-way gender distinction is reduced to a two-way contrast, as for example, in the genitive and the accusative singular, or is completely eliminated as in the genitive plural. Observe, too, how case forms are not differentiated in the nominative, accusative and vocative cases of the feminine and neuter but are differentiated for the masculine. This picture is further complicated if we consider classes of adjectives which are inflected differently. The general tendency however, is for the three-way gender distinction to be observed within the nominative case more systematically than within the other cases.

3.2.3.3 Gender and number

According to Corbett (1991), number is the category most intimately bound up with gender. Languages which show agreement in gender, may do so in one number only. In Russian, for instance, the plural form of masculine, feminine and neuter adjectives is identical, and so is the form of plural target genders in German. Gender agreement is therefore constrained by number. This observation conforms to Greenberg's (1966) universal whereby a language never has more gender classes in nonsingular numbers than in the singular. The expression of gender and number in Greek is fusional: a single suffix marks both categories, as well as case (as shown in Tables 3.1 and 3.2 above). A change in the value of one category induces a change of the suffix. The primacy of number over case in its relation to gender is discussed extensively by Corbett (1991) who argues that, while agreement classes which are based on a difference in agreement in one morphological case are not recognised as genders, but as sub-genders, agreement classes based on a difference in number are treated as genders. This apparent inequality is taken to stem from the relative distribution of case and number distinctions: typically one out of several for case, but one out of two (singular, plural), or three (singular, dual, plural) for number. The sets of agreements associated with number distinctions are not minimally different, that is, they do not differ only for a small proportion of the morphosyntactic forms of any of the targets, but for a half or a third of the forms.

As far as their lexical representation is concerned, gender and number are typically independent; a noun belongs to a particular gender class irrespective of the number it stands in. Gender is inherently specified for nouns and is, in a sense, 'prior' to the number in which they occur in an utterance. In the Levelt et al. model, number constitutes a diacritic parameter, represented by a node at the lemma level. Its value may in part be set by the conceptual representation, particularly by copying the information of a concept classification node to the diacritic of the lemma at hand, and for another part, by syntactic operations

during grammatical encoding. Thus for example, a verb's number is set by agreement with the number of the sentence subject. Number being an obligatory feature in Greek, a speaker always has to check the relevant property (numerosity) of objects in perception or conception. In view of the similarities between the phenomena of gender and number agreement, it is hypothesised that speakers will, to some extent, use the same mechanisms to produce both as they speak. The computation of number agreement has been explored in several studies (e.g., Bock & Miller, 1991; Bock & Eberhard, 1993; Bock, Nicol, & Cutting, 1999; Vigliocco, Butterworth, & Semenza, 1995).

The study by Bock, Nicol and Cutting (1999), which investigated the role of conceptual and syntactic number, suggested some interesting parallelisms in the computation of gender and number agreement. Bock et al. distinguished between a conception-based and a structural account. According to the former, words are retrieved under the control of meaning, while subject-verb agreement is attributed to a joint coding of number on the noun and the verb phrase. That is, it is a consequence of separate lexicalisations of pieces of the same event, each of which reflects something about numerosity. According to the latter account, number agreement is the product of structurally controlled, matching operations between the feature values of linguistic units. Conceptual information about numerosity can still be implicated in setting the stage for agreement (i.e., by directing lexical retrieval towards a noun that is singular or plural). Empirical evidence concerning this account can be obtained with words with conflicting conceptual and linguistic number, most notably collective nouns e.g., the audience, the crew, the staff. Words that denote single objects but are treated as plurals (e.g., scissors, trousers, binoculars, glasses), the referents of mass nouns (e.g., news, money, luggage, mail), abstractions (e.g., religion, freedom, peace), corporate nouns (e.g., government) etc. constitute further instances of lexically specified number assignment.

Bock et al. assessed the two accounts in a sentence completion task in English, with collective noun preambles. They hypothesised that both kinds of number could be at work, each one controlling a different target. Specifically, pronouns could be retrieved with their number value directly set from the message, whereas verbs were more likely to undergo inflectional operations that change morphological number to conform to the linguistic environment. Verbs too, could of course, be influenced by conceptual number. Bock et al.'s predictions were confirmed: when an agreement controller carried conflicting grammatical and conceptual number, verbs serving as agreement targets, tended to reflect the former whereas pronouns tended to reflect the latter, thus extending to English earlier findings from Dutch, French, Italian and Spanish regarding the role of conceptual numerosity and plurality

in agreement processes (see e.g., Vigliocco, Butterworth, & Semenza, 1995; Vigliocco, Butterworth, & Garrett, 1996a; Vigliocco, Hartsuiker, Jarema, & Kolk, 1996b). Importantly, Bock et al.'s findings were in line with the results reported by Vigliocco and Franck (1999) concerning the use, by the production system, of conceptual gender information in the encoding of gender agreement. Taken together, the two studies suggested interesting parallelisms in the way gender and number information are implicated in the production process; they also provided insights into the semantic versus syntactic nature of agreement operations, and into the interactive versus autonomous nature of processing components.

A different question in the interaction between gender and number concerns the patterns of matching between singular and plural. According to Corbett (1991), three systems are distinguished. The most straightforward one, referred to as 'parallel' system, is that in which each singular target gender corresponds to one plural gender and vice versa. That is, there is a one-to-one mapping of the target genders in one number, onto the target genders in the other. In 'convergent' systems, by contrast, gender in one number determines gender in the other, but not vice versa. Thus, there is a many-to-one mapping of target genders in one number onto target genders in the other. Russian and German provide clear examples of such systems. The third possibility is what is referred to as a 'crossed' system, where gender in neither number determines gender in the other. In Rumanian for example, which has such a system, there are two target genders in both singular and plural, and three controller genders, indicated by the lines in the figure below. The mapping between the target genders in the two numbers is of a many-to-many type. Examples of these systems are schematically presented in Figure 3.3 (taken from Corbett, 1991). We conclude this section by noting that the patterns of matching between singular and plural have consequences for the presence or not of gender priming effects, as will be discussed extensively in chapter 6.

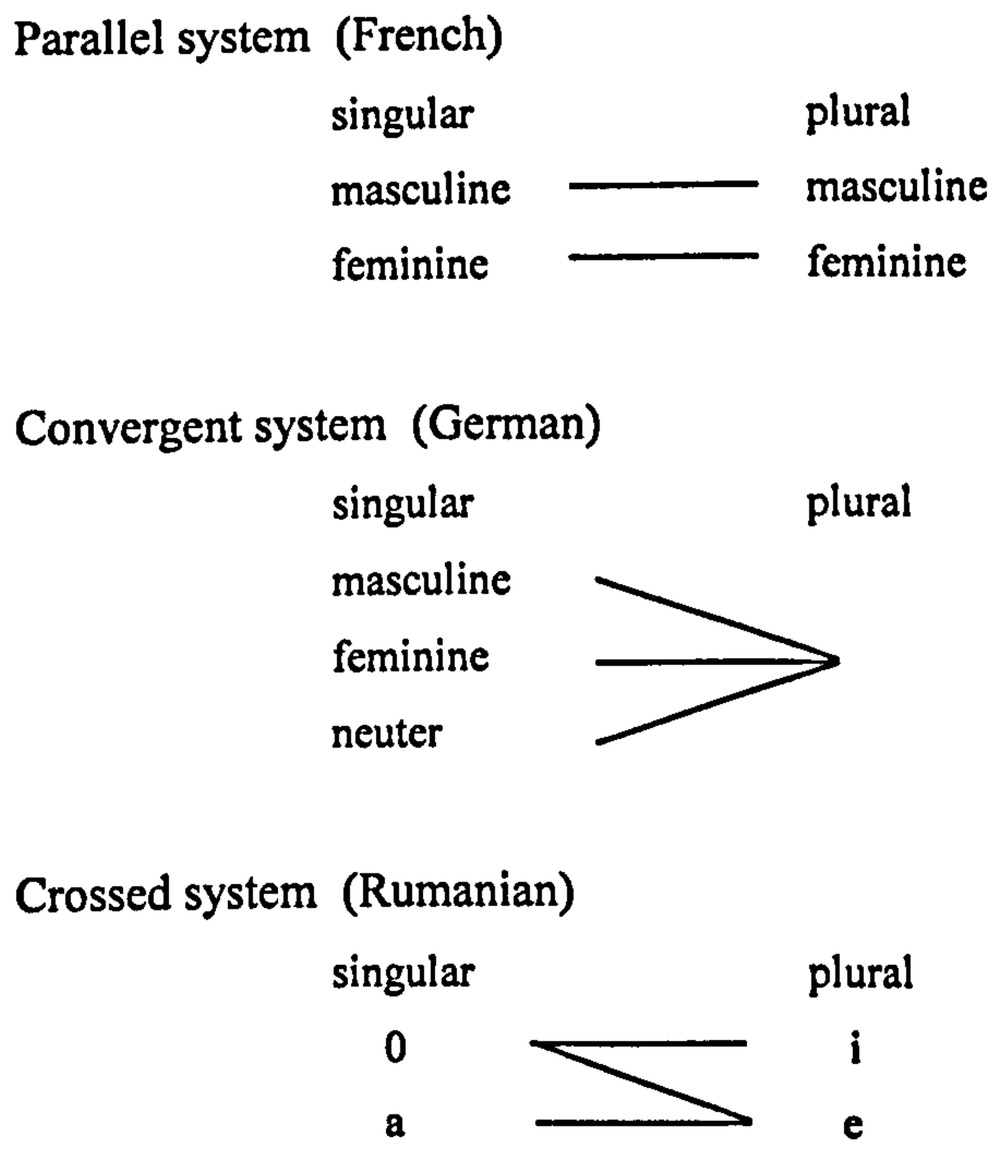

Figure 3.3. Examples of 'parallel', 'convergent' and 'crossed' systems.

3.2.3.4 Summary

It must have already become apparent that there is more to lexical access than a strictly ordered and independent contribution of different kinds of information. In the case of gender, its interaction with the other nominal categories was shown to restrict the possibilities of gender agreement; this will, in turn, be shown (in Chapters 5 and 6) to restrict the occurrence of gender priming effects. Up to this point Levelt et al.'s model has assumed that the various lexical-syntactic properties are represented and selected independently of each other. The lack of internal structure at the lemma level pertains to the representation not only of different categories e.g., gender, case and number, but also of different values of a single category e.g., masculine, feminine and neuter gender, or nominative, genitive, accusative and vocative case.

Thus, Levelt et al.'s model fails to provide a principled account of the relationship between the different nominal categories, which appears however to be motivated by two facts: first, the fused marking of these categories in many languages, and second, the role of paradigms. With respect to the former, we have seen that change of one feature value automatically implies a change in the realisation of another feature. If the lexical processing stages are not as strictly ordered and as encapsulated as Levelt et al. assume, then interactions of this sort at the word form level should feed back to the syntactic level and lead to comparable

interdependencies between their abstract specifications. Similarly, the notion of 'paradigm', typically used to refer to the entire set of morphosyntactic properties or property combinations that defines a set of inflected word forms for any lexeme of a particular syntactic category, draws on the assumption of combined morphosyntactic properties. Each such combination defines a cell of the paradigm. Contrary to claims that paradigms are merely artifacts, parallel to lists of related sentences, or that they are just important descriptive devices, recent empirical findings (e.g., Clahsen & Dalalakis, 1999; Clahsen, Sonnenstuhl, Hadler, & Eisenbeiss, 2000; Varlokosta, Vainikka, & Rohrbacher, 1996) have suggested that the human language processor does in fact make use of such a system.

Clahsen et al. (2000) for example, who investigated regular person and number inflection on finite verbs in German, employing a cross-modal morphological priming paradigm, found asymmetries in the priming patterns between the different affixes that could be predicted from the structure of the paradigm. The psychological reality of paradigms then, entails that the combinations of morphosyntactic properties which define it, may also be psychologically real. What is more, the status of the different property combinations does not appear to be identical, as indicated by the asymmetries in the patterns of priming. In Chapters 5 and 6, we address some of the questions regarding the interaction between nominal categories. Our focus is on gender and its relation to case and number. We do not consider in the present work inflectional class information, as this is a purely morphological property and does not surface, in any way, in syntactic operations. We now move in the next section to a review of the empirical findings which provide the background to the research to be reported in this thesis.

3.3 Empirical studies on gender representation and processing

Over recent years a great many experiments pertaining to gender have been carried out and evidence has been obtained in favour of several theoretical stances. The sometimes, conflicting results have been attributed to differences in the language and modality of the materials, to the specific requirements of the task at hand, or to the contribution of other linguistic and psychological factors. I will not try to review the entire literature on the representation and processing of gender; part of this, has been recently done by Friederici and Jacobsen (1999) for comprehension, and by Schriefers and Jescheniak (1999) for production. I will present only those studies that pertain to the on-line characteristics of language production processes, in particular, to the time-course of activation of syntactic information, and to its relationship to other levels of representation. A question that has

provided the background for many of these studies has been whether, and if so, how and when, prior gender information affects the processing of subsequent words (typically referred to as 'gender priming'). Although our primary focus will be on the mechanisms of lexical retrieval in production, we will also consider how certain findings from research on comprehension may bear on our understanding of the production research. A related objective will be terminological. Given that 'lexical access' and 'gender priming' are often used to refer to different processes, we will attempt to identify the set of phenomena covered by these terms, and provide a terminology for the study of gender in comprehension and production research.

This part is structured as follows. Section 3.3.1 addresses the issue of the relationship between the comprehension and production lexicons. In Section 3.3.2 we review some empirical findings from the study of gender in comprehension. In Section 3.3.3 we review the evidence on the role of gender in production relative to the claims of the Levelt et al. model.

3.3.1 The comprehension and production lexicons: points of convergence and divergence

Word production is often thought of as the mirror-image of word comprehension. Whereas the former involves the mapping from meaning to sound, the latter involves the reverse process. As a consequence of this mirroring, many of the issues that have occupied the psycholinguistic literature have been common to the two fields. As we saw earlier, among these issues are questions regarding the representation of different types of lexical knowledge, the temporal ordering in their retrieval, and the relationship between the various processing stages. Alongside these broad similarities, there are basic disparities in the processing problems that have to be solved during production and comprehension given the differences in the end products. Thus for example, production is taken to involve the retrieval and assembly of different kinds of information (e.g., information concerning the inflectional and the phonological frame of a word) whose properties may not be reconstructed to similar levels of detail during comprehension. Furthermore, the specification of lexical-syntactic information (i.e., lexical category, grammatical property and combinatorial information) is central to the production process, whereas in comprehension the respective emphasis appears to be on the identification of individual sounds or letters as the first step to the decoding of the message. As a consequence of these disparities, the two processes must differ, among other things, in how they access lexical information and in the kinds of information that they actually access.

To what extent then, could the evidence on the role of gender in comprehension be relevant in the context of the present discussion (i.e., lexical retrieval in production)? The answer to this question lies in part on the nature of the relationship between the production and comprehension lexicons, and on the analysis of the cognitive components of word production and comprehension tasks. Regarding the former point, "comprehension and production are held to have separate input and output lexicons, with separate but linked processors for phonological features. However, the point of ultimate convergence between lexical input and output is identified as a shared representation of the semantic and syntactic features of words" (Bock & Griffin, 2001, p. 36).

Some empirical evidence in favour of this position was recently provided by Cutting (1997) who used a picture naming task coupled with a prime-processing manipulation. To ensure different ways of processing the prime, Cutting instructed his subjects to repeat one word of the two-word prime and to ignore the other. The question was whether and how the semantic properties of the prime would affect response latencies in naming the target object. Because 'unattended' words have been shown to be processed to a level that facilitates subsequent recognition, Cutting assumed that the ignored word would undergo perceptual processing only, whereas the produced word would be processed through the entire production and comprehension system. He hypothesised that when a semantic relative is to be ignored, it will influence subsequent naming only to the extent that comprehension processes overlap those of production. In other experiments, the critical manipulation involved the phonological properties of the prime. Cutting obtained evidence for priming from semantically related words, regardless of whether they had been repeated or ignored. By contrast, in the case of phonologically related words, he obtained evidence for priming only with produced, but not with ignored primes. On the basis of these findings he argued that comprehension and production converge on their semantic component but diverge on their phonological one.

Restated in terms of the lemma-lexeme distinction, the above argument holds that whereas the same word lemma subserves both processes, the lexeme that serves production is not the same as the lexeme that serves comprehension; in fact, the two lexemes may not even represent the same type of information. Note, of course, that the terms 'lemma' and 'lexeme' have originated in language production research, and that they are not commonly used in the comprehension literature. From this view of a common lemma specification, one would expect the effects that depend on the retrieval of a word's syntactic properties to emerge

from comprehension and production tasks alike, and to yield a fairly consistent picture of the contribution of syntactic information to lexical processing. Given that gender information is located at the lemma level, we can address some of the issues concerning its role in word production in light of the implications from research on word comprehension.

Besides the argument for a shared lemma representation, the present interest in the processing of gender in comprehension is further warranted by the observation that word production tasks often incorporate the cognitive processes of comprehension in some form. Therefore, it is not always easy to disentangle the components of participants' performance that reflect production from those that reflect the cognitive mechanisms of word comprehension. For example, in the picture-word interference paradigm, a depicted object must be named aloud while an auditory or visual distractor word is being presented. The focus is on the lexical properties (usually semantic or phonological) of the distractor and target, and on their effect on object naming, although completion of the latter task necessarily includes the mechanisms of comprehension, at least to some level of analysis, during the processing of the distractor. Similarly, in priming tasks that involve picture naming, the focus is on response latency variations in producing a target as a function of earlier exposure to a related word (prime), while the comprehension component implicated in the processing of the prime is ignored. Apart from these examples, perhaps the most concrete link between the production and comprehension systems can be found in the kind of proposal formulated by Levelt (1983) regarding the 'perceptual loop'. A speaker attends to his own speech in the same way that he attends to the speech of others; he perceives and parses it by the normal language comprehension system. This enables him to evaluate the semantic, syntactic, morphological or other aspects of his speech, prior to its articulation (internal speech) or after it (external speech). Therefore, on this account, both comprehension and production appear to be intimately bound up with most aspects of human language performance.

3.3.2 Gender priming in comprehension

3.3.2.1 Lexical access in comprehension

As in production, word retrieval in comprehension is commonly divided in two stages. The first involves using sensory input to make initial contact with candidate lexical representations. Semantic, syntactic and phonological information stored with activated lexical candidates is then made available to the language processing system. The second stage (post-lexical) involves the selection and integration with the context of the information

made available in the first place (Tanenhaus & Lucas, 1987). Terminological difficulties arise because researchers use 'lexical access' to refer to different aspects of the word recognition process. In the present context, we follow Frauenfelder and Tyler (1987) and Marslen-Wilson (1989) in assuming that lexical access, together with lexical selection and lexical integration, subserves word recognition. During lexical access the sensory input activates a subset of compatible entries and their associated properties in the mental lexicon, the best candidate of which is selected in the second phase. Finally, the selected lexical item is integrated into a higher level representation, as specified by the semantic and syntactic constraints of the context (Zwitserlood, 1989).

Unlike production, comprehension theories do not make detailed proposals concerning the time course of information retrieval, that is, when the different types of lexical information become available to the rest of the language processing system. Most theories converge on the assumption that some form-based information must be available early, in the initial contact phase of word recognition, in order to provide the basis for a match with the phonetic input. There is disagreement, however, on the point at which other types of stored lexical knowledge become available. The different views are exemplified by the contrast between the cohort and search models. In the former, all stored information is activated simultaneously upon initial contact (Marslen-Wilson & Tyler, 1980). In the latter, some form-based specification must be made available early in the process, whereas syntactic and semantic information does not become available until a word is accessed and recognized. This is because such information is stored centrally in a master file, which is not entered until the word has been recognized (Forster, 1976, 1979). Given the dissimilarity in emphasis with respect to the processes of lexical access, that characterises the word production and comprehension literature, the study of gender has served to address a distinct set of phenomena in the two contexts. In what follows, we consider gender priming in research on comprehension.

3.3.2.2 A note on terminology

In the context of comprehension studies, the phenomenon of gender priming has been taken to refer to a syntactic context effect; it is seen as placing constraints on the way in which elements, here gender agreement controllers and agreement targets, can be combined into higher level units. According to interactive theories, by constraining the syntactic properties of upcoming words and their constituent structure, prior grammatical gender information can intervene in the phases of lexical processing that lead to word recognition. Most studies conducted in English have manipulated word category constraints; in the syntactically

incongruent condition, the target word belonged to a category that, given the grammatical rules of the language, was not allowed to occur in that context (e.g., Seidenberg, Waters, Sanders, & Langer, 1984; West & Stanovich, 1986; Wright & Garrett, 1984). By contrast, studies in other languages e.g., Serbo-Croatian, Hebrew, French and Italian, have primarily manipulated syntactic congruency or incongruency at the level of morphosyntactic agreement (e.g., Bates, Devescovi, Hernandez, & Pizzamiglio, 1996; Deutsch & Bentin, 1994; Grosjean, Dommergues, Cornu, Guillelmon, & Besson, 1994; Gurjanov, Lukatela, Moskoljevic, Savic, & Turvey, 1985; Katz, Boyce, Goldstein, & Lukatela, 1987; Lukatela, Carello, & Turvey, 1990). Reflecting the distinction between modular and interactive accounts of lexical processing, very similar findings from the above mentioned studies have been attributed by the former (i.e., modular accounts), to contextual influences at a post-lexical checking phase, and by the latter (i.e., interactive accounts), to a pre-lexical, or pre-selection phase.

In this context, an *overall priming effect* is commonly used to refer to the resulting difference in performance for targets that follow related primes, relative to the performance for targets that follow unrelated primes. When the latter condition serves as the baseline, and the resulting difference is positive, priming is further qualified as being facilitatory. Conversely, when the difference is negative, priming is inhibitory (Neely, 1991). Furthermore, in syntactic priming studies, the prime that carries potentially helpful information is the *congruent* prime, whereas the one carrying misleading information is the *incongruent* prime. Note, of course, that the condition in which there is no information about gender at all can also be realised by a congruent prime (e.g., in French, the article *l'* in *l'arbre*, or the adjective *pauvre* in *pauvre chat*). The terms *valid* and *invalid* (Jonides & Mack, 1984) are used to further characterise primes with respect to the type of information they carry: helpful in the case of the former (e.g., *la maison, petite maison*), misleading in the case of the latter (e.g., **le maison*, **petit maison*).

3.3.2.3 Summary of findings

The question of whether and, if so, how prior gender information can prime lexical access in comprehension, has been investigated in both the auditory and the visual stimulus modalities, with several different types of primes, including sentence preambles or single word primes, and strings of "xxx" in the visual modality. Most of these studies have employed a lexical decision task, sometimes supplemented by additional tasks, most commonly, word naming. They have been conducted in a number of languages that mark gender overtly. Here, we will attempt to provide a summary of the main findings from the

word recognition literature, against the background of the theoretical views discussed in the Levelt et al. framework.

Perhaps the most robust effect, confirmed by the majority of the results, is that the grammatical gender of the prime becomes available, and affects the response to a gender incongruent target word (Bates et al., 1996; Carello, Lukatela, & Turvey, 1988; Cole & Segui, 1994; Dahan, Swingley, Tanenhaus, & Magnuson, 2000; Gurjanov, Lukatela, Lukatela, Savic, & Turvey, 1985; Jakubowicz & Faussart, 1998; Schriefers, Friederici, & Rose, 1998; Van Berkum, 1996). The effect is interpreted as being inhibitory, while its source is located at a post-lexical level, and attributed to a grammatical-congruence checking mechanism. Thus, in most studies, words preceded by a gender-incongruent prime were recognised more slowly relative to a condition in which they were preceded by a prime that was not grammatically informative (baseline), whereas targets preceded by a gender-congruent (valid) prime were recognised no faster than the same words, in the baseline condition. Overall, inhibition was observed independent of task and language, whereas facilitation, measured as the recognition benefit relative to a baseline, was obtained only under particular sets of experimental conditions.

Regarding the facilitation effect, this was reliably obtained in the study by Grosjean et al. (1994) for French. In two experiments, one employing a gating paradigm and the other one a lexical decision task, Grosjean et al. compared performance between target nouns, masculine and feminine, that were preceded by a valid gender prime of the form article + adjective (e.g., *un cher*, *une chere*), and target nouns that were preceded by a gender neutral baseline, here the homophonous adjective (e.g., *cher-e*) alone. In both tasks prime and target were auditorily presented. Grosjean et al. obtained a robust gender priming effect in both experiments. Subjects needed 9% less of the word for isolation in the gating study, and their recognition latencies were shorter in the lexical decision task. Because the critical comparison involved a condition containing potentially helpful information (a valid prime) and a condition containing no information at all (a gender-neutral rather than a misleading prime), the effect was interpreted as being facilitatory. Without excluding a potential post-lexical contribution of higher-level syntactic operations, in the form of a gender agreement check, Grosjean et al. located the source of this effect at the lexical level, hence adding gender marking to the already long list of factors such as frequency, length, uniqueness point, neighbourhood size and frequency etc. that are known to affect the word recognition process.

Further evidence of a facilitatory effect was reported by Bates et al. (1996) for Italian, in a task (word repetition) that tapped both comprehension and production processes. As in the Grosjean et al. study, here too, primes and targets were auditorily presented. Adjective primes, valid or invalid, preceded noun targets (e.g., *brutta casa* versus **brutto casa*), whereas gender-ambiguous adjectives served as a baseline (e.g., *grande casa*). Bates et al. found a robust gender priming effect involving both facilitation and inhibition relative to the baseline.

So far, we have mentioned studies of gender priming in comprehension with the focus on the relative directionality of the effect (i.e., facilitation versus inhibition). Approached from a different perspective, the question of gender priming also pertains to the issue of the relationship between different types of lexical information. This issue was addressed in a study by Schriefers, Friederici and Rose (1998), which investigated the interaction between gender information and semantic relatedness. Prime and target words were embedded in visually presented strings of words that formed either a correct sentence, a scrambled list of words, or a sentence in which the target noun and the preceding definite article disagreed in grammatical gender. The semantic relation between the verb and the target noun was manipulated. Participants had to make a lexical decision on the target. Critically, although semantic priming was obtained when the noun and its preceding article agreed in grammatical gender, it was reduced or eliminated in the condition of gender disagreement. On this basis, Schriefers et al. concluded that " a gender mismatch between a prime and a target has an influence on word recognition beyond a general inhibitory effect that is, presumably, based on the negative outcome of a syntactic procedure that checks whether the gender agreement rule is being respected or not" (p. 1302). Lexical-semantic and syntactic information were therefore, shown to interact during word recognition.

3.3.2.4 Implications of findings for the Levelt et al. model

In this section we revisit some key claims of the Levelt et al. model about gender processing in light of the implications from the research reported above. We will show that much of the research that has been done to uncover the processes of lexical access in comprehension may ultimately be as much informative about the role of different types of lexical information in production as it is in comprehension.

As far as the very weak facilitation effect of gender congruence is concerned, this follows naturally from Levelt et al.'s claims first, about the linguistic contexts in which a gender node becomes selected, and second, about the nature of the lemma-to-gender connection.

That is, the gender information carried by the prime cannot reduce the set of upcoming nouns to only those of matching grammatical gender nor can it preactivate them, thus leading to facilitation, as the lemma-to-gender connection is unidirectional. This implies that selection of a gender node does not affect the activation level of its associated lemmas. The absence of facilitatory gender priming can also be readily explained by the word category of the target. In all of the studies reported above, the target consisted of a bare noun. If Levelt et al.'s claim that bare noun production does not involve gender selection should also hold for bare noun comprehension, then no reselection of a previously selected gender node is involved. It is an open question whether facilitatory gender priming could be found in the recognition of words with non-inherent gender e.g., adjectives. The general inhibitory effect of gender incongruence, on the other hand, is typically taken to occur outside the lexicon, possibly during the stage at which lexical elements are inserted into a syntactic frame. A checking mechanism responsible for the syntactic coherence of the phrase or the sentence, slows down participants' performance when an incoherence is detected.

However, if the structure of the lexicon and its processing characteristics do not allow for facilitatory gender priming, as suggested above, how are Grosjean et al. and Bates et al.'s findings to be accounted for? The resolution to this apparent contradiction could possibly be found in certain properties of the tasks and of the target languages. Regarding the former, the prime and target were auditorily presented in the successful studies and in no others. Regarding the latter, in both Italian and French, gender marking is more often than not, phonologically transparent. In Italian for example, for the great majority of nouns, masculine forms end in *-o* in the singular and *-i* in the plural, and feminine forms end in *-a* in the singular and *-e* in the plural. Similarly in French, feminine nouns commonly end in *-ion* and *-ence*, whereas masculine nouns end in *-age*, and *-ment*. The phonological reflex of gender marking in the two languages could be taken to trigger gender selection to some extent, hence the resulting facilitation.

A final point concerns the issue of the relationship between different types of lexical information. Schriefers et al.'s finding that the effect of semantic relatedness is modulated by the syntactic (here, gender) properties of the prime and target, suggests that processing at a lower level can feed back and affect processing at a higher level. This finding is therefore, in line with an interactive view of lexical processing, and problematic for the discrete-serial view of Levelt et al.

3.3.3 Gender priming in production

3.3.3.1 A note on terminology

In production studies, *gender priming* has been used to refer to two different phenomena. The first pertains to the question of whether preactivation of a word's gender can facilitate retrieval of that word. The corresponding studies have primarily employed primed picture-naming or picture-word interference tasks, in which the critical comparison has been between a condition in which the prime or distractor carries gender information congruent with the gender of the picture name, and a condition in which prime or distractor gender and picture name gender are incongruent. In order to determine the direction of the effect, that is, whether it is facilitatory or inhibitory, these two conditions are compared to a third one that provides no gender information at all (a neutral baseline).

The second phenomenon concerns the claim of a recency-sensitive link from the lemma to its gender node. It has been suggested that the connection strength between a lemma node and its gender is modulated as a function of the recency of retrieval of that word's gender information: it increases every time the word's gender information is used, and it decays slowly thereafter. On the assumption that selection of gender information is more recent for high frequency than for low frequency words, this account predicts that accessing gender information is faster for high frequency than for low frequency words. Therefore, here, the critical question is whether the retrieval of the gender of a noun can be primed (facilitated) by having retrieved the same noun's gender shortly before. Corresponding studies (Jescheniak & Levelt, 1994; Van Berkum, 1996) suggest that a gender recency effect is obtained with tasks that favour a more strategic, controlled mode of gender processing (e.g., gender decision, error detection or grammaticality judgment tasks), but not with genuine production tasks that are more likely to tap into automatic effects.

3.3.3.2 Review of findings

Research on gender priming in production has produced a wide range of results that are relevant to explaining the on-line characteristics of lexical access, as well as the contribution to the latter of lexical-syntactic processes. The picture-word interference paradigm has been employed in most of these studies. Participants have to name pictures either by a bare noun or by some simple noun phrase, while ignoring any visual or auditory distractor word that is presented during the naming process. Both the relation between distractor word and intended response, and the timing of distractor presentation have an effect on utterance onset latencies, and are therefore, systematically manipulated. For example, in bare-noun picture

naming, a semantic distractor (e.g., *DOCTOR-nurse*)[2] retards processing of the target, relative to an unrelated distractor (e.g., *chair*). The semantic interference effect appears to be maximal when the stimulus onset asynchrony (SOA) is approximately -100 ms (i.e., when distractor presentation precedes picture presentation by 100 ms). By contrast, a phonologically related distractor (e.g., *DOG-dot*) shortens onset latencies relative to an unrelated distractor (e.g., *chair*), with the effect peaking for SOAs around 0 ms (i.e., when picture and distractor have simultaneous onsets). This basic methodology, extended to include a manipulation of the grammatical gender of targets and distractors, has been used extensively. In what follows, we will review the main empirical results relating to the Levelt et al. model, that have been obtained with the picture-word interference paradigm, and with other tasks involving primed picture or word naming.

Schriefers (1993)

The earliest study to investigate the role of lexical-syntactic processes, and of gender in particular, in the production of noun phrases within the picture-word interference paradigm, was that of Schriefers, for Dutch. In a first experiment, participants had to name coloured objects by means of NPs consisting of a (gender-marked) definite determiner, a pre-nominal (gender-unmarked) colour adjective and a noun, while ignoring visually presented distractors. The distractor had either the same gender as the to-be-named picture (gender-congruent distractors) e.g., *HUIS-been* 'HOUSE-leg', or a different gender (gender-incongruent distractors) e.g., *HUIS-tafel* 'HOUSE-table'. The semantic relatedness between targets and distractors was also manipulated: on the assumption that the activation of the corresponding gender information is proportional to the activation of the lemmas, the competition between two different genders should be stronger for conditions with semantically related distractors than with unrelated distractors. The SOA between target and distractor presentation was varied (-200 ms, 0 ms, +450 ms). The results showed that for SOAs of -200 and 0, naming latencies were faster when the distractors were gender-congruent, than when they were gender-incongruent, and that this effect was not modulated by semantic relatedness. A second experiment replicated this interference effect, and showed that it could also be obtained for no-determiner NPs consisting of a (gender marked) colour adjective and a noun (although it was only significant at 0 SOA, and was smaller than the respective effect for definite determiner NPs).

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[2] Capital letters refer to target pictures, lowercase letters refer to distractor words.

Following similar accounts of semantic interference, Schriefers interpreted the gender effect within the framework of the Levelt et al. model. The target noun lemma activates the information about its gender, which is then used to determine the correct form of the definite article and/or the adjective inflection. The distractor noun is also assumed to activate its gender information automatically, even when it is presented in isolation (i.e., without a gender agreement target). When the gender activated by the distractor noun is different from that of the target noun, the selection threshold for the correct gender information is reached later and its selection is delayed. As a result, the specification of the correct article form or adjective inflection is delayed, and the corresponding slots of the phrasal frame are filled later than in conditions with gender-congruent distractor words.

Van Berkum (1997)

Using the same methodology, Van Berkum replicated Schriefers' results in a study in which the primary goal was to investigate the relative ease of gender retrieval for a noun as a function of the recency of earlier access to the same noun's gender. The production of Dutch gender-marked definite article NPs was slower when the picture was shown together with a gender-incongruent word, than when it was shown with a gender-congruent word.

La Heij, Mak, Sander & Willerboordse (1998)

In a further study in Dutch, La Heij et al. used the picture-word interference task to investigate the effects of target utterance format and type of distractor on picture naming. Their aim was to replicate the results of Schriefers (1993), and to examine whether the gender effect could be obtained with different target NPs, particularly with bare nouns, and whether it was affected by the familiarity of the distractor word. Particularly, if it could be shown that the gender of highly familiar words is easier to retrieve than the gender of words of lower familiarity, then highly familiar distractor words should induce a larger gender congruency effect than words of lower familiarity. In a first experiment, where participants had to produce either bare noun or definite determiner + noun NPs, the gender effect was obtained in the latter condition only (113 ms); responses were faster after a congruent distractor than after an incongruent one only when they involved production of a gender agreement target (here, the definite determiner). In this experiment, distractors were words of high familiarity; they were the names of target pictures in the experiment. A second experiment, in which distractor words were not part of the set of target responses, yielded a significantly smaller interference effect (64 ms), also restricted to the condition in which participants had to produce definite determiner + noun NPs. Experiment 3a, which involved

the production of the definite determiner (*de* or *het*) corresponding to the word that appeared on the screen, showed that it takes less time to produce the correct determiner in response to a target picture whose name is of high familiarity than to a target picture whose name is of medium familiarity. This effect however, decreased strongly with practice. A final experiment that used the same target pictures as in Experiments 1 and 2, and the words of high and medium familiarity that were examined in Experiment 3a as distractors, replicated the earlier findings that a gender-congruency effect is obtained only in the condition that involves the production of a determiner + noun NP, and when distractors are words of high familiarity.

Schriefers and Teruel (2000)

The overall gender-congruency effect reported for Dutch was replicated in a similar study in German, by Schriefers and Teruel. Consistent with the earlier results, naming latencies to target pictures, by means of definite determiner + adjective + noun NPs, were faster when a gender-congruent distractor word was auditorily presented than when a gender-incongruent word was presented. Because the semantic relatedness between target and distractor words was also manipulated, Schriefers and Teruel were able to identify the relative position of semantic and gender effects on the SOA dimension. Specifically, they showed that semantic interference, occurring at SOA -150 ms, temporally precedes gender interference, that occurs at SOA +150 ms. A second experiment replicated the main results as well as the size of the effects of Experiment 1 for NPs without an adjectival modifier; the gender interference effect was obtained after the semantic interference effect had vanished.

Miozzo and Caramazza (1999)

The first study to reach a very different conclusion was that by Miozzo and Caramazza for Italian. Working with visually presented distractor words, they repeatedly failed to replicate the gender-congruency effect in NP production reported with Dutch and German speakers. A critical difference between Dutch or German and Italian is that in the latter language there is not a complete match between a noun's syntactic properties and the form of the determiner. Rather, a noun's gender and number activate a phonologically conditioned set of determiner allomorphs: *il* and *lo* for masculine singular, *i* and *gli* for masculine plural. The selection of a specific allomorph depends on the phonological characteristics of the word that follows it in the NP. Therefore, it is only at the stage where the phonological form of the noun (or of other NP constituents) is inserted into a phonological phrase that the features necessary for determiner selection are made explicit.

A first experiment, involving picture naming by means of definite determiner + noun + adjective NPs (e.g., *il tavolo nero*), and including a semantic relatedness condition, yielded a semantic interference effect, but no effect of gender congruency. This pattern was replicated in Experiment 2 for the production of simple determiner NPs (e.g., *il tavolo*), in Experiment 3 which manipulated determiner agreement in target-distractor pairs of simple determiner NPs (e.g., *lo SCOIATTOLO-* [*lo*] *zolfo* versus *lo SCOIATTOLO-* [*il*] *frate*), and in Experiment 4 which varied the phonological form of articles in the production of determiner NPs. The phonological effect obtained in this last experiment led the authors to claim that the negative findings for determiner- and gender-congruency could not be attributed to insufficient activation of the distractors' phonological representations.

A final experiment sought the locus of the negative findings of determiner- and gender-congruency in Italian. It investigated determiner-congruency effects with and without conflicting information at the level of phonological phrase construction (i.e., the level where determiner selection takes place). Participants had to name pictures of different sizes by means of NPs consisting of a determiner, a prenominal adjective denoting picture size, and a noun. Two types of phrases were used. In the 'same-determiner' type, the adjective and the noun both phonologically conditioned the same form of determiner (e.g., *il grande treno* 'the big train' and *il treno*). In the 'different-determiner' type, the adjective and the noun did not agree with respect to the determiner they would take (e.g., *il grande sgabello* 'the big stool' versus *lo sgabello*). The critical question was whether response latencies would be shorter for 'same-determiner' NPs than for 'different-determiner' NPs relative to the respective baseline phrases *il treno* and *lo sgabello*. Such a result would indicate that both the adjective and the noun activate their respective determiner allomorphs, leading to competition in the selection of the appropriate determiner. Importantly, this hypothesis was borne out. On the basis of the combined findings of the five experiments, Miozzo and Caramazza explained the contrasting gender-congruency effects observed in Italian and Dutch or German in terms of operations specific to the processes of determiner selection in the two languages. Specifically, given the robustness of the effect in Dutch (replicated in several studies as shown above), Miozzo and Caramazza favoured an interpretation of their findings whereby the gender-congruency effect is also present in Italian, yet invisible, due to the structure of the determiner system.

Costa, Sebastian-Galles, Miozzo and Caramazza (1999)

In a comparable study in Spanish and Catalan, Costa et al. also failed to obtain a gender-interference effect, consistent with the cross-linguistic hypothesis of Miozzo and Caramazza. Spanish and Catalan differ in the extent to which they depend on phonological context for the selection of the appropriate determiner form. The former is similar to Dutch in that in all but one context, gender information alone (together with other semantic and/or grammatical properties) suffices to select the correct determiner form. The one exception involves the feminine determiner when followed by a noun beginning with a stressed *a*. In this context the correct form is not *la* but *el* (i.e., the determiner typically used with masculine nouns). By contrast, Catalan is closer to Italian in that in most cases, selection of the correct determiner allomorph has to wait until the phonological form of the next phrase in the NP is known; the masculine determiner *el* and the feminine determiner *la* are both realised as *l'* when the following word starts with a vowel. Despite this quantitative difference, the absence of a gender-interference effect in both languages was taken to indicate that the mere existence of even a few contexts that require phonological information, rather than their absolute or relative number, suffices to determine the structure of the determiner system, and of the corresponding processes involved in the production of NPs.

Schiller and Caramazza (2000)

Within the same paradigm, Schiller and Caramazza investigated gender selection during the production of singular and plural NPs in Dutch and German. In the case of these plural NPs, gender distinctions are collapsed since the definite determiner has the same surface realisation for all gender classes (*die* for German and *de* for Dutch). For singular NPs, Schiller and Caramazza replicated the gender-interference effect in line with what had been previously obtained in the two languages. However, they failed to obtain an effect for plural NPs, and for German singular NPs that consisted of a gender-marked prenominal adjective and a noun (see however, Schriefers, 1993, for gender interference with prenominal gender-marked adjectives and nouns, in Dutch). On the basis of their results, Schiller and Caramazza argued that the gender-interference effect is actually a determiner-interference effect; they attributed it to competition for selection between different lexical nodes for the different gender-marked determiners, and not to competition for selection between abstract gender nodes. Furthermore, this competition was taken to be restricted to free morphemes e.g., determiners, and thus, could not obtain for gender-marked bound morphemes, like adjectival inflectional suffixes.

Jescheniak (1999)

In two experiments involving primed picture naming in German, Jescheniak examined whether production of a noun could be facilitated by preactivation of its grammatical gender (gender-to-lexical entry priming). Target pictures were preceded either by a gender-marked, congruent or incongruent, definite determiner prime, or by an unmarked, indefinite determiner prime. An additional gender-neutral baseline ("xxx") was included, to control for possible effects of the linguistic context. Primes were presented visually (Experiment 1) and auditorily (Experiment 2). The results of both experiments provided evidence for inhibition relative to the gender-congruent and the gender-unmarked (indefinite article) conditions; participants were significantly slower to produce a picture name after an incorrect gender prime than after a correct, gender-marked or unmarked, prime. Although no significant difference was obtained between the latter two conditions, the two prime conditions that carried no gender information (indefinite article and 'xxx') did differ reliably. The latter observation pointed to the centrality of baseline choice in determining the direction of priming effects. Jescheniak concluded that the effects obtained in the two experiments did not support the notion of gender-to-lemma priming, but that they probably reflected the workings of alternative mechanisms such as a postlexical output editor.

Jacobsen (1999)

In a similar study also in German, Jacobsen examined the effect of prior gender information provided by a minimal sentence context, on picture and word naming. The former task is assumed to closely resemble normal production processes; it requires that the lexical information associated with the intended noun is retrieved starting at the conceptual level. By contrast, the latter task, which comprises both a comprehension and a production component, can be accomplished without an active search for the lemma, in principle solely based on word form information. Thus, the two tasks are assumed to involve different access routes to possibly the same lexical representation. The pictures that were presented in Experiment 1 were replaced by their respective names in Experiment 2. In both experiments, sentence fragments were presented auditorily rather than visually, to ensure adequate processing. They were of the following types: *dies ist der* $_{\text{MASC}}$*/die* $_{\text{FEM}}$*/das* $_{\text{NEUT}}$ 'this is the', *bitte sage jetzt* 'please say now', and *sage jetzt bitte* 'say now please'. Relative to the baseline condition, the picture-naming task provided clear evidence for both gender facilitation and gender inhibition. By contrast, the word-naming task yielded only inhibition. Furthermore word naming proved to be an easier task than picture naming, with shorter

overall naming latencies and fewer errors. In view of the variable findings between the two experiments, and of the discrepant results between his study and the study by Jescheniak, Jacobsen concluded that prior gender information can affect differentially subsequent lexical processing, but did not provide a unified account of the way this is operationalised.

Akhutina, Kurgansky, Polinsky and Bates (1999)

Using a different methodology, Akhutina et al. examined the effect of grammatical gender on lexical access in Russian. They presented adjective-noun pairs auditorily, employing a cued-shadowing technique in which participants had to repeat the second word (the target noun), following adjectives that were either congruent or incongruent with the noun's gender. Note that word repetition is a hybrid task, involving both comprehension and production processes. Thus, although included in the production literature, this series of experiments should best be viewed as pertaining to the intersection of the cognitive processes of comprehension and production. Within each pair, noun targets were presented immediately after the onset of the adjective prime. Unlike the languages tested in the previous studies (Catalan, Dutch, German, Italian and Spanish), Russian has a three-gender system. The endings of some nouns in the nominative singular act as clear indicators of their gender (phonologically transparent), although the endings of some others do not (phonologically opaque).

A first experiment that used transparent masculine and feminine noun targets did yield a gender-congruency effect. However, in the absence of a baseline (since no adjective form in Russian is equally compatible with both masculine and feminine nouns), the directionality of the effect, i.e., facilitatory or inhibitory, could not be determined. A second experiment addressed the baseline issue by examining gender priming for feminine and neuter nouns; gender-ambiguous adjectives are possible when masculine nouns are not included. Here, the gender-congruency effect that was again obtained, was shown to be primarily inhibitory. A third experiment that used opaque masculine and feminine target nouns, with gender-unambiguous adjective primes, revealed a significant gender effect, although smaller in magnitude than the corresponding effect with transparent nouns (Experiment 1). A final experiment, designed to address the baseline issue further, showed that both the facilitatory and the inhibitory effect in the repetition of the target nouns were significant. Transparent masculine and feminine target nouns were used. However, unlike the previous experiments, Experiment 4 used only one adjective, the word for 'simple' (*prostoj* $_{\text{MASC}}$, *prostaja* $_{\text{FEM}}$), and a phonologically close and highly frequent adverb, the word for 'simply' (*prosto*). Akhutina

et al. hypothesised that response latencies to nouns following *prosto* would be slower relative to nouns following gender-congruent adjectives, but faster relative to nouns following gender-incongruent adjectives. The results of Experiment 4 confirmed this hypothesis, with the effect of the neutral adverb *prosto* falling right in between the effects of the congruent and incongruent adjective conditions.

3.3.3.3 Implications of findings

Our aim in this section is to bring together the empirical evidence from production discussed thus far. We consider the insights it has provided into the representation, retrieval and usage of grammatical gender, and into some more general aspects of lexical-syntactic representation and processing. The findings from these studies, although not fully consistent, allow for the following conclusions.

First, the gender-interference effect, when obtained (La Heij et al., 1998; Schriefers, 1993; Schriefers & Teruel, 2000; Van Berkum, 1997), is compatible with the idea that grammatical gender is represented as an abstract lexical property. It is attributed to the automatic activation of the gender feature of the distractor noun, which interferes with the selection of the gender feature of the picture name when the two do not match. Critical for the interpretation of the gender-interference effect is the fact that the distractor is a bare noun i.e., there is no indication of its grammatical gender by, for example, a gender-marked determiner or a suffix. Both in Dutch and in German, gender cannot be strongly predicted on the basis of the semantic and/or phonological properties of the noun. Thus, the specification of a noun's gender information and the locus of the interference effect have to be at an abstract level of representation.

However, the above interpretation of the gender effect is undermined by its failure to replicate in other languages (Italian, Spanish, Catalan) under comparable experimental conditions. Miozzo and Caramazza (1999) and Costa et al. (1999) identified a potentially confounding factor in the 'gender-as-abstract node' selection hypothesis proposed for Dutch and German. Particularly, they noted that in these two languages the form of the definite determiner and the adjectival inflection are fully conditioned by the syntactic properties of the noun i.e., there is a perfect one-to-one mapping between gender and gender marking devices. Therefore it is not clear whether the effect arises at the stage where the gender feature is selected or at the stage where the surface form of the agreement target is specified. Of course, these two alternatives need not be mutually exclusive. Thus, Miozzo and Caramazza suggested that:

> The gender effect may reflect competition in the selection of specific determiners (or inflectional morphemes in the case of adjective NPs), not competition in the selection of gender nodes. In this view, the activation and selection of a gender node is an automatic (non-competitive) consequence of lexical node selection. However, selection of determiners is a competitive process, just like the selection of lexical nodes. (p. 909)

In the latter, 'gender-as-gender-marking form' selection hypothesis, the distractor is assumed to activate its associated determiner which interferes with the selection of the target determiner, when the two do not match. The selection threshold of the target determiner will be reached later, and its production will be delayed. Note that on both accounts interference is attributed to competition, with the difference lying at the type of lexical feature or element that is drawn upon and at the processing level at which competition is located. The failure to find a gender effect in Italian left this issue unresolved. However, Miozzo and Caramazza favoured an explanation according to which a gender effect did exist, but was rendered invisible by the temporal constraints i.e., the delay in the availability of phonological information. This delay allowed enough time for the resolution of any conflict in gender selection.

The precise locus of the gender effect can be identified by independently manipulating the gender of the target and the distractor and the form of the agreement targets e.g., determiners, pronouns, adjectival inflections etc. This is possible in languages in which the specification of the latter is not fully determined by the selection of the former feature. We saw, for example, that in Italian there are two masculine singular determiner allomorphs (*il* and *lo*) and two plural (*i* and *gli*), in complementary distribution, depending on the phonological characteristics of the word that follows in the NP. The two possibilities outlined above can also be tested in a condition in which selection of a noun's gender does not determine distinct forms of an agreement target as for example, in the case of plural determiner NPs in Dutch and German (Schiller and Caramazza, 2000), or of Italian adjectives that end in *-e* in the singular, and *-i* in the plural, and can be both masculine and feminine.

In sum, the evidence obtained thus far with the picture-word interference paradigm does not allow for a clear decision as to whether competition pertains a) to the selection of an abstract gender node (Levelt et al.), b) to the selection of the surface form of an agreement target or possibly c) to the selection of the abstract lexical node (lemma) that corresponds to this target. Although the latter two possibilities are not clearly distinguished in the discussion of the relevant findings, the choice of one over the other has important implications for the

time-course of activation of syntactic and morphophonological information during lexical access. Particularly, if competition between agreement targets occurs at a morphophonologically specified level of representation, this means that morphophonological encoding is initiated before the computation of agreement has been completed at the lemma level. Such an account runs counter to Levelt et al.'s view of discrete serial processing, while being in line with a more cascaded view of language production.

A critical argument arises from effects of allophony and overlap. Specifically, if the mapping between gender classes and gender agreement targets is one-to-one, as in the case of singular definite determiner NPs in Dutch and German, interference is systematically observed. If the mapping is one-to-many, as in the case of singular definite determiner NPs in Catalan, Italian and Spanish, no gender effect is observed. Finally, if the mapping is of a many-to-one type, as in the case of plural definite determiner NPs in Dutch and German, no gender-interference effect is obtained either.

The issue of whether competition pertains to the selection of an abstract gender node or to the selection of (the abstract lexical node or the form) of an agreement target has a potentially wider scope. It bears on the question of how gender is represented, particularly of what kind of information constitutes a word's gender specification. In the models reviewed earlier a localist approach was adopted, with each gender corresponding to a single node at the syntactic level. On different accounts however (see e.g., Maratsos & Chalkley, 1980), gender information is distributed; it refers to patterns of cue correlations. Registering the co-occurrence of, and eventually linking, individual lexical items with particular grammatical markers, is taken to refer not only to a learning mechanism but also to the way a gender feature is encoded and permanently stored. Thus, gender becomes not a characteristic of the noun per se, but a characteristic of how it fits into related distributional patterns. Note that such an approach to gender bears a close resemblance to its definition (Corbett, 1991, p. 4) according to which its determining criterion is agreement (i.e., the behaviour of associated words). Therefore, any evidence about the locus of the gender-interference effect will provide insights into the question of what constitutes a gender representation.

Second, the activation-selection distinction as formulated in Roelofs, Meyer and Levelt (1998) and adopted in Levelt et al., is in line with what is empirically observed for differential effects of gender in different linguistic contexts. Remember that according to Roelofs et al. the gender of a selected lemma becomes selected only when actually needed in the local syntactic environment of the noun e.g., in order to choose the correct determiner or

to compute noun-pronoun agreement, but not in the production of a bare noun, in which case gender information will only be activated. La Heij et al.'s failure to obtain an interference effect for the production of bare nouns was taken to support this claim. On the other hand, mere presentation of a distractor word, visual or auditory, and with no task to ensure its full processing automatically activated its grammatical gender to the extent that it could interfere with the selection of the target noun gender. In sum, the perception of a bare noun (visual or auditory), which entails the activation of its gender, can cause facilitation or interference, while the production of a bare noun, which also entails the activation of its gender, cannot be facilitated or interfered with. In other words, NPs that involve gender activation can induce priming, but cannot benefit from priming; for the latter to occur, gender selection has to be involved.

Although the above conclusion is fairly straightforward, a question that remains open is whether the activation-selection distinction is equally warranted by cross-linguistic investigations of gender priming. Note that the claim that bare noun production involves activation but not selection of a gender feature, along with most other claims concerning the architecture of the production system, was made, and tested, with reference primarily to Dutch i.e., a language in which gender is not as pervasive and central a feature as in other languages (e.g., Italian, Russian, Greek). In Dutch, nouns do not bear any overt, morphological or phonological, indication of their gender, and adjectives, which constitute agreement targets, do so only selectively, that is, when preceded by an indefinite (or no) determiner (e.g., *een groene* $_{\text{MASC}}$ *stoel* 'a green chair', *een groen* $_{\text{NEUT}}$ *bed* 'a green bed'), but not when preceded by a definite determiner (e.g., *de groene stoel* 'the green chair', *het groene bed* 'the green bed'). By contrast, in Italian for example, there are non-negligible correlations between the phonological properties of words and their gender class; feminine nouns tend to end in *-a*, and masculine nouns tend to end in *-o*. Furthermore, adjectives are marked for gender irrespective of whether they are preceded by a definite or an indefinite or no determiner. It is an empirical issue whether cross-linguistic variation first, in the way gender surfaces in the form of nouns, and second, in the syntactic environments in which agreement targets are gender-marked, may result in variation in the way gender is processed (as e.g., is hypothesised in Bates and MacWhinney's (1989) proposal of linguistic functionalism). In this view, the 'optimal' way of processing gender in Dutch may well be different from the 'optimal' way of processing it in Italian where a surface indication of gender is invariably found on adjectives, and more often than not, also found on nouns.

In fact, even the distinction between activation and selection may not be dichotomous. The two processes might best be viewed as representing different points along a continuum. If, according to the latter view, activation and selection are only quantitatively but not qualitatively different, then one could assume that the production of bare noun NPs in different languages may involve gender activation to varying degrees, as a function of the pervasiveness of the feature in the particular language. Such an example of cross-linguistic variation in the centrality of gender was given above with reference to Dutch and Italian. Similarly, one could assume that the production of different NPs within a single language may involve gender selection to varying degrees, this time as a function first, of the type of agreement target e.g., determiner NP versus adjective NP, and second, of the number of agreement targets e.g., determiner + noun versus determiner + adjective(s) + noun.

Third, as far as the effect of morphophonological markers on gender priming is concerned, this has been explicitly addressed in only one study, by Akhutina et al., in which the formal properties (transparency, opacity) of both primes and targets were manipulated. Although the critical comparison was not within a single experiment, Akhutina et al. showed that priming could be obtained for both transparent nouns (with inflectional suffixes that are clearly and regularly marked for gender) and opaque nouns, but that the effect was smaller for the latter than for the former class. Given that in the experimental description it is not specified whether primes and targets in the transparent-pair condition have the same suffix or not, we do not know whether the critical comparison has been only between transparent versus opaque nouns, or whether this has been confounded by a further comparison between same-suffix versus different-suffix prime-target pairs. In fact, Friederici and Jacobsen (1999) have gone so far as to suggest that when gender agreement involves morphological or phonological constraints, as for example in Italian, where the gender marking inflections between agreeing elements are most often phonologically identical, a congruency check could potentially be performed on the basis of word form information alone, without the activation of a word's grammatical specification or meaning. Although the possibility of recourse to such a mechanism cannot be excluded when morphophonological information is available, the presence of gender effects with opaque prime-target pairs suggests that a word's abstract specification must also be involved.

Apart from Akhutina et al.'s study, we saw that some of the gender-interference studies reviewed earlier (e.g., Schiller & Caramazza, 2000; Schriefers & Teruel, 2000) also pointed to the role of the formal properties of agreement targets in producing gender effects. In fact, the issue of the mapping between gender classes and gender-marking devices is essentially

the same as the issue of the transparency or opacity of words in gender-marked languages; transparent words reflect a one-to-one mapping between the abstract gender feature and its surface form, while opaque words reflect a many-to-one mapping. Recall however, that the critical comparison involved bare nouns (i.e., agreement controllers) in the Akhutina et al. study, but determiner NPs (i.e., agreement targets) in the gender-interference studies. Taken together, these results suggest that the formal properties of a word can modulate the effect typically attributed to preactivation of that word's gender (gender priming). As yet, this conclusion can be stated in very broad terms only, since a number of critical issues pertinent to the role of morphophonological information have hardly been addressed. First, we do not know whether it is the formal properties of the prime, or of the target, or of both that are mainly responsible for modulations in the effect of gender, when other factors are kept constant. Second, we do not know whether these interactions are driven purely by the words' morphophonological properties or whether they also partly reflect interactions of features at an abstract syntactic level. For example, is the absence of a gender-interference effect with plural target NPs in German to be attributed only to the surface characteristics of the determiner, or is it also the outcome of some type of interaction between abstract gender and number at the lemma level? Third, we do not know when during lexical access these formal properties become available and have their effect etc.

The fourth conclusion concerns the effect of prior gender information, provided by the perception, visual or auditory, of a prime, on the production of a noun that serves as a grammatically acceptable continuation to the prime (syntagmatic priming). Overall, this effect was shown to be inhibitory (with the exception of Jacobsen's Experiment 1), favouring an interpretation that located its source at a post-lexical level. Thus, the findings from the production and comprehension studies alike support Levelt et al.'s claim that the lemma-to-gender link is unidirectional, and that the production of a bare noun (which does not involve gender selection) cannot benefit from preactivation of its gender. Note however, that these findings are also consistent with alternative accounts of the inefficiency of syntactic-to-lexical feedback. For example, according to Tanenhaus, Dell and Carlson (1987):

> Syntactic constraints are expressed in terms of syntactic categories. The relationship between a grammatical category and a lexical item is one of set membership. When nodes are in a set membership relationship, the activation of the higher-level node will send activation to all members of the set. As the size of the set increases, feedback will generally become less efficient, because it will fail to discriminate among possible alternatives. (p. 102)

That is, in the latter account, and unlike Levelt et al.'s account, gender-to-lemma feedback is, in principle, possible; however, it is rendered inefficient in practice, due to the large set of lexical items within each gender class.

We conclude this section by noting that although the combined findings from comprehension and production provide ample support to the claim that prior gender information does affect subsequent lexical processing, a number of issues pertaining to the precise locus of the effect, to the conditions under which it is obtained, and to its interaction with other lexical properties, particularly morphophonological but also grammatical, remain unresolved. In the next chapters we will take up some of these issues. Particularly, in Chapter 4 we will attempt to further explore the linguistic contexts in which gender priming can be obtained, and to investigate the patterns of priming that are induced by words of different classes (determiners, adjectives and nouns), with particular reference to Levelt et al.'s claim concerning the activation-selection distinction. Chapters 5 and 6 will then take up the issue of the relationship between gender and the other nominal categories, particularly case and number, in affecting subsequent lexical access. As extensively argued in section (3.2.3), a cognitive processing relationship between the different nominal categories is strongly motivated by theoretical considerations concerning their fusional realisation as well as by empirical observations suggesting their combination in defining the cells of paradigms. Thus, Chapters 5 and 6 will attempt to examine whether, and if so how, case and number information operates in the same way as gender information in affecting subsequent lexical retrieval, and whether the putative gender priming effect is in fact a combined effect that reflects the joint contribution of more than one nominal category, and that is contingent upon the characteristics of more than one selection process.

Chapter 4 Empirical evidence for gender priming

4.1 Introduction

The previous chapter provided an overview of recent psycholinguistic investigations into the representation and processing of grammatical gender. The implications of these studies were addressed in the context of current models of language production. In this chapter, four experiments will be reported that examine whether, and if so how, prior access to the grammatical gender of words can facilitate the production of these words by native speakers of Greek. The first experiment will look for an influence of prior gender information on the production of gender-marked NPs, using definite determiner + noun primes and inflected adjective targets. Having found this influence, the next three experiments explore the limits of this effect by looking at different types of prime and target NPs. In Experiment 2, we use bare noun primes. In Experiments 3 and 4, we examine indefinite determiner + noun, and bare noun target NPs respectively. The findings from these experiments will provide the basis for further treatment of the role of gender, relative to the other nominal categories, in Chapters 5 and 6.

4.2 Methodological and empirical issues

4.2.1 Primed picture-naming

In the production studies reviewed in Chapter 3, two types of lexical priming tasks were used: picture-word interference and phrase- or sentence-completion. Given that these tasks do not have the same temporal structure, possibly tapping into processes that fall within different time spans, and given that they may not affect the same routes to lexical selection, the empirical picture that surrounds research on gender priming becomes fairly complex. Specifically, in the phrase- or sentence-completion task, prime and target are syntagmatically related, that is, they combine to form a grammatically acceptable string of words. Thus prior gender information, provided by for example an article, an adjective or a sentence preamble

should, in principle, be effective in influencing naming latencies to words that serve as grammatically acceptable completions to the prime. In this context, gender effects have a syntactic origin and are typically attributable to events outside the lexicon; they can be taken to reflect a syntactic congruency check that is faster for a gender-congruent element than for a gender-incongruent one. Such a congruency check involves a binary decision, and should lead primarily to inhibition (see e.g., Akhutina et al., 1999; Jescheniak, 1999 etc.). Alternative accounts which locate syntagmatic gender effects within the lexicon rely on the assumptions of a bi-directional lemma-to-gender link, and of structurally unconstrained spreading of activation from a gender node to all gender matching nouns (see Friederici & Jacobsen, 1999). These accounts predict the occurrence of facilitatory and inhibitory gender effects and also allow gender information and semantic information to interact early during processing. However, these predictions are not confirmed by the existing data. Specifically, the combined findings from the behavioural and ERP studies reveal strong inhibitory gender effects only, independent of task and language, and the interaction between gender priming and semantic priming to take place at a late stage of processing (e.g., Bates, Devescovi, Hernandez & Pizzamiglio, 1996; Hagoort & Brown, 1999; Van Berkum, 1996).

In the picture-word interference task by contrast, target and distractor are paradigmatically rather than syntagmatically related; they usually involve words from the same form-class, such as *ΚΗΠΟΣ – χάρτης* 'garden $_N$ – map $_N$', which do not combine into higher-level units. On the assumption that prior gender information provided by the distractor influences response latencies to target words independently of phrase structure information, such gender effects are taken to arise within the lexicon, and to reflect a temporary modification of the processing characteristics of lexical-syntactic properties. As the work reviewed in the previous chapter (e.g., La Heij et al., 1998; Schriefers, 1993; Van Berkum, 1997 etc.) implies, the source of the effect is intra-lexical; it is attributable to the automatic activation of the gender feature of the distractor, which then interferes with the selection of the gender feature of the target. The selection threshold of the latter is reached later, and its production is delayed. In line with this, the major findings within this paradigm have thus far invariably yielded evidence for inhibition: gender-incongruent naming is significantly slower than gender-congruent naming. However, this is only half the pattern predicted by intra-lexical priming. Gender-congruent naming should be faster than naming in a no-distractor condition, but it is not. Thus, activation of the gender feature of the distractor does not facilitate selection of the target word when the two match in gender. This suggests that the mechanisms of interference cannot be adequately accounted for merely in terms of activation level modifications of the corresponding lexical properties.

The experiments reported in this thesis employ a slightly different lexical priming task. Subjects name prime and target pictures that are presented in succession, but that are syntagmatically unrelated, thus excluding the possibility of any gender effects being attributable to a syntactic congruency check. Furthermore, both prime and target pictures are presented in isolation; no phrasal or sentential context is provided in either case. The main advantage of this paradigm compared to the more widely used picture-word interference paradigm is that both prime and target words have to be overtly produced, hence keeping participants' performance strictly within the production domain. In the picture-word interference paradigm by contrast, where distractor words are visually or auditorily presented, the components of participants' performance that reflect the cognitive mechanisms of word production become intertwined with those components that reflect recognition. Therefore, some effects that arise from the way words are recognised can be misattributed to processes of production. Importantly also, because in the present task the prime has to be produced rather than merely ignored, this could give rise to stronger priming effects than are typically observed with the picture-word interference task. This basic methodology is varied to include different types of prime and target NPs e.g., noun, definite determiner + noun, inflected colour adjective etc. The focus is on the consequences of naming successive words that have the same or different gender. The hypothesis tested will always be whether prior access to gender information implicated in the production of an NP influences the subsequent production of words of the same or of different gender.

4.2.2 Noun-phrase production

In several of the experiments to be reported here, participants respond to black-and-white pictures of common objects by the Greek equivalents of noun phrases like *the map*, and to coloured pictures by adjectives like *red* $_{\text{MASC}}$ (fence). In describing these pictures, participants have to go through at least the following processing stages: perception and identification of the object, retrieval of the corresponding lexical entries in the mental lexicon, formation of a syntactic structure, phonological encoding, and articulation of the resulting utterance (e.g., Bock & Levelt, 1994). The issue of whether and how participants can benefit from the different types of prior information in terms of their reaction times is held to be contingent on specific assumptions concerning the temporal organisation of these processes. For example, do speakers have to complete all processes prior to the initiation of articulation, or can they initiate articulation on completion of only a part of these processes? And if language can be produced in parts, what is the size of the relevant planning units?

On the basis of speech-error data (Garrett, 1976) and experimental evidence from languages such as Dutch and German (Meyer, 1996; Schriefers, 1993), a noun phrase is assumed to undergo complete grammatical encoding (involving parallel processing for the selection of the appropriate word lemmas), before articulation can be initiated. Phonological encoding proceeds from left to right, starting from the first word. It can start after grammatical encoding has been completed (Kempen & Huijbers, 1983) or, on a different account, as soon as logically necessary information has been retrieved at the lemma level and irrespective of whether the grammatical encoding of the entire noun phrase has been completed or not (Schriefers, de Ruiter, & Steigerwald, 1999).

These accounts of the temporal coordination of retrieval processes during the production of noun phrases yield interesting predictions regarding the potential influence from prior access to gender information. In the present experiments, successful phonological encoding of the target adjective requires information about the noun's gender in order to determine the correct inflectional suffix. Therefore, phonological encoding of the adjective should start only upon completion of selection of both the noun and the adjective lemmas. As a result, the start of phonological encoding will be determined by the longer of the two lemma processes; this guarantees that the noun's grammatical gender will always be available before phonological encoding starts. Any modulation in the duration of the selection processes should be reflected in the initiation of phonological encoding and, by extension, in the resulting utterance onset latencies. The production of definite-determiner NPs, which also involves the selection of the noun lemma and of its associated gender information for the specification of the correct form of the determiner, should yield similar patterns of results.

Note however, that there seems to be some variation in the coordination of the processes involved in the production of noun phrases depending on the position that the different lexical elements occupy in the syntactic frame. Thus for example, in a series of picture-word interference experiments in French, Schriefers and Teruel (1999) showed that in the production of noun phrases where the adjective occurs in postnominal position e.g., *la maison blanche* 'the $_{\text{FEM}}$ house white $_{\text{FEM}}$', the retrieval of the adjective lemma is not completed before the initiation of articulation. It appears, instead, that adjective lemma selection occurs during the articulation of the first two elements of the noun phrase, that is, of the definite determiner and the noun (*la maison*). This observation is in line with the temporal optimisation assumption suggested earlier, whereby the phonological encoding and articulation of the first element(s) of a noun phrase is initiated as soon as the required

information has been selected at the lemma level, and not necessarily when grammatical encoding of the whole noun phrase has been completed. In the case of French, wherever the adjective occupies the last slot in the syntactic frame, the relevant selection processes are not initiated until later in the production of the noun phrase. The same should hold for the production of no-determiner noun phrases like *maison blanche* 'house white $_{FEM}$'. Under these circumstances, the effect of prior gender information on utterance onset latencies should be weaker than, for example, for determiner NPs, and possibly rendered invisible.

In Experiments 1 and 2, the target response involves the production of a gender-inflected adjective only. The effect of prior gender information should therefore be reflected in naming latencies irrespective of the specific assumptions concerning the temporal dependencies of the different subprocesses. Throughout this discussion we have assumed that gender priming in the production of the target arises from the selection of a gender node that was previously activated during production of the prime and that is shared by the lemma representations of the two words. This assumption has its basis in Levelt et al.'s model, particularly in the claim that there is a single node for each gender, and that all noun lemmas of the same gender are connected to a shared gender node. Extrapolating this claim to all word categories that have gender e.g., pronouns, determiners, adjectives etc. yields the prediction that all words of the same gender should be connected to one shared gender node, hence the expected benefit in naming adjective targets from the production of different types (here, definite determiner + noun) of prime NPs. In contrast to this assumption, one might argue that gender (along with other grammatical property) nodes are not shared by the lemma representations of words of different categories e.g., pronouns and adjectives, so that the expected effect cannot be obtained. Alternatively, one might argue that words with non-inherent gender, that is, all gender-marked words apart from nouns, do not have direct connections to any gender node. Rather, they are only indirectly connected to the latter through the nouns with which they agree. In this case, a gender effect should be obtained. Although there is, to my knowledge, no empirical evidence directly addressing the issue of how different sub-vocabularies, e.g., one containing the nouns and one containing the adjectives, are organised and interconnected, as a working hypothesis we adopt Levelt et al.'s proposal of a single gender node shared by all word lemmas of the same gender.

4.2.3 Anaphoric lexical access in adjective production

Throughout this discussion we have assumed certain parallelisms in the processes involved in the production of different word types; particularly, we have assumed that Levelt et al.'s model of lexical access, that makes extensive reference to the production of nouns, will also

apply to the production of adjectives and determiners. As outlined earlier, these processes involve the activation of lexical concepts, the selection of lemmas, the morphological and phonological encoding of words in their prosodic context, phonetic encoding, and finally, articulation. There is however good reason to assume that there are also non-trivial differences in these processes dependent on word class. Many function words, for example, which lack an obvious semantic content (e.g., *that* in the sentence *He admitted that he was wrong*, or *up* in the particle verb *give up*), are activated as part of a syntactic procedure, commonly referred to as 'indirect election of words', and do not involve the activation of a lexical concept (Kempen & Huijbers, 1983). Note also, that the selection processes of other word types e.g., pronouns, have been largely unexplored. In the following, we focus on the type of target noun phrase used in several of the present experiments, and consider the kinds of representations that participants draw upon in order to determine the form of the adjective that they have to produce. Depending on the nature of the information that is (re-)activated in memory, the pattern of predicted effects from prior gender information may be accounted for in different ways.

Adjective production without production of the noun that is modified, is not an artificial task situation as it might appear at first. In fact, omission of the noun in a noun phrase is very common in natural speaking situations e.g., *είναι υπομονετικός* 'is patient $_{\text{MASC}}$', *φαίνεται κουρασμένος* 'looks tired $_{\text{MASC}}$', *αγόρασε καινούργιες* 'bought new $_{\text{FEM,PL}}$', *έδειξε κάποια άλλα* 'showed some other $_{\text{NEUT,PL}}$', *τί περίεργος* 'how strange $_{\text{MASC}}$' etc. In these contexts adjectives resemble pronouns in that their production (and comprehension) typically involves the identification of a discourse and of a lexical referent. Adjective production is thus, taken to tap into the processes involved in *anaphoric lexical access* (ALA), studied in comprehension (e.g., Love & Swinney, 1996; Shapiro & Hestvik, 1995; Simner & Smyth, 1999), and recently in production (e.g., Meyer & Bock, 1999; Schmitt, Meyer, & Levelt, 1999). Specifically, for the production of an adjective, the noun's lemma and grammatical features must be selected. Recall that in Greek adjectives are always marked for gender irrespective of the linguistic context in which they occur, unlike adjectives in, for example, Dutch or German, where the presence or not of a gender marker is conditioned by the co-occurrence of other gender-marked elements in the linguistic environment of the adjective. This is illustrated in examples (4.1-4.3) where Greek, Dutch and German noun phrases, with or without a definite determiner, are given.

(4.1) Greek

a. *το κόκκινο τραπέζι*	'the red table'
b. *η κόκκινη καρέκλα*	'the red chair'
c. *κόκκινο τραπέζι*	'red table'
d. *κόκκινη καρέκλα*	'red chair'

(4.2) Dutch

a. *de groene stoel*	'the green chair'
b. *het groene bed*	'the green bed'
c. *groene stoel*	'green chair'
d. *groen bed*	'green bed'

(4.3) German

a. *der rote tisch*	'the red table'
b. *das rote haus*	'the red house'
c. *roter tisch*	'red table'
d. *rotes haus*	'red house'

However, no information about the morphophonological form of the noun (its lexeme) is required. Thus, it is reasonable to assume that although adjective production requires access to the lemma properties of the noun, the form of the noun is activated only when the noun itself is produced. In order to generate such a pattern, we have to assume a lexical access model that allows a cut-off of information flow between the noun lemma and its phonemes when the latter are not required. It should be noted here, that most current models of language production do not subscribe to such a view. For example, in cascading activation models (e.g., Dell, 1986; Jescheniak & Schriefers, 1998; Peterson & Savoy, 1998), activation of a noun lemma will always lead to some activation of the corresponding word form, even when the form itself is not produced. Phonological activation of the noun's phonemes without noun production is also assumed by strict serial stage models, whereby the form of the noun becomes activated as a consequence of lemma selection (Levelt et al., 1999; Roelofs, 1992).

The issue of whether noun lexeme activation is implicated in adjective production is critical for the types of lexical effects that are likely to be obtained in the present task. Particularly, if lexeme activation is not instrumental in adjective production, lexical effects that have been shown to reside at the lexeme e.g., word frequency effects, lexical ambiguity effects,

phonological priming effects etc. should not be observed. Thus far, studies on anaphoric lexical access, which have largely focused on the processing of pronouns, have not yielded a consistent picture. For example, Simner and Smyth (1999) have shown that, in comprehension, anaphoric lexical access involves a guided search which targets a lexical entry at the level of the lemma and not at the lexeme, and that the word frequency effect is absent (although they allowed for incidental lexeme activation to take place). Contrary to this, Schmitt et al. (1999), who investigated anaphor processing during pronoun production, demonstrated that the phonological form of the replaced noun becomes activated, and that this activation is not a residual of the use of the noun in a preceding trial. The task they employed involved lexical decision during naming; participants had to name pictures of objects. On some trials, the naming process was disturbed by the presentation of an acoustic probe, in which case the participant had to postpone picture naming and to classify the probe as word or pseudo-word. The probe task made it possible to determine whether the form of a word was activated at a given moment in time. Schmitt et al. concluded that lemma access of a noun automatically entails activation of the corresponding word form, even when the form is not uttered because the noun is replaced by a pronoun. In sum, although the results from these studies have begun to illuminate lexical retrieval during anaphor processing, a number of issues pertaining to the conditions of adjective production remain unexplored.

4.2.4 Age-of-acquisition effects

Word frequency is widely believed to be an important determinant of the relative speed and accuracy of lexical access in speech production (e.g., Glaser, 1992; Griffin & Bock, 1998; Jescheniak & Levelt, 1994). Particularly, it has been shown that the less frequent a word is in a language (i.e., the less common its occurrence is), the longer it will take to name its pictorial representation. Word frequency has been shown to influence the retrieval of phonological word-forms (Jescheniak & Levelt, 1994). In spite of these well-attested findings, the validity of frequency measures as determinants of naming latencies has long been challenged. That is, it has been argued that frequency is subsumed by the more important variable of age-of-acquisition, and that it makes no independent contribution to the time required to name a picture (e.g., Gilhooly & Logie, 1980a,b; Morrison, Ellis, & Quinlan, 1992). Age-of-acquisition norms are taken to "reflect judgements of how early in life a particular word was learned, and they correspond well with empirical observations of word learning in children" (Bock & Griffin, 2000, p. 26). They are typically derived by asking subjects to use a rating scale to estimate the age at which they have learned a given

word. As with frequency, the age-of-acquisition effect has been shown to reside in the retrieval of phonological word-forms.

In the present study, we used age-of-acquisition scores because frequency counts for nouns in Greek were not available. To obtain these scores, we asked subjects to rate the age at which they believed they had learned certain nouns on a seven-point scale from 1 = *learned by age 2* to 7 = *learned at ages 13+*. Rate-age correspondences are shown Table (4.1) below. Every low-acquired (LA) word in our materials had a value of 2.5 or below on the scale i.e., it was thought to be learned by the age of four; every medium-acquired word (MA) had a value of 2.6-5 i.e., it was thought to be learned between the ages of four and nine; and every high-acquired word (HA) had a value of 5.1 or above i.e., it was thought to be learned after the age of nine. These cut-off points were taken from Morrison et al. (1992).

Table 4.1

Rating to Age-of-acquisition correspondences

Rate	AoA
1	0-2
2	3-4
3	5-6
4	7-8
5	9-10
6	11-12
7	13+

Although predictions about possible frequency effects in noun phrase production are commonly derived on the basis of frequency measures of the nouns, it has been recently shown (Alario, Costa, & Caramazza, 2001) that adjectives exhibit frequency effects as well, and that in noun phrases consisting of a determiner, an adjective and a noun, such as *the red chair*, the noun and adjective frequency effects are additive. Thus age-of-acquisition scores could have a variety of effects in the production of the target NPs in Experiments 1 and 2. One possibility is that adjective age-of-acquisition scores are the sole determinants of noun phrase naming latencies; this would be in line with the assumption that age-of-acquisition scores have consequences for the retrieval of phonological word-forms, and that, as a result, they are not found when the target noun is not actually produced. Another possibility is that (in line with Alario et al.'s proposal) noun and adjective age-of-acquisition scores jointly

determine noun phrase production latencies; this could follow from the assumption that there is no strict cut-off of information flow from the lemma to the lexeme, and that the word form of the noun is activated even when the noun itself is not produced, but also from the, rather implausible, assumption that the age-of-acquisition effect resides at both the lexeme and the lemma. Yet another possibility is that no age-of-acquisition effects are observed both because noun lexemes are not accessed and because age-of-acquisition effects may diminish and possibly disappear over repeated production of the adjective item set.

4.2.5 Gender priming and inflectional morphemes

The critical manipulation in the experiments to be reported in this thesis concerns the gender relation between prime and target. This relation is either one of identity (i.e., prime and target have the same gender), or one of difference (i.e., prime and target have different gender). The prediction derived from the Levelt et al. model is that the former relation should lead to shorter utterance onset latencies than the latter relation. A potential caveat here is that this prediction rests on the assumption that gender relations across prime and target do not covary with other types of lexical relations e.g., semantic, morphological or phonological. However, in the description of the gender system of Greek, I showed that such correspondences do exist, most notably that between gender and inflectional morphology. Therefore, greater speed in processing a target word when this is preceded by a word of the same gender may not constitute evidence that the abstract syntactic property that is shared between the prime and the target has been repeatedly accessed. Priming between same-gender words normally involves the partial repetition of morphological as well as of grammatical information, and these features together could determine the size of gender effects. For example, in the pair *γιακάς* – *κουβάς* 'collar $_{\text{MASC}}$ – bucket $_{\text{MASC}}$', the relation between prime and target is not solely one of gender identity but also one of inflectional suffix *-ας*, of number (singular), and of case (nominative) identity. Thus, disentangling the individual contribution of these components is critical for the understanding of how gender relations operate and of how they influence lexical access. In the following, we consider the possible influence of inflectional-suffix relations on the types of effects explored in this thesis.

The first question that we consider is: can overlap of inflectional-suffixes prime word production? A theoretical conclusion concerning the role of inflectional morphology can be drawn from the way morphological structure is represented in models of language production. The Levelt et al. model assumes an intermediate level of morphological representations between lexical-syntactic and phonological representations. In this level,

morphologically complex words are represented as combinations of component morphemes. Lexical decomposition is both theoretically and empirically motivated. Specifically, if morphemes are not stored with words in memory, they cannot be used in production; only decomposed form entries allow morphemes to be planning units. In speech errors, morpheme exchanges such as **slicely thinned* instead of *thinly sliced* (Stemberger, 1985) demonstrate that morphologically complex words are indeed generated on the basis of constituent morphemes. Similarly, aphasic performance is often characterised by problems with inflected words only. Morphological paraphasia, that is, the production of combinations such as **newing* or **discussionly*, shows that morphemes are available for combinatorial processes, which apparently can go astray (Badecker & Caramazza, 1991). It is therefore reasonable to assume that the language production system is sensitive to the morphological relationships between words, in the same way that it is sensitive to semantic and phonological relationships. This parallelism, in turn, entails that morphological overlap across two words should influence the processing of the second word, extrapolating from the kinds of effects that are commonly observed for semantic and phonological overlap (e.g., Meyer & Schriefers, 1991; Schriefers, Meyer & Levelt, 1990; Starreveld & La Heij, 1995; Wheeldon & Monsell, 1994).

Does morphological overlap in general, and inflectional overlap in particular, prime word production? It should be noted here, that evidence for the role of morphemes in production from experiments with normal subjects is still relatively rare. An exception to this is the research reported by Janssen (1999), Roelofs (1996a,b, 1998) and Zwitserlood, Bolte, and Dohmes (2000). In what follows, we briefly consider some of the basic findings, many of which have been obtained with the implicit priming paradigm. This paradigm involves the production of words from a list of previously learned paired associates. That is, participants learn to associate a particular word with a prompt word, e.g., to say *bible* in response to *religion*. After learning a number of such combinations, they are asked to produce the associated word upon presentation of the prompt only. The produced words form either heterogeneous or homogeneous sets. In a homogeneous set, the produced words share a morphemic component; in a heterogeneous set, this is not the case. A comparison of the production latencies for the same words in the homogeneous and heterogeneous sets can illustrate whether shared morphemic components influence production. Roelofs (1996a) showed that subjects exhibit a morphological priming effect due to shared initial morphemes e.g., *bypass*, *byway*, *bylaw*, that is significantly larger than the priming effect due to shared initial syllables e.g., *bible*, *biker*, *bypass*. Interestingly, however, no priming was obtained for shared, non-initial morphemes e.g., *subway*, *byway*, *leeway*. Morphologically complex

verbs of Dutch e.g., *zoek op* 'look up', were also produced faster in homogeneous sets than in heterogeneous sets, and here again the effect was restricted to the condition of initial-morpheme overlap only (Roelofs, 1998). Roelofs interpreted his findings as evidence for a process of morphological generation that proceeds incrementally from left to right, and that is not influenced by morphological headedness or 'underlying' word order (in the case of verbs with separable particles).

To assess the role of morphemes in production further, Roelofs (1996b) examined the influence of morpheme frequency in lexical access. Given that low-frequency morphemes take longer to retrieve from memory than high-frequency ones, the effect from response preparation should be larger for low-frequency morphemes than for high-frequency morphemes. The results confirmed this prediction; the priming effect that was obtained for shared initial morphemes of Dutch nominal compounds was larger when the morpheme was of low frequency than when it was of high frequency. This finding further supported the idea that the component morphemes of compounds are planning units in speech production. Otherwise, frequency effects for constituent morphemes should not be obtained.

Working within the same paradigm, Janssen (1999) replicated Roelofs' finding of a morphological priming effect with homogeneous sets when the response words had the same initial morphemes, but not when they had the same final morphemes. Particularly, he showed (Experiment 9) that a priming effect was absent not only for non-initial morphemes of the stem e.g., for the second morpheme of a compound noun like *street* in *bystreet* or of a complex verb like *zoeken* in *opzoeken* 'look up', but also for inflectional suffixes (here, the verbal past-tense inflections *-de* and *-te*). This observation confirmed the hypothesis of strict left-to-right encoding of the full inflectional word so that no preparation of the segments of the suffix is possible unless the verbal stem itself has been prepared.

Using a different methodology, Zwitserlood et al. examined the influence of morphologically complex and simple words on the production of morphologically complex and simple picture names, in five picture-word interference experiments in German. To separate pure effects of morphology from effects of form and semantic overlap, two variants of picture-word interference were employed. In the first variant, distractor words were presented concurrently with the pictures which had to be named. Morphological relatedness involved the plural form of words. Semantic distractors produced the expected interference. Morphological and phonological distractors also yielded facilitation, but the magnitude of the effect was much larger for morphological distractors. In the second variant, distractors

and pictures were separated by a lag of seven to ten intervening trials. Here, morphological relatives again produced facilitation, but no effect was found for semantic and phonological distractors. Thus, the delayed variant revealed a dissociation of these effects. In the last experiment, distractors from different morphological classes were investigated. They were either inflected e.g., *blumen* 'flowers', derived e.g., *blumig* 'flowery', or compounded e.g., *blumentopf* 'flowerpot' variants of the picture name e.g., 'flower'. Note that these distractors shared a free morpheme with the picture name, but differed from the latter at the conceptual and the lemma level. The results from this experiment showed that all three types of distractors had the same facilitatory effect on picture naming despite the differences in the degree of semantic similarity between the distractor types and the target.

What are we to conclude about the potentially confounding role of morphological information in the present manipulation of gender relatedness across prime and target? The results presented above show that there is a level of morphemes that serve as planning units in production. Implicit and explicit primes yielded similar findings, namely that there is facilitation in the production of a word as a result of advance knowledge about its first constituent morpheme but no facilitation as a result of advance knowledge about non-initial morphemes. Because words are encoded incrementally, from left to right, the preparation and phonological encoding of inflectional suffixes cannot start before the segments of the stem itself are prepared. Accordingly, our gender manipulation should be insensitive to inflectional-suffix overlap across prime and target, despite the non-negligible correlations in Greek, between gender classes and inflectional markers. That is, there should be no greater impact on the target by a same-gender prime with the same inflectional suffix e.g., *χάρτ-ης, φράχτ-ης* 'map – fence', than by a same-gender prime with a different inflectional suffix e.g., *χάρτ-ης, γιακ-άς* 'map – collar'. More importantly however, finding no response-time benefit for shared non-initial morphemes is critical for excluding the possibility that apparent lexical-syntactic gender priming is in fact, morphological priming.

We conclude this section by noting that in the studies reviewed above, morphological relatedness was largely confounded with semantic relatedness, and, to a lesser extent, with syntactic relatedness. A prime-target pair of the form *dogs – dog* arguably exhibits both semantic and morphological overlap. This confound is inherent in most studies of morphology, in both comprehension and production, in which morphological relatedness almost invariably involves stem-morpheme identity. Stems carry primarily semantic information. By contrast, inflectional morphology has, in many languages, a primarily grammatical or syntactic function, marking properties such as number, case, aspect, tense,

person etc. Inflectional morphemes are intimately bound up with the syntactic representation of an utterance. However, even in the case of inflectional-morpheme overlap, relatedness in other levels of representation is not entirely eliminated (e.g., the plural *-s* or the progressive *-ing* marker have both conceptual- and syntactic-level correlates). Of course, the above-mentioned distinction between stems and inflectional morphemes is one of relative degrees of specialisation of function.

4.3 Experiment 1: (Definite determiner + noun) Primes – (Colour adjective) Targets

In this experiment, we test whether the production of a definite determiner + noun prime influences response latencies to a colour-adjective target of the same or of a different gender. Specifically, two assumptions of the Levelt et al. model are examined: first, that the gender feature of a word becomes selected when agreement has to be computed (in the prime), and second, that the time-course of subsequent word retrieval is modulated as a function of the same gender feature having to be reselected (in the adjective target) or not. Note that in the present task both utterance formats ensure that the gender feature is selected: for the choice of the correct determiner form in the prime, and of the correct inflectional suffix in the target. If grammatical gender selection during production of the prime influences gender reselection during production of the target, one would expect that response latencies to targets preceded by same-gender primes e.g., *χάρτης* MASC – *κόκκινος* MASC 'map – red' should be systematically lower than the corresponding latencies to targets preceded by different-gender primes e.g., *σύννεφο* NEUT – *κόκκινος* MASC 'cloud – red'.

4.3.1 Method

Participants. Thirty-two volunteers, native speakers of Greek, from the University of Athens community, participated in this experiment. Their ages ranged from 19-30 years.

Materials. Two sets of pictures, a set of experimental items and a set of filler items, were selected. The experimental set comprised a total of 128 pictures[3]. Sixty-four pictures depicting 32 masculine and 32 neuter nouns served as targets. The choice to use masculine and neuter nouns in the critical prime and target trials was motivated by the intention to use the same set (or at least, a subset) of experimental items in all the experiments to be reported in this thesis, and hence was motivated by considerations regarding the appropriateness of

[3] I thank Linda Wheeldon for allowing me to use her picture database.

the choice of particular gender classes in subsequent experiments. Particularly, the distinction between masculine and neuter nouns, as opposed to masculine and feminine or neuter and feminine, was thought to serve best the purposes of Experiments 5 and 6, which will investigate the role of formal case distinctions relative to gender. Masculine singular nouns distinguish nominative and accusative formally, feminine singular nouns do not have distinct forms for the two cases but mark the relevant distinction on the determiner, and neuter singular nouns do not mark the nominative-accusative distinction neither in their form nor in the form of any other agreeing element. Thus, in this respect, masculine and neuter nouns appear to be maximally distinct and therefore, most appropriate to examine the effect of formal markers in case distinctions. Masculine and neuter target nouns were matched for age of acquisition (AoA) ($t < 1$); they all belonged to the medium AoA range, with the exception of two masculine and two neuter nouns that were of low AoA. Targets were combined with the remaining 64 pictures of comparable objects, which served as primes. Half of the primes had masculine, and the other half had neuter names. Care was taken not to introduce unwanted phonological or semantic overlap between a prime and target response. Target pictures appeared in one of the following four colours: red, green, orange and light blue. Each picture appeared in one colour only. Across the sixteen different pictures within each priming condition, all four colours were used equally often. Prime pictures appeared in black-and-white only. See Table 4.2 for examples of the resulting prime-target combinations, and see the Appendix for a complete list of the materials used.

Table 4.2

Example materials from Experiment 1

P – T gender	Prime		Target	
masc – masc	ο χάρτης *o hartis*	(the map)	πράσινος [τοίχος] *prasinos [tihos]*	(green [wall])
neut – masc	το κλειδί *to klidi*	(the key)	πράσινος [τοίχος] *prasinos [tihos]*	(green [wall])
neut – neut	το κλειδί *to klidi*	(the key)	πράσινο [τούβλο] *prasino [tuvlo]*	(green [brick])
masc – neut	ο χάρτης *o hartis*	(the map)	πράσινο [τούβλο] *prasino [tuvlo]*	(green [brick])

Note. P = prime; T = target; masc = masculine; neut = neuter. The words in square brackets are not overtly produced. The words in italics are broad phonological transcriptions of the Greek words.

Sixty-four pictures with feminine names were used as fillers in the trials preceding the prime-target pairs. Half of the filler pictures appeared in black-and-white, and the other half

in colour. Thus, the pre-prime naming response was either of the same type as the prime response (i.e., definite determiner + noun), or of a different type (i.e., gender-inflected colour adjective). Feminine nouns belonged mainly to the low and medium AoA ranges. A further set of fifteen pictures with names from the three gender classes was selected to serve in the practice trials. This resulted in a total of 207 pictures.

Design. Experiment 1 had four experimental conditions, which resulted from the combination of the factors Gender Identity (the prime and target had either the same or different gender; within participants, within items) and Target Gender (masculine or neuter; within participants, between items). Four experimental lists were constructed such that, within each list, 16 of the 64 target pictures occurred in each one of the four conditions, and each target picture occurred only once. Across the four lists, each target item occurred once in each condition. The order of trial presentation was randomised for each participant, with the constraint that a filler item would always intervene between two prime-target pairs. Each experimental list consisted of 192 trials (64 prime trials, 64 target trials, and 64 filler trials), presented in a single block.

Procedure. An experimental session lasted approximately 40 minutes. Participants were tested individually. They were seated in a quiet room, at a distance of approximately 60 cm from a computer screen (Macintosh G3 PowerPC) on which the pictures were presented. Pictures were displayed centered on the screen, as black-and-white or colour drawings, on a light gray background. Display size of the pictures was approximately 10 x 10 cm. Presentation of the picture stimuli and collection of the response-time data were controlled by the PsyScope 1.2.1 experimental software (Cohen, MacWhinney, Flatt, & Provost, 1993). Participants responded into a microphone, and speech onset latencies were measured by a voice key connected to the computer. Each session was recorded on tape. Because every colour adjective served as its own control, phonetic effects on voice key operation were controlled for.

Before the experiment proper, participants were given written instructions indicating that they would see black-and-white and coloured pictures of objects. Their task would be to name these objects by means of definite determiner + noun NPs, e.g., *ο χάρτης* 'the map', or colour adjective NPs, e.g., *κόκκινος* 'red $_{\text{MASC}}$', respectively. These instructions were then summarised by the experimenter, who stressed the fact that response speed and accuracy were particularly important. Subsequently, participants were familiarised with the materials to be used in the experiment; in a preview block, all pictures were shown in black-and-white

together with their names. They were presented for 2s, after which the name appeared underneath the picture. Participants were asked to think of the name of the picture as soon as the picture was presented, to compare the name they had thought of to the intended name as soon as the latter appeared below the picture, and to pay extra attention to the intended name if it differed from the one they had thought of. They were asked to use these picture names during the experiment. At this stage, no overt response was required. Participants could either initiate the next preview trial by pressing a button, or wait for each trial to self-terminate (at 6s after picture onset). In addition, they were shown four squares on the computer screen, in the four colours to be used in the experiment. They were given the corresponding colour names, and were asked to use these during the experiment. After the instructions, participants performed fifteen practice trials.

The structure of an experimental trial was as follows. First, a fixation point (an asterisk) appeared for 200 ms, after which the screen was cleared for 600 ms. The picture was then displayed. Pictures remained on the screen until a response was provided, or for a maximum of 2s. When a response was provided, the picture disappeared from the screen at voice onset. The screen was then cleared for another 1.5s (inter-trial interval), after which the next naming trial began. A voice key measured response latencies from the onset of the stimulus to the beginning of the naming response.

Analyses. Five types of responses were classified as errors: (a) production of a wrong prime name; (b) production of an incorrectly inflected adjective; (c) production of a wrong colour adjective; (d) production of a target noun instead of adjective; and (e) verbal disfluencies in target trials e.g., stuttering, utterance repairs, production of non-verbal sounds that triggered the voice key, outlying response times (less than 300 or more than 2000 ms), and voice key failures. In this and in all subsequent experiments, target responses were not classified as errors if the prime response involved a verbal disfluency e.g., stuttering. The reaction times (RTs) of erroneous responses were excluded from further analyses. Responses that deviated by more than 2.5 SDs from a participant's (.016) or an item's mean (.005) were replaced by the participant or the item mean +/- 2.5 SDs, respectively. ANOVAs were performed on error rates and response latencies, as a function of Gender Identity (same or different gender between prime and target), and Target Gender (masculine or neuter). Separate analyses were carried out with participants and items as random variables, yielding F_1 and F_2 statistics, respectively. All effects reported to be significant were reliable at least at the .05 level. *F*-ratios that approached significance are reported as well; when not reported their probability was .10 or higher. Subsidiary correlation analyses were carried out between mean response

latencies and gender priming in order to explore potential differences in the magnitude of gender priming in different response-time ranges.

4.3.2 Results

Erroneous responses (15.1%) were distributed as follows: 2.2% for wrong prime name production; 3.4% for incorrectly inflected adjectives; 0.7% for wrong colour adjectives; 2.4% for the production of a target noun instead of adjective; and 6.4% for verbal disfluencies, outlying responses, and voice key malfunctioning. Table 4.3 displays mean response latencies and error rates as a function of Gender Identity, first collapsed over the two genders, and then for each gender separately. Every mean shown is an average over the mean response time and percentage errors of 32 subjects, each responding to 64 items.

Table 4.3

Effects of determiner + noun prime gender on colour adjective target naming: Mean response latencies (ms), number of valid observations and error rates as a function of Gender Identity and Target Gender (Experiment 1)

	Target Gender								
	masc & neut			masc			neut		
G-Ident	RT	n	e %	RT	n	e%	RT	n	e%
Same G	1202	867	15.2	1195	420	18	1208	447	12.5
Diff G	1239	871	14.8	1235	424	17.2	1243	447	12.5
G effect	37		-0.4	40		- 0.8	35		0

Note. Masc = masculine; neut = neuter; G-Ident = gender identity; Same G = same gender; Diff G = different gender; G effect = gender effect.

Target-utterance onset latencies provided evidence for gender priming: producing a gender-marked target response such as *κόκκινος* 'red $_{\text{MASC}}$' was faster after a same-gender prime response such as *ο χάρτης* 'the $_{\text{MASC}}$ map $_{\text{MASC}}$', than after a different-gender prime response such as *το φύλλο* 'the $_{\text{NEUT}}$ leaf $_{\text{NEUT}}$'. Specifically, there was a 40 ms advantage in the production of masculine targets, and a 35 ms advantage in the production of neuter targets. The overall gender priming effect (37 ms) was highly significant (main effect of Gender Identity), F_1 (1,31) = 12.09, MS_E = 3636, p = .002; F_2 (1,62) = 12.22, MS_E = 5434, p = .001. The main effect of Target Gender and the interaction between Gender Identity and Target Gender were not significant (all Fs < 1). The correlation analysis revealed that longer mean production latencies for targets were associated with larger priming effects, r = .47, N = 64, p < .01. Age-of-acquisition, when introduced as a covariate, had neither an independent effect (F < 1), nor an effect on priming, F (1,61) = 2.72, p = .104.

The corresponding analysis of errors showed a significant main effect of Target Gender, F_1 (1,31) = 8.65, MS_E = 2.257, p = .006; F_2 (1,62) = 4.54, MS_E = 4.301, p = .037, reflecting the higher proportion of errors observed with the masculine than with the neuter colour adjectives. Given that the actual response set was the same for the two genders, that is, the same four colour names were used in both cases, this was an unexpected finding. However, the key for understanding this discrepancy could lie in the fact that the 'default' gender of colour names in Greek is the neuter. Thus, if colour adjectives do not modify some other word, then they agree in gender with the noun *χρώμα* 'colour', which is neuter, as for example in the phrase *μου αρέσει το κόκκινο* 'I like the red $_{\text{NEUT}}$ (colour)'. As the default or the unmarked colour gender, the neuter is less prone to error, while the masculine and feminine colour names are more marked ones. The main effect of Gender Identity and the interaction between Gender Identity and Target Gender were not significant (all Fs < 1). Further analyses of the conditions of occurrence of erroneous responses revealed that Type B errors, that is, the production of incorrectly-inflected colour adjectives, occurred more often after a same-gender prime both for masculine (n = 31) and neuter (n = 16) targets than after a different-gender prime (n = 17, and n = 6, respectively). Therefore this type of error is not likely to have occurred due to interference or to some form of attraction from the different gender information of the prime. Rather, most of these 'mis-affixation' errors were in fact correct adjectival inflections marking gender agreement with some alternative name of the picture, and not with the one indicated in the preview of the experiment. Finally, because error percentages were comparable in the two priming conditions across the two genders, the errors do not indicate a speed-accuracy trade off.

4.3.3 Discussion

The present experiment provides evidence for a response-time benefit in the production of gender-marked adjectives from same-gender definite determiner NPs as compared with different-gender NPs. Two aspects of the results are of main theoretical importance. First, the benefit obtained from advance access to gender information confirms the predictions of Levelt et al.'s model concerning the role of gender in production. Thus, our interpretation of the present results is as follows: in the prime, gender is selected for the production of a noun phrase that involves the computation of agreement (here, the specification of the correct form of the determiner). In the target, gender is also selected for the specification of the correct form of the adjective. If target gender is the same as prime gender, its reselection is facilitated as a result of its earlier selection. Experiment 1 was designed to study the role of gender under conditions that increased the likelihood of gender priming. That is, both prime

and target utterances involved the computation of agreement, hence the selection, as opposed to the mere activation, of a gender node. Recall of course, that according to Levelt et al., gender selection should be facilitated even by prior activation of the same gender. We will return to this issue in Experiment 2.

Second, the present results provide evidence for the nature of the information that is drawn upon and for the possible loci of the gender effect. Particularly, given that prime and target involve different utterance formats, and that, in each case, gender determines the form of a different agreement-target type (of the definite determiner in the former, and of the adjectival inflectional suffix in the latter), we conclude that gender priming is not contingent upon the class-identity, let alone the form-identity, of agreement targets. This converges with related evidence and with Levelt et al.'s proposal, insofar as it shows that gender is represented as an abstract lexical-syntactic property that is clearly distinct from form-level representations, and that the computation of gender agreement draws on information from this abstract level of grammatical processing. Furthermore, again because of the difference between the prime- and target-utterance formats, we conclude that gender priming is not contingent upon the identity of processes involved in the production of noun phrases. Specifically, although there is good reason to believe that there are broad similarities in the processes underlying prime and target production, most notably the process responsible for the computation of agreement, there are also differences which result in the two distinct noun-phrase types.

The presence of gender priming across different agreement-target types supports Levelt et al.'s claim of a single abstract node for each grammatical gender, shared by all nouns of the same gender, but also extrapolates it to the representation of different word categories (here, to determiners and adjectives). Recall that the assumption of one shared gender node for each gender class has been critical for the interpretation of gender priming. Thus, on the basis of our findings, it appears to be reasonable to assume that not only words of the same category e.g., determiners, but also words of different categories e.g., nouns, determiners, adjectives etc., with the same gender, are all connected to a single gender node. Viewed in terms of the inherent- versus non-inherent-feature distinction, this would imply that not only same-gender words with inherent gender i.e., nouns, but also same-gender words with non-inherent gender e.g., determiners, adjectives, pronouns etc., are all connected to a single gender node. As noted earlier, Levelt et al.'s proposals are largely restricted to the representation of nouns, and do not explicitly address the issue of gender representation in words with non-inherent gender. In fact, even in the present context, it appears to be rather difficult to determine the precise nature of the connection between a word with non-inherent

gender and a gender node, as it is difficult to infer it from the format of the eventual utterance or from the time it takes to initiate it. Thus, although on one account same-gender words, with inherent or non-inherent gender, are all directly connected to a single gender node, on a different account, words with non-inherent gender should not bear any direct connections to gender nodes. Rather, they should be connected to the latter only indirectly, through the nouns (or through any other inherently marked lexical elements) with which they agree. Nevertheless, we can be sure from our present results that they are connected in some way.

Throughout the discussion thus far, care has been taken not to confound the issue of gender priming i.e., the presence or not of an influence on the retrieval of a word from the preactivation of its gender, with the more intriguing issue of the relative directionality of the effect i.e., with the interpretation of gender priming as being facilitatory or inhibitory. In what follows, we attempt to address this issue. Critical for the distinction between facilitation and inhibition is the specification and use of a neutral baseline. According to Jonides and Mack (1984):

> Two comparisons can be made against this baseline, one for the valid trials to assess a benefit in performance that may accrue with an informative cue, and one for the invalid trials that could show a cost in performance due to an informative but misleading cue. If the neutral and informative cues result in reliably different performance, one can argue for a selective preparatory effect of the informative cue that is different from, or at least added to, the general warning effect that might be produced by a neutral cue (p. 30).

How then is gender priming to be interpreted in the present context? Particularly, does the difference in production latencies between targets preceded by a same-gender prime and targets preceded by a different-gender prime reflect a processing benefit (facilitation) for the former type of target over the latter, or does it reflect a processing cost for the latter type of target over the former? Given here that prime and target are structurally unrelated and cannot form a grammatical sequence, it is reasonable to assume that prior gender information could not selectively prepare participants to process the target more efficiently by, for example, restricting the set of potentially upcoming words to those that were consistent with this gender (as, in fact, would be the case in syntagmatic priming), nor could it provide them with misleading information; a pair in which prime and target did not have the same gender was no less grammatical than a pair in which prime and target had the same gender. Similarly, a different-gender prime was no more invalid than a same-gender prime. It appears therefore that, in the present context, Jonides and Mack's proposal does not offer a way to identify

possible positive or negative gender effects, insofar as it rests on the assumption of a neutral baseline as its starting point.

The direction of the effects in gender priming can be more readily explained with reference to the Levelt et al. model in which the need for a neutral baseline against which facilitation and inhibition can be measured is eliminated. Thus, according to Levelt et al., gender priming reflects facilitation in the selection of a gender node. Facilitation speeds up response latencies. On this account, the shorter response latencies obtained for same-gender prime-target pairs should be taken to reflect facilitation relative to the condition in which prime and target had different genders. Although this explanation appears to be plausible, our findings could also be accommodated by an alternative account, one that would assume inhibition rather than facilitation. Specifically, if gender nodes are not independently represented, but are instead interconnected forming a subnetwork within the lexical network as suggested by Caramazza (1997), and if the connections between the nodes in a subnetwork are inhibitory, then selection of a gender node would automatically suppress or inhibit the selection of the other nodes. Consequently, in different-gender prime-target pairs, the production of the target should be delayed due to suppression of its gender by the prior selection of a different gender. The difference in production latencies obtained with the present task would then reflect inhibition for different-gender prime-target pairs, rather than facilitation for same-gender pairs. To conclude, the different accounts that we reviewed all fall short of unambiguously identifying the direction of the effects in gender priming. For present purposes, given that the Levelt et al. model has served as the general framework for this thesis, we will adopt the account that derives from this model, and will assume that same-gender prime-target pairs lead to facilitation.

A different aspect of the results that is of interest concerns the significant positive correlation between mean production latencies and the magnitude of the gender priming effect; the reaction-time benefit from prior gender information increased with longer production latencies. If reaction-time differences reflect variation in processing demands, and if longer reaction times reflect greater processing demands, then we can conclude that greater benefit from advance gender information is obtained where there is greater cost associated with the task demands. On the other hand, the absence of an age-of-acquisition effect is compatible with the assumption that word-form information is not retrieved when the words are not eventually produced, suggesting that lexical processing can be 'shut off' between the lemma and word form levels.

In sum, Experiment 1 demonstrated that gender priming effects can be found between definite determiner + noun NPs and adjectives, as predicted by Levelt et al.'s model. In Experiment 2, we examine whether gender priming effects can be found in another context, between bare nouns and adjectives, in which unlike Experiment 1, production of the prime does not involve gender selection.

4.4 Experiment 2: (Bare noun) Primes–(Colour adjective) Targets

The aim of Experiment 2 is the same as that of Experiment 1: to obtain empirical evidence on the role of prior gender information in the production of gender-marked utterances. The black-and-white/colour picture-naming task of Experiment 1 is maintained, but a different type of prime NP is involved. Specifically, participants are instructed to name black-and-white pictures by means of bare nouns. For the critical target trials, they have to produce, as in the previous experiment, gender-inflected colour adjectives.

As discussed earlier, according to Levelt et al. gender priming should be obtained only when the target utterance involves the computation of agreement, that is, when a gender node has to be selected for the specification of the correct form of a gender-marked element. It should not be obtained in 'pure' object naming, that is, when the target utterance involves the production of bare nouns. Of course, bare noun production can boost the level of activation of a gender node, and can therefore induce priming if the same gender node has to be subsequently selected. In the previous experiment, in order to increase the likelihood of obtaining a gender effect we ensured that both prime and target utterance formats required not merely the activation but also the selection of a gender node.

In Experiment 2, we attempt to qualify further the effects found in the first experiment relative to the activation-selection distinction. Particularly, we examine whether mere activation of the prime gender implicit in bare noun production, can still induce priming. In the Levelt et al. model, the predictions derived for the two experimental manipulations are not clearly distinguished. Specifically, it is assumed that both prime types i.e., Determiner + noun, and bare noun can potentially induce priming, the critical operation being the computation of gender agreement in the target. Importantly also, the model does not clearly predict any modulation in the magnitude of the gender effect as a function of prime type; both bare noun and Determiner + noun primes should yield equal amounts of priming as long as the target variable is held constant. This is somewhat counter-intuitive given that the activation-selection distinction, which roughly corresponds here to the distinction between bare noun and Determiner + noun production, should reflect quantitative and/or qualitative

differences in the processing of gender. Thus for example, if a critical difference between activation and selection is that selection is binary (with the implication that a criterial activation level has to be reached for selection to take place), whereas activation is graded, one might expect priming effects to vary as a function of the level of activation of the prime gender if the node is merely activated; by contrast, selected nodes might always induce the same degree of priming insofar as all selected nodes will be activated to the same degree.

Furthermore, one should bear in mind that although in Dutch the activation-selection distinction is held to be reflected in the processes involved in the production of bare nouns and gender agreement targets respectively, it is an empirical issue whether this distinction is reflected in the production of the same types of NPs in different languages. Thus for example, in the previous chapter (section 3.2.2) we considered some nouns in Greek e.g., *αδερφ-ός* MASC – *αδερφ-ή* FEM 'brother – sister', *ανθρωπάκ-ος* MASC – *ανθρωπάκ-ι* NEUT 'little man', *γλωσσ-άς* MASC – *γλωσσ-ού* FEM 'babbler' which, on a certain account, could be viewed as counter-examples of Levelt et al.'s claim that noun lemmas are inherently specified for a particular gender value. On the assumption that a specification of gender has to be made for the choice of the appropriate inflectional or derivational suffix, we argued that not only gender activation but also gender selection is likely to be implicated in the production of these nouns, in the same way that it is implicated in the production of agreement targets. A similar claim regarding the processing of gender during bare noun production could be made for most nouns in Greek given that, unlike in Dutch, they are gender-marked. Therefore, if Experiments 1 and 2 produce similar patterns of results, these can be attributed either to analogous effects on the target of gender-activation and gender-selection in the prime or, more interestingly, to similar gender selection processes in the production of prime NPs with and without determiners in Greek.

4.4.1 Method

In this experiment, native speakers of Greek were instructed to name black-and-white pictures by means of bare nouns, and coloured pictures by means of gender-inflected colour adjectives.

Participants. Sixteen volunteers, native speakers of Greek, from the University of Athens community, participated in the experiment. Their ages ranged from 19-26 years. None of them had participated in Experiment 1.

Materials, Design. Materials and design were the same as in Experiment 1.

Table 4.4

Example materials from Experiment 2

P – T gender	Prime	Target
masc – masc	χάρτης (map) *hartis*	πράσινος [τοίχος] (green [wall]) *prasinos [tihos]*
neut – masc	κλειδί (key) *klidi*	πράσινος [τοίχος] (green [wall]) *prasinos [tihos]*
neut – neut	κλειδί (key) *klidi*	πράσινο [τούβλο] (green [brick]) *prasino [tuvlo]*
masc – neut	χάρτης (map) *hartis*	πράσινο [τούβλο] (green [brick]) *prasino [tuvlo]*

Note. P = prime; T = target; masc = masculine; neut = neuter. The words in square brackets are not overtly produced. The words in italics are broad phonological transcriptions of the Greek words.

Procedure. The procedure was identical to that of Experiment 1, except that participants were instructed to name the black-and-white pictures by means of NPs that consisted of a bare noun. Each experimental session lasted approximately 40 minutes.

Analyses. Errors and extreme reaction times were treated in the same way as in Experiment 1. ANOVAs were performed on error rates and response latencies as a function of Gender Identity (same or different gender between prime and target), and Target Gender (masculine or neuter).

4.4.2 Results

Erroneous responses (13.5%) were distributed as follows: 1.6% for wrong prime name production; 2.7% for incorrectly inflected adjectives; 1.6% for wrong colour adjectives; 2% for the production of a target noun instead of adjective; and 5.6% for verbal disfluencies, outlying responses and voice key malfunctioning. Table 4.5 displays mean response latencies (ms), number of valid observations, and error rates as a function of Gender Identity, first collapsed over the two genders, and then for each gender separately. Every mean shown is an average over the mean response time and percentage errors of 16 subjects, each responding to 64 items.

Table 4.5

Effects of bare noun prime gender on colour adjective target naming: Mean response latencies (ms), number of valid observations, and error rates as a function of Gender Identity and Target Gender (Experiment 2)

	Target Gender								
	masc & neut			masc			neut		
G-Ident	RT	n	e %	RT	n	e%	RT	n	e%
Same G	1138	449	12.5	1135	218	15	1140	231	10
Diff G	1179	437	14.5	1178	217	15	1180	220	14
G effect	41		2	43		0	40		4

Note. Masc = masculine; neut = neuter; G-Ident = gender identity; Same G = same gender; Diff G = different gender; G effect = gender effect.

The analyses of target-utterance onset latencies provided evidence for gender priming: producing a gender-marked target response such as *κόκκινος* 'red $_{MASC}$' was faster after a same-gender prime response such as *χάρτης* 'map $_{MASC}$', than after a different-gender prime response such as *φύλλο* 'leaf $_{NEUT}$'. Specifically, there was a 43 ms advantage in the production of masculine targets, and a 40 ms advantage in the production of neuter targets. The overall gender priming effect (42 ms) was highly significant (main effect of Gender Identity), F_1 (1,15) = 6.67, MS_E = 4139, p = .02; F_2 (1,62) = 4.69, MS_E = 11347, p = .034. The main effect of Target Gender and the interaction between Gender Identity and Target Gender were not significant (all Fs < 1). A correlation analysis between mean production latencies and gender priming showed larger priming effects with longer production latencies, r = .71, N = 64, p < .001. Age-of-acquisition, when introduced as a covariate in the items' analysis, was without effect, F (1,61) = 2.88, p = .095. The corresponding analyses of errors did not show any significant effects. Furthermore, unlike in Experiment 1, the analyses of the conditions of occurrence of erroneous responses revealed that the production of incorrectly-inflected colour adjectives occurred as often after a same-gender prime both for masculine (n = 11) and neuter (n = 3) targets as after a different-gender prime (n = 10 and n = 4, respectively). As in Experiment 1, most of the 'mis-affixation' errors were correct adjectival inflections marking gender agreement with some alternative name of the picture presented.

4.4.3 Discussion

Experiment 2 replicated the main finding of Experiment 1 for a different type of prime NP; participants were faster to produce a gender-inflected colour adjective after having produced a bare noun of the same gender than after having produced a bare noun of a different gender.

Thus, as in Experiment 1, advance information about the gender of the target, provided by the production of the prime, led to a reaction-time advantage for same-gender NPs compared with different-gender NPs. The current results further confirm the predictions derived from the Levelt et al. model according to which gender priming is obtained when the target NP involves the computation of agreement and therefore, a gender node has to be selected. Furthermore, they show that the gender effect is obtained with a prime NP that does not involve the computation of agreement. However, the precise 'source' of the gender effect in the processes underlying the production of bare nouns is still unclear. As we have seen, there are two possibilities. First, it could be that only in the production of the target is the activation-selection distinction critical for the presence or absence of gender priming. On this account, gender selection in the target should be equally influenced by the prior activation or selection of the same gender node. This is the assumption made by Levelt et al. Alternatively, it could be that there is cross-linguistic variation in the processes involved in the production of noun phrases, and that the formulation, for Dutch, of the activation-selection distinction in terms of the processes involved in the production of bare nouns and gender-marked lexical elements respectively, does not apply equally to the production processes in other languages. This would support our suggestion that because many nouns in Greek are gender-marked, their production could involve not merely the activation but also the selection of the appropriate gender node.

The question of the precise 'source' of priming relative to the processes involved in prime production could be addressed by comparing the magnitude of the reaction-time advantage for the two prime conditions. Particularly, any difference in the size of the effect between the different prime conditions could be taken to reflect the differential impact of gender activation versus gender selection or, as suggested in section 4.4, the differential impact of varying degrees of activation/selection. In general, comparisons of effect size across experiments are not straightforward. In the present case, the comparison of the gender effect between Experiments 1 and 2 is partly warranted by the fact that precisely the same set of items was used in both experiments, and the same manipulations were included. A potential caveat however, concerns the differnce in grand mean between the two experiments, and the significant correlation between mean reaction times and gender priming. With these issues as background, two questions are addressed. First, we attempt to examine whether the gender effect in the first experiment (37 ms) is larger than the respective effect in the second experiment (41 ms), although descriptively the reverse appears to be the case, and second, we compare the overall performance between the two experiments.

To answer these questions, the items from the two experiments were submitted to an ANOVA with three factors: Gender Identity (same or different gender, within items), Experiment (1 or 2, within items), and Target Gender (masculine or neuter, between items). The analysis showed a significant main effect of Gender Identity, F (1,62) = 12.70, MS_E = 9393, p = .001, but a non-significant interaction between Gender Identity and Experiment (F < 1), thus confirming the observation of a descriptively similar pattern of results between the two experiments. Furthermore, the observed difference (58 ms) in the overall performance between the two experiments (1218 ms mean RT in Experiment 1, and 1160 ms mean RT in Experiment 2) produced a significant main effect of Experiment, F (1,62) = 24.01, MS_E = 9133, p < .001; the mean reaction times for both primed and unprimed items were significantly different between the two experiments, t (1,63) = 3.69, p < .001, and t (1,63) = 3.65, p = .001, respectively. The fact that the interaction between Gender Identity and Experiment was not significant despite the difference in the overall performance between the two experiments, and the repeatedly observed correlation of longer production latencies with larger priming effects, suggest strongly that the processing of the different types of primes had a similar effect on the production of the target. However, a within-experiment comparison of the effect size associated with each type of primes is still required before the issue at hand can be resolved.

In summary, as in Experiment 1, the results from the present experiment provided converging evidence for the claim that advance access to the gender of a word leads to a reaction-time advantage in the production of that word; target responses were faster after a same-gender prime than after a different-gender prime. However, in addition, the gender effect was now shown to obtain for prime NPs that did not involve the computation of agreement. Finally, a comparison of the present experiment with Experiment 1 did not show any significant reduction in the priming effects when definite determiner + noun primes were replaced by bare noun primes.. Thus far, however, a single type of target response has been used. In the next two experiments, we attempt to evaluate further the conditions under which gender priming can be obtained by looking at different types of target NPs.

4.5 Experiment 3: (Bare noun) Primes – (Indefinite determiner + noun) Targets

The aim of Experiment 3 is to discover whether the gender effect can be replicated for target NPs consisting of an indefinite determiner + noun. If gender priming also occurs for indefinite determiner + noun NPs, then we can conclude that the effect is independent of

whether gender information conditions the selection of a free-standing lexical element (here, of the indefinite determiner), or of a bound morpheme (e.g., the adjectival inflection) in the target utterance. The theoretical reason for expecting potentially distinct patterns of results has to do with the distinction that is commonly drawn in the production literature between the two types of closed-class elements (e.g., Bock, 1989; Bock & Levelt, 1994; Caramazza & Hillis, 1989; Lapointe & Dell, 1989). Thus for example, in Lapointe and Dell's model, the assumption is that the inflectional affixes are intrinsic features of the grammatical frame, which serve to define as well as to mark the functions and grammatical relations of the open-class words. By contrast, the free-standing function words (e.g., the determiners and auxiliaries) are not given directly in the frame; rather, they have to be inserted to it, as is also the case for the open class words. Despite this apparent similarity, Lapointe and Dell maintain in their model the distinction between open-class and free-standing function words by assuming distinct operations for their insertion in frames. Specifically, although there is competition among all major lexical stems and selection of the most highly activated stem node for a given stem slot, the selection of function words is 'competitionless'. This is so because function words are directly associated with function word fragments, and for each designated function word slot there is only one filler. However, during phonological encoding, open class and function words undergo the same operations suggesting that both should be equally prone to phonological errors.

Levelt et al.'s treatment of most function words also distinguishes them from inflectional affixes. Specifically, the selection of function words resembles the selection of open-class words in that both involve lemma selection. Each function word has its own lemma, that is, its own syntactically specified, abstract representation; the latter can be selected in just the same way that is proposed for the selection of the lemmas that correspond to open-class words (that is, through the selection of a lexical concept), insofar as it is used to express a grammatical as well as a semantic content. By contrast, inflectional affixes do not have their own lemmas; rather, they are always 'indirectly elected' through the specifications that other word lemmas carry about the closed-class elements that can or must accompany them. In Levelt et al.'s terms, inflectional affixes are generated on the basis of a lemma's diacritics and inherent properties.

Given the difference in the mechanism by which the morphosyntactic representations of determiners and adjectival inflections are supposed to be selected, there is good reason to assume that prior gender information will not affect their production in the same way. Thus far, empirical evidence on the difference in the behaviour of free-standing function words

and affixes has mainly come from speech-error data (e.g., Dell, 1990) and aphasic performance (e.g., Caramazza & Hillis, 1989; Lapointe, 1985). For example, in an analysis of the speech of Italian- and English-speaking aphasics, Lapointe noted that unlike function words which tended to be omitted, affixes tended to be replaced with other affixes. The question to be addressed here, then, is whether the gender effect that was obtained for inflectional suffixes in the adjective targets can also be obtained for function words in the indefinite determiner + noun targets.

The present task also bears on the question of whether the relative position of gender-marked elements in the noun phrase matters for the pattern of predicted benefits from advance gender information. Determiners occupy the first slot in a syntactic frame, unlike inflectional affixes, which occupy non-initial slots. As discussed in an earlier section (4.2.2), different types of advance information may lead to different patterns of reaction-time benefits depending on the serial order of constituents in the noun phrase, and on the processing mode that the speaker opts for. A speaker can initiate phonological encoding and articulation as soon as the first slot of the syntactic frame has been filled. Alternatively, he can delay phonological encoding and articulation until the grammatical encoding of the entire phrase has been completed, that is, until all slots have been filled. In the latter case, facilitating or inhibiting the selection of a lemma and of its associated features during grammatical encoding should have the same effect irrespective of the position of the word in the syntactic frame.

One could argue that in Experiments 1 and 2, as in the present experiment, the target utterance had the gender-marked word, that is, the colour adjective, as its first element. Therefore, the issue of the temporal coordination of the processes involved in the production of the two types of target utterances should not affect gender priming. However, given that inflections are held to be accessed separately from stem forms during generation, and that in Greek they occur word-finally, one could also hypothesise that speakers can initiate their utterance by articulating the beginning (here, the stem) of the colour adjective, and that they carry out further processing during articulation. Such a processing mode could lead to a trade-off between picture-naming latencies and the duration of naming, with shorter onset latencies being associated with longer articulation durations. The latter would provide speakers with additional planning time for the later parts of their response. Although in the present study we restrict our analyses to utterance onset latencies, information on articulation duration could also provide insights into the effect of prior gender information on word retrieval.

Linked to the question of the processes involved in the production of determiner NPs is a current controversy over the locus of the gender effect relative to the system of determiner selection. In the previous chapter (3.3.3.3), we saw that the discrepant findings of comparable studies in Dutch and German on the one hand (e.g., Schriefers, 1993; Schriefers & Teruel, 2000), and in Italian, Spanish and Catalan on the other (e.g., Costa et al., 1999; Miozzo & Caramazza, 1999) motivated the distinction between early- and late-selection languages. An early-selection language is one in which the form of the determiner is fully conditioned by the syntactic properties of the head noun. For example, in Dutch, as soon as the gender feature of the noun is selected, the specific form of the definite determiner can also be selected. By contrast, in a late-selection language, the choice of a particular determiner form requires the prior specification of the grammatical features of the head noun, but also of the phonological features (the onset) of the following word. Furthermore, in a language in which modifiers can occupy both pre-nominal and post-nominal positions in the noun phrase, the form of the determiner cannot be specified until the major NP constituents are serially ordered. The assumption is that in a late-selection language, a noun activates an allomorphic set of determiners. However, determiner selection will have to wait for the ordering and insertion of words in the syntactic frame. This built-in delay is held to be responsible for rendering invisible any gender effects. More precisely, it is argued that in late-selection languages, determiner selection is a multi-stage process driven by a combination of factors that are implicated in production at different stages; the relevant syntactic and morpho-phonological information is distributed over several processing levels. Therefore, there is enough time for any conflicting information to be resolved, or for any facilitative information to be attenuated (Miozzo & Caramazza, 1999).

Greek resembles Dutch and German in that definite and indefinite determiner selection is contingent upon the syntactic specifications of the head noun. Furthermore, in the Fnominative singular that is elicited in the present task, the correspondence between the indefinite determiner forms and the gender classes is one-to-one (*έναζ* MASC, *μια* FEM, *ένα* NEUT). Such is also the correspondence between the definite determiner forms and the three gender classes (*ο* MASC, *η* FEM, *το* NEUT). We can therefore conclude that gender priming, if present, should be visible with Greek. Note here, that the early- versus late-selection distinction has been drawn upon to account for the results obtained with the picture-word interference paradigm where distractor- and target-gender information become available almost concurrently, and where the gender effect appears to be particularly sensitive to the relative duration of the different processing stages. In the present task, prime and target are

invariably separated by a longer time lag (that is, an inter-trial interval of 1500 ms), a delay which could arguably render invisible any effect of the particular determiner-selection system. The production of indefinite over definite determiner target NPs in the present task was opted for in order to ensure that the two determiner forms (*έναζ* and *ένα*) would be maximally comparable.

4.5.1 Method

In this experiment, native speakers of Greek were instructed to name black-and-white pictures by means of bare noun NPs, and red pictures by means of NPs of the form indefinite determiner + noun.

Participants. Thirty-two volunteers, native speakers of Greek, from the University of Athens community, participated in the experiment. Their ages ranged from 20-28 years. None of them had participated in any of the previous experiments.

Materials. Two sets of pictures were selected: a set of experimental items and a set of filler items. The experimental set comprised a total of 64 pictures. Thirty-two pictures, 16 of which depicted masculine, and 16, neuter nouns, served as targets. Their distribution across the three AoA ranges was as follows: twelve masculine nouns were medium-acquired, two were low-acquired, and two were high-acquired. The distribution of neuter nouns in the three AoA ranges was thirteen medium-acquired and three low-acquired. Targets were combined with the remaining 32 pictures of comparable objects, which served as primes. Half of the primes had masculine, and the other half had neuter names. Target pictures were always presented in red. Prime pictures were presented in black-and-white, eliciting bare noun NPs. See Table 4.6 for examples of the resulting prime-target combinations, and see the Appendix for the full set of materials.

Table 4.6

Example materials from Experiment 3

P – T gender	Prime		Target	
masc – masc	σωλήνας *solinas*	(pipe)	ένας πίνακας *enas pinakas*	(a painting)
neut – masc	σίδερο *sidero*	(iron)	ένας πίνακας *enas pinakas*	(a painting)
neut – neut	σίδερο *sidero*	(iron)	ένα κόκαλο *ena kokalo*	(a bone)
masc – neut	σωλήνας *solinas*	(pipe)	ένα κόκαλο *ena kokalo*	(a bone)

Note. P = prime; T = target; masc = masculine; neut = neuter. The words in italics are broad phonological transcriptions of the Greek words.

Thirty-two pictures with feminine names were used as fillers in the trials preceding the prime-target pairs. Half of the filler pictures appeared in black-and-white, and the other half in red. Thus, the pre-prime naming response was either of the same type as the prime response (i.e., a bare noun), or of a different type (i.e., indefinite determiner + noun). Feminine picture names were of medium (n = 20) and low (n = 12) AoA. A further set of 15 pictures with names from the three gender classes was selected to serve in the practice trials. This resulted in a total of 111 pictures.

Design. Experiment 3 had four experimental conditions, which resulted from the combination of the factors Gender Identity (the prime and target had either the same or different gender; within participants, within items) and Target Gender (masculine or neuter; within participants, between items). Four experimental lists were constructed such that, within each list, 8 of the 32 target pictures occurred in one of the four conditions, and each target picture occurred only once. Across the four lists, each target item occurred once in each condition. The order of trial presentation was randomised for each participant, with the constraint that a filler item would always intervene between two prime-target pairs. Each experimental list consisted of 96 trials (32 prime trials, 32 target trials, and 32 filler trials), presented in a single block.

Procedure. Picture preview and trial structure were the same as in the previous experiments. For the main experiment, participants were instructed to name black-and-white pictures by means of bare nouns, and red pictures by means of NPs of the form indefinite determiner + noun. They were asked to respond both accurately and quickly, and to try to use the picture

names they had seen during the preview. Each experimental session lasted approximately 20 minutes.

Analyses. Three types of responses were classified as errors: (a) production either of a wrong target name or of the correct target name but with omission of the indefinite determiner; (b) production of a wrong prime name; and (c) verbal disfluencies e.g., stuttering, utterance repairs, production of non-verbal sounds that triggered the voice key, outlying response times (less than 300 or more than 2000 ms), and voice key failures. The reaction times of erroneous responses were excluded from further analyses. Responses that deviated by more than 2.5 SDs from a participant's or an item's mean were replaced by the overall participant (.02) or the overall item mean (.018), +/- 2.5 SDs, respectively. ANOVAs were performed on error rates and response latencies, as a function of Gender Identity (same or different gender between prime and target), and Target Gender (masculine or neuter). Subsidiary correlation analyses were also carried out between mean response latencies and gender priming.

4.5.2 Results

Erroneous responses (11.6%) were distributed as follows: 3.4% for wrong or no-determiner target name production; 2.5% for wrong prime name production; and 5.7% for verbal disfluencies, outlying responses and voice key malfunctioning. Table 4.7 displays mean response latencies, number of valid observations, and error rates as a function of Gender Identity, first collapsed over the two genders, and then for the two target genders separately. Every mean shown is an average over the mean response time and percentage errors of 32 subjects, each responding to 32 items.

Table 4.7

Effects of bare noun prime gender on indefinite determiner + noun target naming: Mean response latencies (ms), number of valid observations, and error rates as a function of Gender Identity and Target Gender (Experiment 3)

	Target Gender								
	masc & neut			masc			neut		
G-Ident	RT	n	e %	RT	n	e%	RT	n	e%
Same G	866	443	13.5	872	219	14.5	860	224	12.5
Diff G	903	462	9.7	916	230	10	890	232	9.4
G effect	37		-3.8	44		-4.5	30		-3.1

Note. Masc = masculine; neut = neuter; G-Ident = gender identity; Same G = same gender; Diff G = different gender; G effect = gender effect.

The analyses of target-utterance onset latencies provided evidence for gender priming: producing a gender-marked target response such as *ένας κήπος* 'a $_{MASC}$ garden $_{MASC}$' was faster after a same-gender prime such as *χάρτης* 'map $_{MASC}$', than after a different-gender prime such as *φύλλο* 'leaf $_{NEUT}$'. Specifically, there was a 44 ms advantage in the production of masculine targets, and a 30 ms advantage in the production of neuter targets. The overall gender priming effect (37 ms) was again highly significant (main effect of Gender Identity), F_1 (1,31) = 8.32, MS_E = 5172, p = .007; F_2 (1,30) = 4.66, MS_E = 3401, p = .039, while the main effect of Target Gender, F_1 (1,31) = 2.86, MS_E = 4122, p = .1; F_2 (1,30) = .316, MS_E = 18337, p = .57, and the interaction between Gender Identity and Target Gender (F_1, F_2 < 1) were not significant. And as in Experiments 1 and 2, longer production latencies were associated with larger priming effects, r = .6, N = 32, p < .001. In this case, there was a significant main effect of Age-of-acquisition for nouns, F_2 (1,29) = 18, p < .001, and a significant correlation between mean production latencies of primed and unprimed items and age-of-acquisition measures, r = .61, N = 32, p < .001, and r = .53, N = 32, p = .002, respectively. That is, naming latencies were longer for later acquired than for earlier acquired nouns, and the priming effect was bigger for later acquired nouns.

In the analysis of errors, the main effect of Gender Identity was marginally significant, F_1 (1,31) = 3.3, MS_E = .853, p = .08; F_2 (1,30) = 4.056, MS_E = 1.391, p = .053. The main effect of Target Gender and the interaction between Gender Identity and Target Gender were not significant (Fs < 1).

4.5.3 Discussion

Experiment 3 confirmed the general pattern of results obtained in the previous two experiments; participants were faster to produce an indefinite determiner + noun NP after having produced a bare noun of the same gender, than after having produced a bare noun of a different gender. For the target NP, the syntactic processes in the present case concerned the selection of the grammatical gender of the noun and, on the basis of this information, the retrieval of the corresponding determiner form.. The present results indicate that free-standing function words, like inflectional affixes are susceptible to gender priming. Interestingly, the magnitude of the priming effects was numerically very similar in the two cases: 41 ms in Experiment 2, and 37 ms in Experiment 3. This is all the more interesting given the by now well attested positive correlation between mean response latencies and the magnitude of priming, and the descriptively non-negligible 274 ms difference in mean response latencies between the two experiments (1159 ms in Experiment 2, and 885 ms in

Experiment 3). The replication then, of the same general pattern across the two experiments indicates that the gender effect may occur at different response-time ranges, and is not contingent solely upon the increase in reaction times.

If, as the present results suggest, the gender effect is independent of the specific syntactic format of the target utterance as long as this involves the computation of agreement, then one would expect similar results also to obtain for other types of target NPs that require the production of gender agreement targets e.g., pronouns or participles. Moreover, the results of Experiments 2 and 3 could be taken as an indication of the similarity of processes involved in gender selection irrespective of the proposed differences in the representation and generation of free lexical elements and bound morphemes. Of course, further empirical evidence from a within-experiment comparison of gender priming for adjective and determiner + noun target NPs will be needed before one can conclude that there is no modulation of the gender effect by the target utterance format.

Experiment 3 also showed that the system of determiner selection of Greek renders visible the influence of prior gender information. This is in agreement with the prediction derived from the early-selection assumption, which attributes the presence of gender priming to the one-to-one correspondence between determiner forms and gender classes. Thus, in Greek, the appropriate indefinite determiner allomorph can be selected as soon as the relevant syntactic properties of the noun (i.e., gender, number and case) become selected. As discussed earlier, one could argue here that the relatively long inter-trial interval between prime and target presentation in the present task, compared with the almost concurrent presentation of target and distractor in the picture-word interference paradigm (from which most of the relevant evidence has been obtained) always leaves enough time for any conflicting information to be resolved or for any facilitatory information to be attenuated, so that the early- versus late-selection distinction is of no relevance. In the latter case, the interpretation of the gender effect in all these experiments should be accounted for by some other mechanism. The present findings do not allow us to resolve this issue. What is important however, is that gender priming was obtained for, and extended to a different type of target NP, and that this effect confirmed the predictions derived from the system of determiner selection in Greek.

Finally, unlike Experiment 2, the present experiment yielded a significant positive correlation between mean response latencies and AoA scores; in both the primed and unprimed condition, longer response latencies were associated with higher AoA scores. This

is an important finding insofar as it confirms the assumption that AoA effects, like frequency effects, in production are tied to phonological form, and therefore have consequences for the retrieval of phonological word forms. Because in Experiments 1 and 2 the target nouns did not have to be overtly produced, processing of their phonological form was not required, hence the absence of AoA effects. In the present experiment however, the target nouns had to be produced, and therefore the impact of AoA could be evidenced in the time required for the retrieval of the corresponding word forms. Furthermore, the significant positive correlation between mean response latencies and the magnitude of priming further confirmed the pattern observed in the previous two experiments.

Arguably then, gender priming works in Greek whenever gender must be selected. In Experiment 4, we ask whether gender priming effects can be found in another context, between bare-noun primes and targets, in which unlike all previous experiments, production of the target does not involve any gender selection.

4.6 Experiment 4: (Bare noun) Primes – (Bare noun) Targets

Our aim in Experiment 4 is to specify still further the conditions under which gender priming can be obtained. We now look for gender priming on bare noun targets. According to Levelt et al., in the production of bare nouns the corresponding gender information becomes merely activated. On the assumption that gender priming is obtained when an activated gender node has to be subsequently selected, Levelt et al. predict that bare noun production in the target NP should not yield priming. By contrast, bare noun production in the prime NP should induce priming if a gender-marked element (involving gender selection) is produced in a subsequent naming trial. There is therefore, an asymmetry in the directionality of the gender effect: a bare noun in the prime can induce priming but a bare noun in the target cannot be primed.

With Experiments 2 and 3 we established that advance access to gender information provided by the production of bare nouns does affect the subsequent production of gender-marked utterances. Furthermore, a comparison of Experiment 2 with the first experiment, which involved the production of determiner + noun primes, did not provide any indication for a difference in the magnitude of priming between the two experiments as a function of prime type. Although these findings were in line with the predictions derived from Levelt et al., a potential caveat was discussed: it was argued that there could be cross-linguistic differences in the processes involved in bare noun production reflecting differences in the relative salience and pervasiveness of lexical properties between languages.

In our treatment of gender in Greek, we noted that although bare noun production does not involve the computation of agreement, it does, on most accounts, involve gender marking. Therefore, unless a strictly linear view of information flow in production is adopted as in Levelt et al's model, one would expect that the selection of the gender-marking element at the form level should affect the activation (or the selection) process of the corresponding feature(-s) at the syntactic level. In Dutch, the morphological make-up of a bare noun does not reflect its syntactic make-up; its abstract gender information does not surface at the form level. Given this dissociation, Levelt et al.'s model correctly predicts that gender information need not be selected (and is not selected) during bare noun production. However, where there is a more systematic and 'transparent' relationship between syntactic and morphophonological features as is the case of gender in Greek, Levelt et al.'s claim becomes weaker. In the latter case, it is reasonable to assume that even in bare noun production, the selection of the appropriate-gender marking element may trigger the selection of the corresponding gender node. Such an assumption is further motivated by the fact that inflectional suffixes in Greek are integral parts of words: because stems are bound, and thus the selection of the appropriate suffix is an inextricable part of the word production process. If gender selection can be triggered by the process of inflectional suffix selection, it should occur invariably each time a bare noun is produced.

If the latter account is correct, then the presence of a gender effect in Experiments 1 through 3 could be attributed not to analogous effects of gender selection (Experiment 1) and gender activation (Experiments 2 and 3) in the production of the prime, but to the similar processes in the production of the two types of prime NPs. This account, unlike Levelt et al.'s, also predicts that gender priming should also be obtained with bare noun targets in Greek, because their inflectional affixes involve gender selection.

4.6.1 Method

In this experiment, participants were asked to name black-and-white pictures by means of bare nouns.

Participants. Twenty-eight volunteers, native speakers of Greek, from the University of Athens community, participated in the experiment. Their ages ranged from 21-27 years. None of them had participated in any of the previous experiments.

Materials, Design. Materials and design were the same as in Experiment 3. Examples of the prime-target combinations are given in Table 4.8

Table 4.8

Example materials from Experiment 4

P – T gender	Prime		Target	
masc – masc	σωλήνας *solinas*	(pipe)	πίνακας *pinakas*	(painting)
neut – masc	σίδερο *sidero*	(iron)	πίνακας *pinakas*	(painting)
neut – neut	σίδερο *sidero*	(iron)	κόκαλο *kokalo*	(bone)
masc – neut	σωλήνας *solinas*	(pipe)	κόκαλο *kokalo*	(bone)

Note. P = prime; T = target; masc = masculine; neut = neuter. The words in italics are broad phonological transcriptions of the Greek words.

Procedure. The procedure was identical to that of the previous experiments, except that a single utterance format was produced. All pictures were presented in black-and-white; the participants' task was to name them by means of a bare noun. Response speed and accuracy were again emphasised. Each experimental session lasted approximately 20 minutes.

Analyses. Three types of responses were classified as errors: (a) production of a wrong prime name; (b) production of a wrong target name; and (c) verbal disfluencies e.g., stuttering, utterance repairs, production of non-verbal sounds that triggered the voice key, outlying response times (less than 300 or more than 2000 ms), and voice key failures.

4.6.2 Results

Erroneous responses (6.7%) were distributed as follows: 2.4% for wrong prime name production; 1.9% for wrong target name production; and 2.4% for verbal disfluencies, outlying responses and voice key malfunctioning. Table 4.9 displays mean response latencies, number of valid observations, and error rates as a function of gender identity, first, collapsed over the two genders, and then for the two target genders separately. Every mean shown is an average over the mean response time and percentage errors of 28 subjects, each responding to 32 items.

Table 4.9

Effects of bare noun prime gender on bare noun target naming: Mean response latencies (ms), number of valid observations, and error rates as a function of Gender Identity and Target Gender (Experiment 4)

	Target Gender								
	masc & neut			masc			neut		
G-Ident	RT	n	e %	RT	n	e%	RT	n	e%
Same G	837.5	417	6.9	874	207	7.6	801	210	6.2
Diff G	839	419	6.5	865	212	5.4	813	207	7.6
G effect	1.5		.04	-9		-2.2	12		1.4

Note. Masc = masculine; neut = neuter; G-Ident = gender identity; Same G = same gender; Diff G = different gender; G effect = gender effect.

The analyses of target-utterance onset latencies did not provide evidence for gender priming: producing a bare-noun target response such as *κήπος* 'garden $_{\text{MASC}}$' was no faster after a same-gender prime response such as *χάρτης* 'map $_{\text{MASC}}$' than after a different-gender prime response such as *φύλλο* 'leaf $_{\text{NEUT}}$' (F_1, $F_2 < 1$). The main effect of Target Gender was significant in the participants' analysis only, F_1 (1,27) = 29.28, $MS_E = 3773$, $p < .001$; F_2 (1,30) =2.58, $MS_E = 28633$, $p = .11$, reflecting the difference in performance for masculine and neuter nouns. The interaction between Gender Identity and Target Gender was not significant (Fs < 1). As before, longer production latencies were associated with larger priming effects, $r = .48$, $N = 32$, $p = .005$. There was a significant main effect of Age-of-acquisition, F_2 (1,29) = 46.87, $p < .001$, a marginal interaction between Age-of-acquisition and Gender Identity, F_2 (1,29) = 3.87, $p = .059$, and a significant correlation between mean production latencies and Age-of-acquisition, $r = .7$, $N = 32$, $p < .001$ for primed items, and $r = .8$, $N = 32$, $p < .001$ for unprimed items. Items with higher AoA induced longer production latencies. The analysis of errors did not show any significant effects.

4.6.3 Discussion

Unlike the previous three experiments, Experiment 4 did not yield any evidence for gender priming; participants were as fast to produce a bare noun after having produced a bare noun of the same gender, as after having produced a bare noun of a different gender. This finding is in agreement with Levelt et al.'s claim that prior access to gender information cannot affect the production of bare nouns. Importantly this prediction was confirmed for Greek, indicating that cross-linguistically bare noun production is subserved by similar mechanisms irrespective of differences in the salience and the morphophonological realisation of lexical-

syntactic properties. Particularly, the present results strongly suggest that in Greek as in Dutch, bare noun production does not involve gender selection, hence the absence of a gender effect. The similarity in the pattern of results between the two languages follows naturally from the processing assumptions of the Levelt et al. model: because lexical features are selected in a strictly linear order so that there is no feedback from lower to higher representational levels, the selection processes at the morphophonological level cannot affect the corresponding processes at the syntactic level.

Of course, one could argue that priming effects were not obtained here because overall reaction times were very fast (much faster than in Experiments 1 and 2), and therefore there was a ceiling effect: advance gender information could not render the already fast responses any faster. On this account, the absence of gender priming would be attributed not to the non-selection of gender information in the target noun phrase but rather to the fact that target responses were quicker to produce. However, this is an implausible explanation because the mean reaction times in this experiment were comparable to those in Experiment 3, where a gender priming effect was found.

4.7 Summary

The main results obtained in Experiments 1 through 4 can be summarised as follows. First, prior access to gender information implicated in the production of bare-noun or determiner + noun NPs can induce priming in the production of target utterances; there is a clear reaction-time advantage for targets preceded by same-gender primes as compared with targets preceded by different-gender primes. Second, this advantage is observed only with target utterances that involve the production of a gender-agreement target e.g., adjective or determiner. Bare-noun production is not susceptible to priming. Third, insofar as a gender-agreement target has to be produced, the specific format of the target utterance e.g., colour adjective or determiner + noun, appears not to matter for the predicted pattern of results.

Overall, these results confirm the predictions derived from the Levelt et al. model. In particular, this model makes the prediction that boosting the level of activation of a gender node by producing a word of that gender affects subsequent lexical access when the same gender node has to be selected. Selection occurs when gender information is needed for the computation of agreement between a gender controller and a gender-agreement target. In line with this prediction, we found that gender priming is obtained for adjective and determiner + noun targets, but not for bare noun targets. We therefore showed that in Greek as in Dutch, the activation-selection distinction largely reflects the distinction between the processes

involved in the production of bare nouns and those involved in the production of gender-marked utterances. As pointed out in 4.6.3, this finding is particularly interesting given the non-negligible cross-linguistic differences between Greek and Dutch in the salience and surface realisation of gender information on nouns. In particular, the absence of gender priming with bare noun targets in Greek strongly suggested that mere obligatory affixation of a noun stem cannot in itself trigger gender selection. Therefore, what is critical for the occurrence of gender priming is not the presence of a gender marker per se in the target utterance, but rather the presence of a lexical item that is not inherently specified for a particular gender. Insofar as nouns have inherent gender, they cannot give rise to priming effects.

Having examined in this chapter some of the conditions under which gender priming can be obtained, we attempt in the next two chapters to further explore the nature of the gender effect. Particularly, given that a prime and target utterance may have not only the same gender but also the same case and number (recall that noun phrases in Greek have to be case- and number-marked), it is plausible that not only advance access to gender information but also advance access to case and number could have an effect on the time-course of subsequent lexical access. If this is the case, then the question that arises is whether gender operates independently of the other two nominal categories, so that the observed effect is indeed a purely gender priming effect, or whether it interacts with case and number, and hence contributes jointly with these categories to the processes underlying word production. Chapter 5 examines the relationship between gender and case while Chapter 6 examines the relationship between gender and number.

Chapter 5 Gender and Case

5.1 Introduction

Chapter 4 presented evidence for the effect of prior access to gender information from the production of bare noun and determiner + noun NPs on the production of different target utterances: colour adjectives, indefinite determiner + noun NPs, and bare noun NPs. Target responses which involved gender selection were faster when preceded by a same-gender prime response than when preceded by a different-gender prime response. Importantly, the production of bare noun targets did not benefit from prior access to same-gender information. This suggested that in Greek as in Dutch, gender selection is not implicated in the production of bare nouns despite the obligatory affixation of noun stems with (potentially) gender-marking inflectional suffixes. The present chapter focuses on the relation between gender and case, two nominal categories reflected in the same Greek inflections, and on their joint contribution to lexical access in production. Here, as in Chapter 6, we will be asking whether prior access to gender information affects the time-course of subsequent word retrieval independently of other types of advance lexical-syntactic information, or whether the observed gender priming effect reflects their joint contribution. The present chapter is structured as follows. First, we introduce some relevant properties of the Greek inflectional system. Then we examine two theoretical approaches to the issue of the coordination of multiple selection processes underlying word production in Greek. Finally two experiments test for gender priming with nominative- and accusative-case nouns, in same- and different-case prime-target pairs.

5.2 Theoretical approaches to the gender-case relation

5.2.1 Describing a fusional system

Lexical selection involves the retrieval of different types of information about how a given word combines with other words. Such information concerns the grammatical class (verb,

adjective, noun etc.) and other grammatical features that control a word's combinatorial requirements (e.g., nouns must be specified as count or mass, and if count, as singular or plural; verbs must be specified as transitive or intransitive, and if transitive, as simple or ditransitive, etc.). The information that is retrieved during lexical selection varies from one language to another. For example, in Greek, lexical selection of the word *πράσινος* 'green' in the phrase *πράσινος κήπος* 'green garden' will involve retrieval of the information adjective, masculine, positive (degree), nominative and singular. Lexical selection of the equivalent English word however, will involve retrieval only of the information adjective and positive, and selection of the equivalent French word, *vert*, in *jardin vert*, will involve retrieval of the information adjective, masculine, positive and singular. These examples show that cross-linguistically, word production involves the retrieval of different types of information or properties, which can be thought to become available at different points in the course of preparing an utterance. These properties or property combinations impose constraints on how lexical items become selected. Therefore a theory of word production should provide a detailed account of how the different types of information described above guide the selection process.

Implicit in the architecture of the Levelt et al. model is the assumption that the information about grammatical gender is recovered independently of other types of information e.g., case or number. Lemma representations, which contain abstract specifications of all the syntactically relevant properties of a word, do not have internal structure so that these properties are unrelated (though see Caramazza, 1997, for a subnetwork organisation of lexical-syntactic properties). In keeping with our emphasis on gender processing, this implies first, that the activation or selection of a particular gender node should not affect the activation level of competing gender nodes, and second, that gender selection should contribute to lexical access independently of other selection processes such as case or number selection. However, Levelt et al.'s view of a cognitive architecture that sharply distinguishes between the different types of lexical-syntactic information, and between the different operations responsible for the retrieval of this information during lexical selection might be oversimplified because it does not consider the status of these categories in various languages. In the following, I focus on Greek and consider some arguments that could motivate a 'combinatorial' view of lexical-syntactic properties.

The first argument is logical, and reflects a basic property of the language: nominal categories in Greek are fused, that is, they are systematically expressed by a single affix or by a single allomorph. Suppose a speaker wants to produce the word *πράσινος* 'green'. At

the lemma level, this will require the selection of the features masculine, nominative and singular, which jointly specify the morphology of the selected word. Changing one feature value results in a change in the word's morphology, and therefore, in a change in the realisation of the two other features. For example, keeping case and number constant but changing gender from masculine to feminine yields the form *πράσινη* instead of *πράσινος*. The upshot is that a given inflectional suffix (see e.g., any of the adjectival inflections illustrated in Table 5.1) or a given allomorph (see e.g., any of the determiner forms illustrated in Table 5.2) marks more or less uniquely identifiable combinations of feature values, and that altering a single one of the feature values affects the surface realisation of the two other features. Given this type of interdependency, it is plausible to assume that adjective or determiner lemmas in Greek should be connected to nodes that correspond to feature combinations or clusters rather than to individual features, and that lexical access should involve the selection of such feature clusters. In other words, the hypothesis is that output form could determine internal lemma organisation.

Table 5.1

Gender agreement in the singular forms of the adjective πράσινος,-η, -ο 'green'

	Singular		
	Masculine	Feminine	Neuter
Nominative	πράσιν-ος	πράσιν-η	πράσιν-ο
Genitive	πράσιν-ου	πράσιν-ης	πράσιν-ου
Accusative	πράσιν-ο	πράσιν-η	πράσιν-ο
Vocative	πράσιν-ε	πράσιν-η	πράσιν-ο

Table 5.2

Gender agreement in the singular forms of the indefinite determiner ένας-μια-ένα 'a'

	Singular		
	Masculine	Feminine	Neuter
Nominative	ένας	μια	ένα
Genitive	ενός	μιας	ενός
Accusative	ένα(ν)	μια	ένα
Vocative	-	-	-

From an empirical standpoint, the evidence for the mutual relationship of morphosyntactic properties is very scarce. Perhaps the most readily appreciated evidence that the human

language processor encodes lexical-syntactic information in the form of feature clusters comes from findings concerning the role of morphological paradigms in on-line language processing. Recall that a paradigm refers to the entire set of morphosyntactic property combinations associated with the actually or potentially distinct word forms belonging to a lexeme. Each 'cell' of the paradigm refers to a particular property combination within the set. Consider here for example, the paradigm for the Greek lexeme *ουρανός* 'sky', which consists of eight cells (Table 5.3). Possible labels for these cells, in terms of morphosyntactic properties, are given alongside the corresponding word forms.

Table 5.3

Morphosyntactic properties and corresponding word forms for the lexeme ουρανός 'sky'

	Singular	Plural
Nominative	ουρανός	ουρανοί
Genitive	ουρανού	ουρανών
Accusative	ουρανό	ουρανούς
Vocative	ουρανέ	ουρανοί

In a recent study in German (Clahsen et al., 2000) investigating regular person and number inflection on finite verbs, the results of two cross-modal lexical priming experiments showed asymmetries in the priming patterns between the various person and number forms of verbs; these asymmetries could be readily explained by the structure of the paradigm. In particular, the results strongly suggested that neighbouring cells that occupied a sub-paradigm were competitors for one cell in the general paradigm, and therefore caused inhibitory effects in the experiments. Clahsen et al. also reported on evidence from disorders of aphasia indicating that the inflectional errors of language-impaired subjects are constrained by the structure of paradigms. Thus for example, in a study also examining person and number inflection on verbs, the agreement errors produced by the aphasics involved the exchange of either person or number, but not the exchange of both. That is, a patient would produce a 1st singular instead of a 3rd singular form, but would never produce a 2nd singular instead of a 1st or 3rd plural form. The substitution errors resulted from exchanges between individual cells of a paradigm e.g., 3rd person mis-selected for 1st person, while maintaining the correct number feature. Clahsen et al. interpreted these findings as evidence that production processes may draw on lexical information defined in terms of property combinations. Paradigms then, constitute indices or access systems for mapping these property combinations to their exponents or affixes.

5.2.2 Independent Features

Given the above, there appear to be two ways in which lexical selection processes can be accounted for. On one account, adopted here by Levelt et al., the different nodes that correspond to a word's syntactic properties become activated or selected independently of each other. This means that in the production of a word such as *ουρανός* 'sky', lexical selection will implicate the selection of the property NUMBER:Singular independently of the selection/activation of the other relevant properties, that is, of CASE:Nominative and GENDER:Masculine. We will refer to this account as the *independent features account* because it assumes the independent contribution of the different types of information to lexical selection (see Figure 5.1).

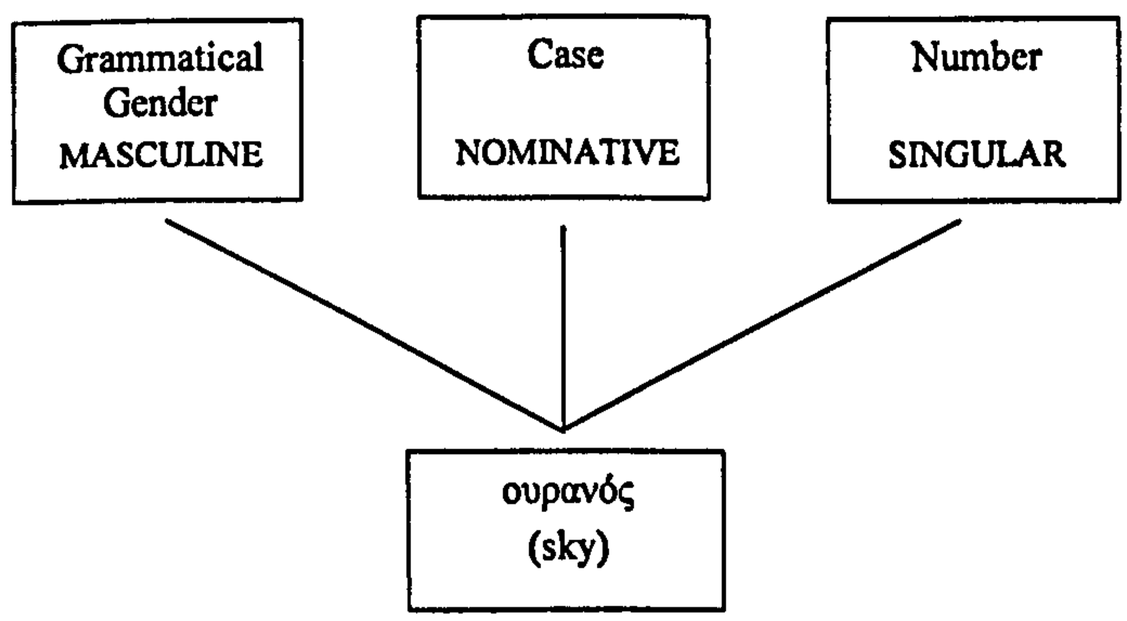

Figure 5.1. Schematic representation of the *independent features account* with the different types of lexical-syntactic information contributing independently to lexical access.

Note that although there might be differences in the temporal availability of these types of information, these should not matter for the time-course of lexical retrieval, that is, for the initiation of the processes that yield an abstract specification of the form of the selected word. That is, although one can hypothesise that for example, gender, which is an inherent property of nouns, may become available earlier than number, which is specified by information at the conceptual level and is valid only in the current context of speaking, and that number becomes available earlier than case, which is specified upon structure assignment, none of these order effects should have behavioural consequences. This follows from Levelt et al.'s seriality assumption which posits tight constraints on the influence of syntax on morphophonological processing. This assumption entails that word-form encoding is initiated only upon completion of all the processes involved in lemma selection, and not incrementally as the different pieces of lexical-syntactic information become available.

Therefore, lexical retrieval cannot be affected by differences in the relative availability of different types of information at the lemma level.

5.2.3 Feature Clusters

Alternatively, the different lexical-syntactic properties may act together as a single information chunk. Under this sort of model, feature values combine to form feature clusters, which must become selected before the corresponding word form can be activated and retrieved. Feature clusters can be thought of as sub-networks within the lexical-syntactic network encoding the mutual relationship of the properties that define a word. Therefore a basic architectural and processing assumption of this account is that a word's syntactic specification is localised in a single feature cluster rather than distributed across independently represented feature nodes. In the example considered earlier, production of the word *ουρανός* 'sky' would now involve the selection of the feature cluster {GENDER:Masculine, NUMBER:Singular, CASE: Nominative}. We will refer to this account as the *feature clusters account* (see Figure 5.2).

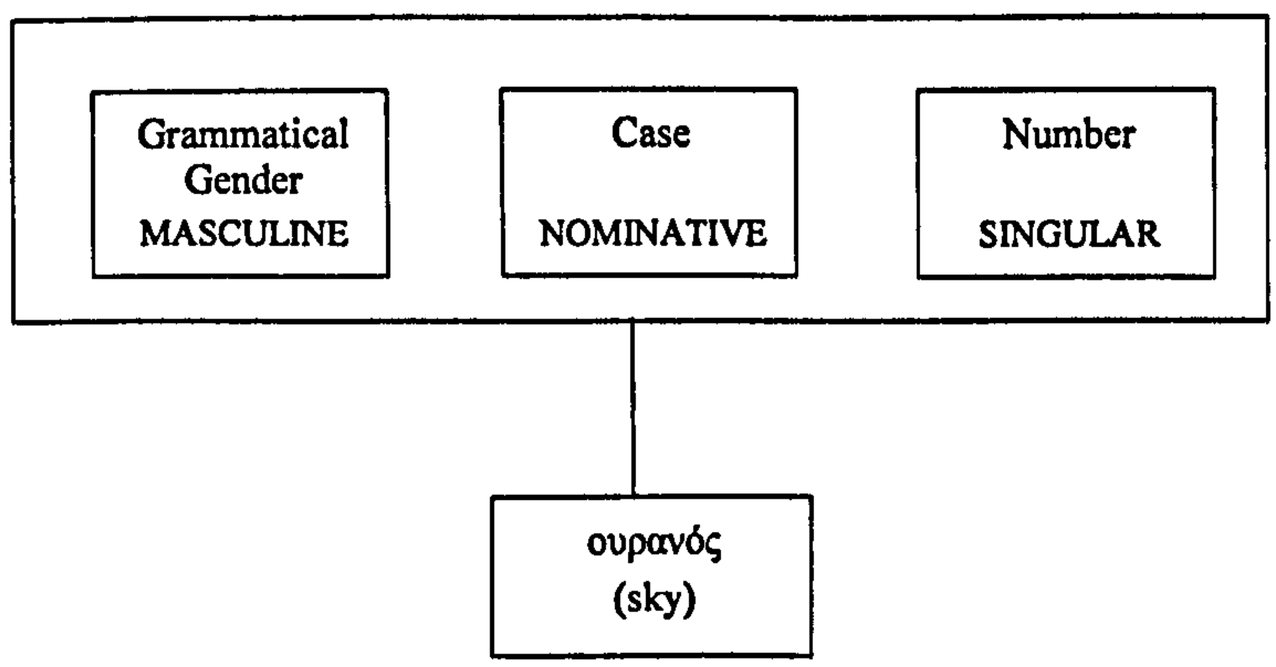

Figure 5.2. Schematic representation of the *feature clusters account* with the different types of lexical-syntactic information contributing together as a single information chunk to lexical access.

A basic disparity between this and the independent features account concerns the role of the connections between the features. In the former case, these connections are stored as part of a word's syntactic specification and are therefore accessed together with the relevant features each time the word has to be produced. If lemma-level information is sensitive to repeated encounters over the speaker's lifespan or has strong age dependencies as has been shown for form-level information, then it is reasonable to assume that some connections might be

stronger than others and that some feature clusters might be easier to retrieve than others. If this assumption is correct and given that, for example, in Greek language acquisition, the percentage of masculine nouns marked as genitive singular is in the early years much lower than the percentage of nouns marked as nominative singular (by -ς), or given that consistent marking of the genitive singular is achieved earliest with feminine nouns (Stephany, 1997), then we would expect the retrieval of the feature cluster {Masculine, Nominative, Singular} in the production of e.g., *ουρανός* 'sky' to be faster than the retrieval of the feature cluster {Masculine, Genitive, Singular} in the production of e.g., *ουρανού*. Similarly, the retrieval of the feature cluster {Feminine, Genitive, Singular} in producing e.g., *μητέρας* 'mother' should be faster than the retrieval of the cluster {Masculine, Genitive, Singular} in producing e.g., *πατέρα* 'father'.

The postulation of feature clusters could provide a principled way of accounting for the possibility of priming between features. If, as proposed earlier for Greek, the feature Masculine is more strongly connected to the features Nominative and Singular than to the features Genitive and Singular, then it could be argued that the retrieval of the Masculine feature primes the retrieval of the Nominative more than the retrieval of the Genitive. A related issue here concerns the relative prominence of the different features, and of the feature contrasts which partition a paradigm. That is, is the distinction between cells which differ in Gender more fundamental, in some sense, than the distinction between cells which differ in Case? In general, if all the syntactic properties that define a paradigm were equally fundamental, one would expect to find a cell for every property or possible property combination. However, the Greek data in Table 5.1 show this to be wrong. For example, there are no cells for distinct masculine and neuter gender forms in the genitive and the accusative, and no cells for distinct nominative and accusative case forms in the feminine. Although the reason why this is so has not yet been systematically investigated, it is conceivable that there might be differences in the relative importance or salience of the different nominal categories reflected in the way these categories are realised. The question of whether, and if so, how a word's syntactic properties are inter-related has both theoretical and methodological ramifications for accounts of word production. In keeping with the emphasis on gender processing, the aim of this chapter is to examine whether the effect of prior access to gender information on subsequent word retrieval is independent of the effect of advance access to case information. The remainder of the chapter is structured as follows. In the next section, I outline the predictions derived from the independent features and the feature clusters accounts regarding the conditions under which gender priming should be obtained. I then review some empirical findings that bear on the processing of different case

forms. Next, I report two experiments which investigate whether the effect of prior access to gender information on word production is modulated by case manipulations in the prime and target.

5.2.4 Predictions from the two accounts

In the two accounts sketched out earlier the role of the features that contribute to lexical selection is implemented differently. In the feature clusters account, an undifferentiated information chunk drives word production; all the required information acts as a single unit to activate the corresponding word form. This working model of lexical selection predicts that the effect of prior gender information on word production should be modulated (in fact, cancelled out) by any case differences between prime and target. This should be so because the internal characteristics of the cluster, that is, its constituent features, do not contribute individually to the process of lexical retrieval. In other words, lexical retrieval is influenced only by the characteristics of the cluster as a whole and not by the characteristics of the individual features. On this hypothesis, the gender effect obtained in Experiments 1-3 should best be viewed as a 'feature cluster' effect reflecting facilitation in repeatedly accessing the same feature cluster. Recall that in the same-gender condition, prime and target also had the same number and case. Therefore, their production involved the selection of the same feature cluster. By altering one feature value however, in the prime or the target, as was the case in the different-gender condition, this resulted in a different feature cluster altogether, and no priming was obtained. Note also, that on this account it should make no difference whether a prime and target differ by one or more than one feature since even a single change would result in a different feature cluster.

The independent features account by contrast, predicts that gender priming could, in principle, be obtained even with different-case prime-target pairs. Because all the required information is retrieved individually, the process of gender selection should not be affected by the processes of case and number selection. Therefore, gender priming should be obtained irrespective of whether the prime and target share the same case and number feature or not.

I conclude this section by addressing a potential caveat. Throughout this discussion I have assumed that the different features and feature values are uniformly represented and uniformly processed. This assumption has also been implicit in the Levelt et al. model where all syntactic properties are represented by nodes at an unstructured lemma level. Extended to the word-form level, this assumption entails that the corresponding word forms should also be processed uniformly so that the production of, for example, *ουρανός* 'sky $_{\text{MASC, NOM, SING}}$'

should take as long as the production of *ουρανού* 'sky MASC, GEN, SING' or *ουρανό* 'sky MASC, ACC, SING'. If, contrary to this assumption, the word forms that correspond to the different property combinations are not processed uniformly, then such variation and not the type of relationship postulated between the different syntactic properties could be responsible for the presence or absence of gender effects. For example, given the systematically observed positive correlation between mean production latencies and the magnitude of gender priming (Experiments 1-3), one could hypothesise that if nominative forms are produced faster than accusative forms, then nominative targets should be less susceptible to gender priming than accusative targets. Similarly, if plural forms are slower to produce than singular forms, then one could predict that plural targets should be more susceptible to gender priming than singular targets. In these cases then, the presence or the magnitude of the gender effect is conditioned not by the characteristics of lexical (lemma) selection but by the characteristics of form-level processes. Given the above, the question that arises is whether there is any empirical evidence indicating that there are, in fact, differences in the processing of the different case forms. In the next section I will review some of the research that has addressed this issue.

5.3 The processing of case forms

Linked to the issue of the relationship of the syntactic features that define the cells of a paradigm is the question of the relationship of the corresponding word forms. These word forms may simply be distinct, implying no special mutual relationship. Alternatively, one word form may appear to be built on another, or one word form may be identical with another. This, in turn, can have implications for the way the different case forms are processed. In what follows, we briefly consider some theoretical accounts on how a word's case forms can be inter-related, and we then review some empirical findings on the processing of case forms.

5.3.1 Theoretical accounts of case-form relationships

Are the different case forms of a word as for example *ουρανός* 'sky MASC, NOM, SING' and *ουρανού* 'sky MASC, GEN, SING' related in any way? Current morphological processing models provide conflicting answers to this question. Some researchers (e.g., Butterworth, 1983) argue that the morphological structure of words plays no role in the way these words are produced or perceived. The lexicon is a store of full word forms operating in such a way that lexical representations corresponding to these forms are accessed by a direct mapping of the word's letters or phonemes. Put into the terms of the Levelt et al. framework, this account

entails that each lemma does not have pointers to the individual morphemes that constitute the word (in the case of morphologically complex words) but is instead connected to a single, non-decomposed word form. Consequently, the lexemes that correspond to a lemma with different case diacritics, as is the case for the different case forms, cannot be related in any way except through meaning.

Alternative accounts however (e.g., Taft, 1988), posit that word forms are decomposed and looked up under some meaningful subpart. Morphological structure is detected and used as the basis of access to the lexicon. Morphological relatives such as *ουρανός* and *ουρανού* 'sky' are listed within the same entry in a morphologically decomposed form. Moreover, morphological models which assume decomposition are further distinguished between those which postulate an obligatory decomposition procedure prior to access, and those which propose both whole-form and morpheme-access mechanisms (see e.g., Caramazza, Laudanna, & Romani's 1988 'Augmented Addressed Morphology' model). Both of these morphological models make the critical assumption that the representations of affixed words are organised around the representation of their base morpheme. Note here, that a similar assumption is also shared by some non-decomposition models (e.g., Feldman and Fowler, 1987; Lukatela, Gligorijevic, Kostic, & Turvey, 1980) which assume that morphological relatives i.e., affixed words that have the same base, are interconnected and that the common base form constitutes the head of the 'nucleus'. Here, morphological information is partly encoded in the relationship of the members of the family. Each affixed form constitutes a lexical entry of its own but is not isolated. Such proposals are also made by network models, which posit separate entries for words and morphemes; the lexical entries of morphologically related words are linked by a node that represents their shared stem morpheme (e.g., Schreuder, Grendel, Poulisse, Roelofs, & Van de Voort, 1990; Schriefers, Friederici, & Graetz, 1992). In the Levelt et al. model, the production of morphologically complex words involves the retrieval of their constituent morphemes. Following the pointers stored at the lemma level, the production mechanism enters the form lexicon and retrieves the morphemes that make up the word. The pointers to the form lexicon must be numbered to account for the serial order of morphemes. Once the morphemes are incrementally selected, they are simply concatenated and fed into the next stage of phonological processing. On the assumption that there is only one abstract node for each morpheme in the same way that there is only one node for each grammatical property, all words that share a morpheme should be connected to one shared morpheme node.

Perhaps the most detailed proposal concerning the architectural and processing relationship of case forms comes from studies in Serbo-Croatian (e.g., Feldman & Fowler, 1987; Katz, Boyce, Goldstein, & Lukatela, 1987; Kostic, 1995; Lukatela, Gligorijevic, Kostic, & Turvey, 1980; Lukatela, Kostic, Feldman, & Turvey, 1983; Lukatela, Carello, & Turvey, 1987; but see Todorovic, 1988, and Kostic, 1995, for conflicting evidence), and is referred to as the 'satellite-entries' model (Lukatela et al., 1980). This model assumes that each case form of a noun is represented separately in the lexicon. The entry for the nominative singular functions as the nucleus of the noun, and it encodes the frequency of occurrence of the noun that it represents. The lexical entries of the remaining case forms cluster relatively uniformly around the nominative singular by a principle other than frequency. That is, the lexical entries of the oblique cases of a noun are 'satellites' to the lexical entry of the noun's nominative singular. Although frequency of occurrence is held to be encoded in the lexical entry of each case form, this measure does not appear to be a predictor of its processing time. For example, lexical decision times for the nominative singular are significantly faster than the decision times for either of the two other cases i.e., the instrumental and the dative singular, which do not differ from each other in terms of decision times although they differ in frequency.

5.3.2 Empirical accounts of case-form relationships

Much of the empirical evidence relating to the above position comes from studies using lexical decision and repetition priming paradigms. Repetition priming refers to the fact that, when participants are presented with a series of words and non-words for lexical decisions, the lexical decision to the second presentation of a given word is faster than to its first presentation. Repetition-priming effects have been found for different morphological variants of the same base form (e.g., Feldman & Fowler, 1987).

Lukatela et al. (1980) showed that for both masculine and feminine nouns in Serbo-Croatian, (visual) lexical decisions to nouns in the nominative case were faster than to the same nouns in the genitive or instrumental case. Two characteristics of the target language were particularly important. First, the same word form can represent more than one grammatical case (i.e., there is syncretism). Where such identities exist, case frequencies can be compounded. Second, although the base form (root morpheme) in the declension of masculine nouns is an actual case form, the nominative singular, the base form for feminine nouns is an abstraction; it is bound and thus, it never occurs as an independent word. This entails that when the frequencies of identical forms are compounded, the ordering of

frequencies for masculine and feminine nouns is not the same. Specifically, although for masculine nouns the compounded frequency of the nominative singular form is greater than that of the genitive, for feminine nouns the reverse is true. In both genders, the instrumental occurs far less frequently than the other two cases. Lukatela et al. compared lexical decision latencies to the three cases, nominative, genitive and instrumental. Response latencies revealed a single pattern of results for the two genders; the nominative singular induced the shortest reaction times, and there was no reaction-time difference between the genitive and instrumental singular of both genders. There results were taken to support the privileged status of the nominative case and the satellite organisation of the case forms. Converging evidence on the satellite organisation of inflected forms was also obtained by Lukatela et al. (1987) who showed that decision latencies were fastest for nominative forms, and that there were no latency differences among oblique cases for regular nouns in both genders, and for irregular feminine nouns.

The study by Feldman and Fowler (1987), again on inflected nouns in Serbo-Croatian, extended the assumptions of the satellite model along two lines. Using morphological variants as primes and as targets, it examined first, whether decision latencies to inflected forms of a noun correlated strongly, and second, whether priming was symmetrical for nominative and oblique case forms (that is, whether the morphological variants that led to full priming of the stem could also be primed fully by the stem and by other morphological variants). Any differences in the magnitude of priming as a function of the type of prime or target could provide an index of the cohesion among lexical entries in a noun system. A lexical decision task that involved repetition priming was employed. A first experiment examined the priming of nominative-case nouns by identical and morphologically related words, and a second experiment examined the priming of dative-case targets by nominative-, dative- and instrumental-case primes.

The results showed full priming for nominative forms as targets by dative or instrumental forms as primes, but only partial priming for oblique case targets preceded by different oblique case primes. The connection between nominative and oblique cases appeared to be as strong as the connection between oblique and nominative cases in that neither was significantly different from the identity prime condition. If magnitude of priming is taken to indicate the structure and coherence of inflected noun forms, then such asymmetries reveal certain inhomogeneities in the organisation of the satellite system. In particular, they suggest that the connections between two satellite entries that represent different inflected case forms are weaker than the connection between an entry and its nucleus. By contrast, the

connections between the nominative nucleus and all of its inflected case satellites are equally strong. The latter outcome is taken as evidence for the privileged status of the nominative. In sum, Feldman and Fowler interpreted their results as indicating that the different inflected forms of a noun are independently represented and yet connected to each other.

At the same time, Todorovic (1988) found one effect that could not be easily explained by the 'satellite-entries' view: on presentation of four forms of high, medium and low familiarity feminine nouns with a 150 ms exposure duration, the pattern of response latencies averaged across familiarity indicated faster recognition for the nominative singular, but the other forms were not uniform in latency. In particular, the genitive singular was processed faster than expected relative to the other oblique forms. Todorovic was able to account for this result by pointing out that the genitive singular of feminine nouns has the same form as the nominative plural. On the assumption that both the nominative singular and the nominative plural forms have a privileged status, the processing advantage for the genitive form follows naturally from its syncretism with the nominative. However, Todorovic did not account for the fact that the genitive singular form was also identical with the accusative plural, and that the nominative singular form was identical with the genitive plural. That is, neither of the two forms could be unambiguously treated as nominative. As a result, there should be no processing difference between the two forms due to the pivotal role of the nominative, unless an effect of number was assumed. These and similar inconsistencies between the findings of Lukatela et al. (1980) and Todorovic (1988), as for example, in the relative magnitude of the processing difference between the nominative and genitive forms, as well as the failure to obtain the same pattern of results in a replication of the original Lukatela et al. (1980) study (Kostic, 1995) prompted the conclusion that nouns cannot be organised in a satellite-like fashion and more importantly, that the factors determining processing variation for the inflected noun forms remain unclear.

In order to resolve some of the above-mentioned uncertainties, Kostic (1995) put forward the 'Informational Approach', which we consider here briefly. Our emphasis is on the insights it provides into the types of stimulus properties to which the human language processor appears to be sensitive. According to this approach, the processing latency to identify an inflected noun form is some function of the amount of information derived from the average frequency per thematic role within a particular inflected form. The proper description of a subject's sensitivity to an inflected noun form derives from the amount of information carried by that form. Because the number of thematic roles and form frequency have inverse processing effects, an increase in the number of roles, which implies an increase in

informational load, is compensated for by a frequency increase and therefore, by a decrease in informational load. Importantly, in most cases the increase of one parameter is not associated with a proportional increase in the other parameter. Consequently, the informational load for different noun forms will vary. Processing latencies to inflected noun forms can thus be viewed as reflecting the interaction of the two inverse processing effects. For example, inspection of frequency values and number of thematic roles carried by the nominative case indicates that the shorter processing latency is due to the value of the ratio of frequency to thematic roles, which is large compared to the ratio values for other cases. This is so because the nominative is characterised by high frequency and few thematic roles. Consequently, the contribution of relative frequency to informational load is disproportionately large compared to other cases; this causes its informational load to decrease, and its processing latency to shorten. What is important on this account is that the nominative case has no privileged status compared to the other cases, as there is no difference in the way its informational load value is calculated; what makes its processing so fast relative to the other forms is merely its minimal informational load.

As is clear from this brief review, the empirical evidence that bears on the processing of case forms in word recognition does not converge on a single account. Thus, although the findings reported above demonstrate that there are processing differences between nominative and oblique case forms, these differences are hard to explain in terms of a single model of the recognition of inflected forms. The crucial point however, is that case distinctions appear to be mentally represented and that the language processor draws on such representations during recognition. It remains to be seen whether such processing differences can be found in production, and for languages other than Serbo-Croatian. Particularly, in keeping with our present emphasis on gender, the critical questions are first, whether (and if so, how) advance access not only to gender but also to case affects subsequent word retrieval, and second, whether the different case forms are equally sensitive to these types of advance lexical-syntactic information. With these questions as background we move to Experiment 5, which provides evidence for gender priming with nominative and accusative case words.

5.4 Experiment 5: Same-Case (Nominative, Accusative) (Bare noun) Primes – (Colour adjective) Targets

Experiment 5 has two main goals. The first is to discover whether gender priming can be obtained with accusative-case primes and targets. The choice to use nominative and

accusative rather than any other two cases is motivated by the observation that in Greek the nominative and accusative are by far the most frequently used cases, the genitive being used perhaps less than half as frequently as either of these; the vocative is the least frequently used case, being usable only in a limited number of circumstances (see e.g., Mackridge, 1985; Stephany, 1997). Furthermore, although the nominative is usually considered to be the basic case, and nouns, pronouns, adjectives etc. appear in dictionaries in the nominative singular, it is often argued with some justification that in Greek the accusative is the prime (unmarked) case. It appears therefore, that the nominative and accusative stand out from the other two cases in that they are the most frequent and 'basic' cases in the language. If the gender effect also occurs with these types of NPs, this would indicate that there are no facets of performance peculiar to the production of accusative-case forms that cancel out or that render invisible the effect that was previously obtained with nominative-case forms. Recall that both the independent features and the feature clusters account do not predict any difference in the effect of prior access to gender information on subsequent word retrieval as a function of the case in which the prime-target pair occurs: same-gender nominative and accusative pairs alike should involve the selection of exactly the same individual feature values (or feature clusters) across prime and target. Therefore, on both of these accounts, and under the assumption that there are no intrinsic differences in the representation of case values at the lemma level, gender-marked nominative- and accusative-case targets should benefit equally when preceded by same-gender nominative- and accusative-case primes, respectively.

The second goal is to look for potential effects of inflectional homonymy, that is, whether similar patterns of results are obtained with formally marked and unmarked case distinctions. This issue is addressed by comparing participants' performance with masculine and neuter words. As was shown in Tables 5.1 and 5.2 , only masculine words have distinct forms for the nominative and accusative, e.g., *πράσινος* MASC, NOM, SING – *πράσινο* MASC, ACC, SING versus *πράσινο* NEUT, NOM, SING – *πράσινο*NEUT, ACC, SING 'green'. Neuter words (both nouns and agreement targets) fail to mark the relevant distinction in all grammatical contexts. Feminine nouns and agreement targets, which also have overlapping nominative and accusative forms, differ from the neuter in that they mark the particular case distinction on the definite determiner (*η – τη(ν)*). Given that on certain accounts it is the knowledge of the contexts or of the patterns of co-occurrences of a word with other words that constitutes the knowledge of its class or grammatical properties (see e.g., Maratsos & Chalkley, 1980), even the distinct (or non-distinct) determiner forms could be viewed as part of a word's case specification. Therefore, masculine and neuter words reflect important differences in the way case

distinctions are formally realised. Note also that the accusative provides the context for the occurrence of yet another instance of inflectional homonymy, namely between a masculine and neuter form e.g., *πράσινο* MASC, ACC, SING – *πράσινο* NEUT, ACC, SING 'green', *ένα* MASC, ACC, SING – *ένα* NEUT, ACC, SING 'a' etc.

From a common-sense point of view, all inflectional homonymy should impair communicative efficiency by increasing the likelihood of misunderstanding due to ambiguity. In practice however, the lexical, semantic and/or pragmatic context of any utterance nearly always prevents misunderstanding. It remains therefore to be seen whether such inflectional homonymy facilitates or poses additional demands on the production system. For example, Carstairs-McCarthy (1998) has pointed out that for a lexeme with cumulative inflection (that is, where two or more categories are systematically expressed by one affix), inflectional homonymy is motivated by the fact that it reduces the amount of morphological material to be distributed among the cells of a paradigm. On a different account (Kostic, 1995), inflectional homonymy entails an increase in the number of thematic roles that can be expressed by a noun form, hence an increase in informational (and processing) load, which can however, be counteracted by a corresponding frequency increase. Put into the terms of the Levelt et al. framework, inflectional homonymy is a property of word forms. Because syntactic processes are blind to the formal characteristics of words, the presence or not of word forms that exhibit inflectional homonymy should not matter for the types of effects that are typically attributed to syntactic-level operations. Therefore, the prediction is that there should be no significant difference in the processing of nominative and accusative forms between the two genders.

5.4.1 Method

Participants. Forty volunteers, native speakers of Greek, from the University of Athens community, participated in this experiment. Their ages ranged from 21-29 years.

Materials. Two sets of pictures, a set of experimental items and a set of filler items, were selected. The experimental set comprised a total of 64 pictures. Thirty-two pictures, 16 of which depicted masculine, and 16, neuter nouns, served as targets. Masculine and neuter target nouns were matched for age of acquisition ($t < 1$); thirteen masculine nouns were of medium AoA, two of low and one of high AoA. Of the neuter nouns, thirteen were of medium AoA, and three, of low AoA. Targets were combined with the remaining 32 pictures of comparable objects, which served as primes. Half of the primes had masculine, and the other half had neuter names. Their distribution in the three age-of-acquisition ranges was as

follows: twelve masculine nouns were of medium AoA, three were of high, and one was of low AoA. Of the neuter nouns, nine were of medium AoA and seven, of low AoA. Care was taken not to introduce unwanted phonological or semantic overlap between a prime and target response. Target pictures appeared in one of the following four colours: red, green, orange and light blue. Each picture appeared in one colour only. Prime pictures appeared in black-and-white only. See the Appendix for the full set of materials.

Thirty-two pictures with feminine names were used as fillers in the trials preceding the prime-target pairs. Half of the filler pictures appeared in black-and-white, and the other half in colour. Thus, the pre-prime naming response was either of the same type as the prime response (i.e., bare noun), or of a different type (i.e., gender-inflected colour adjective). Feminine nouns belonged mainly to the low and medium AoA ranges, with the exception of one noun that was of high AoA. Two further sets of ten pictures each, with masculine and neuter names, were selected to serve in the practice trials at the beginning of each block. This resulted in a total of 116 pictures.

Design. Experiment 5 had eight experimental conditions that resulted from the crossing of the factors Gender Identity (the prime had either the same or a different gender from the target; within participants, within items), Target Gender (masculine or neuter; within participants, between items) and Case (nominative or accusative; within participants, within items). Each participant was presented with two experimental blocks. Within each block, case was kept constant. Each experimental item was presented once in each block, hence twice throughout the experiment. Each filler item, by contrast, was presented in only one of the two blocks. Across the two blocks every target item was seen in both priming conditions (same versus different gender) and in both cases (nominative versus accusative). See Table 5.4 for examples of the resulting prime-target combinations. Order of block presentation was varied so that half of the participants saw the nominative block first and the accusative block second, and the other half saw the accusative block first and the nominative block second. Within blocks, the order of trial presentation was randomised, with the constraint that a filler item would always intervene between two prime-target pairs. Each block comprised 96 naming trials.

Table 5.4

Example materials from Experiment 5

P – T gender	Prime	Target
Nominative		
masc – masc	χάρτης (map) *hartis*	πράσινος [κουβάς] (green [bucket]) *prasinos [kuvas]*
neut – masc	σύννεφο (cloud) *sinefo*	πράσινος [κουβάς] (green [bucket]) *prasinos [kuvas]*
neut – neut	σύννεφο (cloud) *sinefo*	πράσινο [κόκαλο] (green [bone]) *prasino [kokalo]*
masc – neut	χάρτης (map) *hartis*	πράσινο [κόκαλο] (green [bone]) *prasino [kokalo]*
Accusative		
masc – masc	χάρτη (map) *harti*	πράσινο [κουβά] (green [bucket]) *prasino [kuva]*
neut – masc	σύννεφο (cloud) *sinefo*	πράσινο [κουβά] (green [bucket]) *prasino [kuva]*
neut – neut	σύννεφο (cloud) *sinefo*	πράσινο [κόκαλο] (green [bone]) *prasino [kokalo]*
masc – neut	χάρτη (map) *harti*	πράσινο [κόκαλο] (green [bone]) *prasino [kokalo]*

Note. P = prime; T = target; masc = masculine; neut = neuter. The words in square brackets are not overtly produced. The words in italics are broad phonological transcriptions of the Greek words.

Apparatus, Procedure. Apparatus and procedure were nearly identical to these of the previous experiments. Participants were instructed to name black-and-white pictures by means of bare nouns, and coloured pictures by means of the appropriate gender-inflected colour adjectives, in one of the two cases. Before each block, participants were told which case they had to use in this block (nominative or accusative). At the end of the experiment, participants were debriefed with regard to their performance in the accusative block. In particular, they were asked whether they had relied on a carrier phrase for the elicitation of the accusative prime and target utterances. An experimental session lasted approximately 40 minutes.

Analyses. Six types of responses were classified as errors: (a) production of a wrong prime name; (b) production of an incorrectly inflected adjective; (c) production of a wrong colour adjective; (d) production of a target noun instead of adjective; (e) production of an incorrectly inflected prime name; and (f) verbal disfluencies e.g., stuttering, utterance

repairs, production of non-verbal sounds that triggered the voice key, outlying response times (less than 300 or more than 2000 ms), and voice-key failures. The reaction times of erroneous responses were excluded from further analyses. Responses that deviated by more than 2.5 SDs from a participant's or an item's mean were replaced by the participant or the item mean +/- 2.5 SDs, respectively. ANOVAs were performed on error rates and response latencies, as a function of Gender Identity (same or different gender between prime and target), Target Gender (masculine or neuter), and Case (nominative or accusative).

5.4.2 Results

Erroneous responses (18%) were distributed as follows: 1.1% for wrong prime-name production; 3.5% for incorrectly inflected adjectives; 2% for wrong colour adjectives; 3% for the production of target nouns instead of adjectives; 2.4% for incorrectly inflected primes; and 6% for verbal disfluencies, outlying responses, and voice-key malfunctioning. Table 5.5 displays mean response latencies, number of valid observations, and error rates as a function of Gender Identity and Case, collapsed over the two genders. Table 5.6 gives the same information separately for the two target genders. Every mean shown is an average over the mean response time and percentage errors of 40 participants, each naming 32 items twice.

Table 5.5

Effects of bare noun prime gender on colour adjective target naming within case: Mean response latencies (ms), number of valid observations, and error rates as a function of Gender Identity and Case, collapsed over the two target genders (Experiment 5)

	Nominative			Accusative		
G-Ident	RT	n	e%	RT	n	e%
Same G	1106	534	16.5	1097	529	17
Diff G	1106	521	18.5	1151	517	19
G effect	0		2	54		2

Note. G-Ident = gender identity; Same G = same gender; Diff G = different gender; G effect = gender effect.

Table 5.6

Effects of bare noun prime gender on colour adjective target naming within case: Mean response latencies (ms), number of valid observations, and error rates as a function of Gender Identity, Target Gender and Case (Experiment 5)

	Nominative						Accusative					
	masc			neut			masc			neut		
G-Ident	RT	n	e%	RT	n	e%	RT	n	e%	RT	n	e%
Same G	1095	258	19	1117	276	14	1106	245	23	1088	284	11
Diff G	1102	252	21	1110	269	16	1170	272	15	1132	245	23
G effect	7		2	-7		2	64		-8	44		12

Note. masc = masculine; neut = neuter; G-Ident = gender identity; Same G = same gender; Diff G = different gender; G effect = gender effect.

Target-utterance onset latencies provided evidence for gender priming: producing a gender-marked target response such as *πράσινος* 'green $_{\text{MASC}}$' was faster after a same-gender prime response such as *καθρέφτης* 'mirror $_{\text{MASC}}$' than after a different-gender prime response such as *κόκαλο* 'bone $_{\text{NEUT}}$'. The overall gender priming effect (main effect of Gender Identity) was significant in both the participants' and the items' analyses, F_1 (1,39) = 5.34, MS_E = 10893, p = .026; F_2 (1,30) = 7.33, MS_E = 5943, p = .011. The main effect of Target Gender and the interaction between Gender Identity and Target Gender were not significant. Furthermore, neither the main effect of Case nor the interaction between Case, Gender Identity and Target Gender were significant (all $Fs < 1$). The interaction between Case and Gender Identity was nearly significant in the participants' analysis only, F_1 (1,39) = 3.86, MS_E = 15057, p = .056; F_2 (1,30) = 2.70, MS_E = 6516, p = .111.

In the corresponding analyses of errors, the interaction between Gender Identity and Target Gender was significant, F_1 (1,39) = 13.64, MS_E = 1.028, p = .001; F_2 (1,30) = 16.23, $p < .01$, reflecting, as in the previous experiments, the higher proportion of errors observed with the masculine colour adjectives. Furthermore, the interaction between Gender Identity, Target Gender and Case was significant in the participants' analysis but non-significant in the items' analysis, F_1 (1,39) = 10.52, MS_E = 1.254, p = .002; F_2 (1,30) = 2.23, p = .145. All other effects were non-significant. Further analyses of the conditions of occurrence of erroneous responses revealed that type-2 errors, that is, the production of incorrectly inflected colour adjectives, occurred more often after a different-gender prime both for masculine and neuter targets (n = 44 and n = 9, respectively) than after a same-gender prime (n = 30 and n = 5, respectively). Therefore, it is possible that some of the errors of this type

occurred due to interference or to some form of attraction from the different gender feature of the prime. Note here that unlike Experiments 1-2, incorrect inflection on the target response in this and the following experiment may reflect a gender selection error or it may reflect a case selection error. Furthermore, type-2 errors were almost twice as frequent with nominative case responses (n = 59) than with accusative responses (n = 29).

In the analyses reported until now, target-utterance reaction times to the first and second presentation of a picture were collapsed. However, it could be the case that certain effects are not resistant to repetition of the items, and that they dissipate with repeated production of a word. I therefore carried out the same analyses as before separately for the first and second presentation of items. Table 5.7 displays mean response latencies, number of valid observations, and error rates as a function of Gender Identity, Target Gender and Case, on first and second presentation of items.

Table 5.7

Mean response latencies (ms) in Experiment 5 as a function of Gender Identity, Target Gender and Case, on first and second presentation of items.

	Nominative				Accusative			
	1st pres		2nd pres		1st pres		2nd pres	
G-Ident	masc	neut	masc	neut	masc	neut	masc	neut
Same G	1081	1164	1109	1070	1101	1100	1111	1076
Diff G	1146	1130	1058	1089	1176	1148	1164	1116
G effect	65	-34	-51	19	75	48	53	40

Note. 1st pres = 1st presentation; 2nd pres = 2nd presentation; masc = masculine; neut = neuter; G-Ident = gender identity; Same G = same gender; Diff G = different gender; G effect = gender effect.

The analysis of first presentation of items revealed a gender priming effect approaching significance, F_1 (1,38) = 3.30, MS_E = 18125, p = .077; F_2 (1,30) = 3.62, MS_E = 22387, p = .066. All other effects were non-significant. In the analysis of second presentation of items, the interaction between Gender Identity and Case was significant by participants, but only marginally significant by items, F_1 (1,38) = 4.70, p = .036; F_2 (1,30) = 3.13, MS_E = 9026, p = .087. All other effects were non-significant. A comparison of the first with the second presentation of items, with Presentation Order treated as a within-items factor, showed a clear gender-priming effect, F_2 (1,30) = 5.84, MS_E = 12606, p = .022, a significant main effect of Presentation Order, F_2 (1,30) = 7.30, MS_E = 6562, p = .011, and a marginally

significant interaction between Gender Identity and Case, F_2 (1,30) = 3.52, MS_E = 12548, p = .07.

5.4.3 Discussion

Experiment 5 investigated the effect of prior access to gender information with nominative and accusative prime-target pairs. The main pattern of results replicated that found in Experiments 1-3, again supporting the predictions of the Levelt et al. model concerning the conditions under which gender priming is obtained. Thus, Experiment 5 provided evidence for a response-time advantage in the production of gender-marked adjectives from same-gender bare noun primes as compared with different-gender primes. This finding provides support to the claim that gender priming is obtained when the target utterance involves the computation of gender agreement, and that mere activation of a gender node, implicated in bare noun production, can induce priming.

A main objective of Experiment 5 was to discover whether the presence and/or magnitude of gender priming is affected by case manipulations. The empirical findings reviewed in Section 5.3.2 suggested that there are differences in the processing of nominative and oblique case words that could cause prior gender information to exert different effects. For example, one possibility could be that nominative case words are more sensitive to properties of the grammatical context than oblique case words; under this assumption, one would expect gender priming to decrease or dissipate with oblique case target responses. Another possibility could be that part of the locus of the facilitation in target picture naming is in facilitated selection times for the target forms. Because different case forms are presumably associated with different production latencies, such facilitation could vary as a function of the time required for the retrieval of the corresponding word form. This might occur because when a word form acquires activation more slowly, it could leave more room for a weaker priming effect to appear (although the reverse could also be true). Regardless of the precise reason, the upshot is that there are likely to be differences between nominative and oblique case words in their production latencies and in the patterns of priming, as indicated by the performance differences in their recognition.

That said, two aspects of the present results were of main theoretical interest. First, the interaction between Gender Identity and Case was shown not to be significant. Inspection of Table 5.6 however, reveals a numerical difference in the magnitude as well as in the direction of the gender effect between the two cases. The 64 ms advantage for primed masculine words in the accusative is reduced to a mere 7 ms advantage in the nominative. A

similar pattern is observed for the neuter words where the 44 ms advantage for primed targets in the accusative is reversed into a negative -7 ms in the nominative. This trend towards a more sizeable gender effect for accusative than for nominative forms was reflected, in the statistical analyses, in the marginally significant by-participants interaction between Gender Identity and Case. The same interaction was significant in the participants analysis and marginally significant in the items analysis of the second presentation of target stimuli. The reason for this difference in the gender effect between nominative and accusative forms is not clear. A possible account of this finding will be outlined in 7.2.2. Given however, that the main effect of Case was not significant, an explanation in terms of some intrinsic difference in the difficulty of processing of the two case forms does not appear to be plausible.

Second, the interaction between Case and Target Gender also failed to reach significance; production latencies for nominative and accusative forms did not differ in any significant way between the two genders, suggesting that differences in the surface realisation of abstract syntactic properties do not matter for the obtained pattern of results. Recall that in Greek, the nominative and accusative forms of neuter words are identical so that the relevant case distinction is merely an abstract syntactic one. In the respective forms of masculine words by contrast, this distinction is overtly marked. In the production of adjectives, case, like gender, constitutes an agreement property; it is assigned to the adjective by virtue of it being the dependent member of an agreement relation (unlike for nouns, where case is a governed property typically constrained by the head of the phrase). On the assumption that case agreement, like gender agreement, is computed at an abstract level of grammatical processing that is largely blind to the eventual phonological form of the utterance, case selection cannot simply be bypassed even if the selected case value does not surface in the form of the agreement target. The present findings, insofar as they show comparable patterns of performance for masculine and neuter words, are consistent with this account.

In summary, Experiment 5 demonstrated that gender priming effects, although weaker, can be found between bare nouns and colour adjectives in a case other than the nominative (here the accusative). Experiment 6 examines gender priming between bare nouns and colour adjectives in another context, when case changes between the prime and target.

5.5 Experiment 6 (Bare noun) Primes – (Colour adjective) Targets across Case (Nominative, Accusative)

The present experiment extends the research reported above to the production of different-case primes and targets. It asks first, how the different types of grammatical information that are implicated in lexical access contribute to that process, and second, whether speakers can benefit from advance access to this information in terms of their reaction times. In Section 5.2, I presented an extrapolation of Levelt et al.'s model to the production of Greek noun phrases and derived certain predictions for potential benefits from advance information. Recall that in Greek noun lemma retrieval is assumed to include the retrieval of a noun lemma's grammatical gender, as well as of case and number information.

Two theoretical proposals concerning the structural coordination of multiple retrieval processes involved in the production of noun phrases were outlined. Although the present focus is on gender and its relation to case, much of this discussion can be easily extended to the relation between other grammatical properties such as number and case, or number and gender. In the independent features account, gender and case were taken to contribute separately to lexical access; gender activation/selection occurred independently of case selection. In other words, two independent processing channels were assumed, one for gender and one for case retrieval, so that processing in the former channel should not be affected by processing in the latter. Given this dissociation, the independent features account predicts that, other things being equal, gender priming should be obtained irrespective of whether the prime and target share the same case value or not. In the feature clusters account by contrast, all the required grammatical information including gender and case but also number and degree (in the case of adjectives) was inextricably intertwined and encoded as an undifferentiated information chunk that has to be selected prior to morphophonological encoding. This account predicts that prior access to grammatical information can facilitate subsequent word production only if the same feature cluster is implicated in the production of the prime and target, as it was in Experiment 5, indeed in Experiments 1-5. In summary, the latter account predicts that a single type of advance information cannot have an independent effect on the time-course of subsequent word retrieval.

Following this proposal, a tentative interpretation of the results thus far could be that gender priming in fact reflected the joint effect of advance access to same gender, case and number information while the absence of priming in the gender-unprimed condition was due to advance access to a different feature cluster rather than to a different gender node. The aim

of Experiment 6 is to identify the precise locus of gender priming and to establish the benefits from the two types (gender and case) of advance lexical-syntactic information for word retrieval. In order to obtain independent evidence for the effect of these types of information, we have participants name pictures by means of nominative- and accusative-case noun phrases. Unlike Experiment 5, the present experiment involves a case manipulation across primes and targets. That is, a prime and target will always have a different case (that will be signalled by the position of the picture on the computer screen), and the same or different gender.

As will be described in greater detail in 5.5.1, this procedure will require two experimental blocks with corresponding instructions, and as a consequence, will focus participants' attention on the case of the intended utterance in each naming trial. This situation is clearly different from the situation in which participants have to produce a single case throughout the entire experiment or the entire block, insofar as the case manipulation can induce a directing of the focus of attention to a particular 'region' of the mental lexicon. Particularly, it is plausible to assume that the process of accusative case selection in the production of a single word utterance (i.e., where there is no function assignment) is more consciously directed than gender selection which could simply be a consequence of the way in which lexical syntactic information is organised and retrieved during the production of a gender marked response. It should be noted however, that the production of oblique-case single word utterances is not an artificial task situation as it might first appear. After all, such utterances are often produced in natural speaking situations where the lexical item that imposes the restrictions on the morphosyntactic properties of some other item (here the verb or preposition that governs the case of its nominal object) is omitted.

Experiment 6 addresses one further issue. It investigates whether masculine and neuter words yield similar patterns of results despite their difference in the surface marking of case distinctions. In Greek, masculine words have distinct forms for the nominative and the accusative while neuter words have the same form in the two cases. If the presence and/or type of morphophonological case markers matters for the way case is processed, then one would expect to see a difference in performance between masculine and neuter words.

5.5.1 Method

Participants. Thirty-six volunteers, native speakers of Greek, from the University of Athens community, participated in the experiment. Their ages ranged from 19-30 years.

Materials, Apparatus. The same materials (prime, target and filler items) and apparatus were used as in Experiment 5. See Table 5.8 for examples of the resulting prime-target combinations.

Table 5.8

Example materials from Experiment 6

P – T gender	Prime	Target
Nominative-Accusative		
masc – masc	χάρτης (map) *hartis*	πράσινο [κουβά] (green [bucket]) *prasino [kuva]*
neut – masc	σύννεφο (cloud) *sinefo*	πράσινο [κουβά] (green [bucket]) *prasino [kuva]*
neut – neut	σύννεφο (cloud) *sinefo*	πράσινο [κόκαλο] (green [bone]) *prasino [kokalo]*
masc – neut	χάρτης (map) *hartis*	πράσινο [κόκαλο] (green [bone]) *prasino [kokalo]*
Accusative- Nominative		
masc – masc	χάρτη (map) *harti*	πράσινος [κουβάς] (green [bucket]) *prasinos [kuvas]*
neut – masc	σύννεφο (cloud) *sinefo*	πράσινος [κουβάς] (green [bucket]) *prasinos [kuvas]*
neut – neut	σύννεφο (cloud) *sinefo*	πράσινο [κόκαλο] (green [bone]) *prasino [kokalo]*
masc – neut	χάρτη (map) *harti*	πράσινο [κόκαλο] (green [bone]) *prasino [kokalo]*

Note. P = prime; T = target; masc = masculine; neut = neuter. The words in square brackets are not overtly produced. The words in italics are broad phonological transcriptions of the Greek words.

Design. Experiment 6 had eight experimental conditions, which resulted from the crossing of the factors Gender Identity (the prime had either the same or a different gender from the target; within participants, within items), Target Gender (masculine or neuter; within participants, between items), and Case Sequence (nominative-accusative or accusative-nominative; within participants, within items). Four experimental lists were constructed such that, within each list, 8 of the 32 target pictures occurred in each of the priming conditions (gender primed or unprimed), . Across the four lists, each target item occurred once in each condition. The order of trial presentation within each block was randomised, with the constraint that a filler item would always intervene between two prime-target pairs. Each experimental list consisted of 192 trials (64 prime trials, 64 target trials, and 64 filler trials).

The naming session comprised two blocks. In each block, the production of a prime-target pair involved a different case sequence. In one block, bare-noun primes were produced in the nominative case and colour-adjective targets in the accusative case, and in the other block, primes were produced in the accusative case and targets, in the nominative case. Production of a nominative- or an accusative-case response was signaled by picture position on the screen. Experimental items were presented once in each block, thus twice throughout the experiment. Each filler item was presented once, in only one of the two blocks. Across the two blocks every target item was seen in both priming conditions (that is, preceded by a same-gender and by a different-gender prime), each time in a different case sequence. Order of block presentation was systematically varied so that half of the participants produced the nominative-accusative case sequence first, and the accusative-nominative case sequence second, and the other half produced the accusative-nominative case sequence first, and the nominative-accusative case sequence second. The two blocks were presented successively. Unlike in Experiment 5, they were not separated in any way that would draw participants' attention to the change of case sequence in the prime-target pairs. A single set of instructions that applied to the entire naming session was provided at the beginning of the experiment. Participants were randomly assigned to one of the four experimental lists that were created.

Procedure. Preview-block presentation and trial structure were the same as in the previous experiments. In this experiment however, position of picture display on the screen was systematically varied; a picture could appear either in the upper half or in the lower half of the screen. The type of response required was contingent upon the position of picture display. Half of the times, picture presentation in the upper half of the screen would induce nominative-case responses, and in the lower half of the screen, accusative-case responses. In the other half, the reverse would hold. Position of display of the visual warning signal (asterisk) prior to picture presentation was also varied; it appeared centered, either in the lower or in the upper half of the screen, indicating the position of the upcoming picture.

Participants were instructed to name black-and-white pictures by means of bare noun NPs, and coloured pictures by means of gender-inflected colour adjectives. Furthermore, half of the participants were instructed to produce nominative-case responses for pictures displayed in the upper half of the screen, and accusative-case responses for pictures displayed in the lower half of the screen, and the other half were given the reverse instructions. Response speed and accuracy, and the correspondence between case and position of picture display were emphasised. The instructions were followed by a practice session of twenty trials. At

the end of the experiment, participants were debriefed with regard to the way they had carried out the experiment. Specifically, they were asked whether they had associated the different response types with carrier phrases, and whether they had relied on the latter to produce the case distinctions. Each block comprised 96 naming trials. The entire experiment lasted approximately 40 minutes.

Analyses. Six types of responses were classified as errors: (a) production of a wrong prime name; (b) production of an incorrectly inflected adjective; (c) production of a wrong colour adjective; (d) production of a target noun instead of adjective; (e) production of an incorrectly inflected prime name; and (f) verbal disfluencies e.g., stuttering, utterance repairs, production of non-verbal sounds that triggered the voice-key, outlying response times (less than 300 or more than 2000 ms), and voice-key failures. The reaction times of erroneous responses were excluded from further analyses. Responses that deviated by more than 2.5 SDs from a participant's or an item's mean were replaced by the participant or the item mean +/- 2.5 SDs, respectively. ANOVAs were performed on error rates and response latencies, as a function of Gender Identity, Target Gender and Case Sequence.

5.5.2 Results

Erroneous responses (17.8%) were distributed as follows: 1.1% for wrong prime-name production; 3.9% for incorrectly inflected adjectives; 1.1% for wrong colour adjectives; 2.9% for the production of a target noun instead of adjective; 1.9% for incorrectly inflected primes; and 6.9% for verbal disfluencies, outlying responses and voice-key malfunctioning. Table 5.9 displays mean response latencies, number of valid observations, and error rates as a function of Gender Identity and Case Sequence, collapsed over the two genders. In Table 5.10, this information is given separately for the two target genders. Every mean shown is an average over the mean response-time and percentage errors of 36 subjects, each naming 32 items twice.

Table 5.9

Effects of bare noun prime gender on colour adjective target naming across case: Mean response latencies (ms), number of valid observations, and error rates as a function of Gender Identity and Case Sequence, collapsed over the two target genders (Experiment 6)

	Nominative-Accusative			Accusative-Nominative		
G-Ident	RT	n	e%	RT	n	e%
Same G	1182	492	14.5	1211	446	23
Diff G	1171	492	14.5	1227	464	19.5
G effect	-11		0	16		-3.5

Note. masc = masculine; neut = neuter; G-Ident = gender identity; Same G = same gender; Diff G = different gender; G effect = gender effect.

Table 5.10

Effects of bare noun prime gender on colour adjective target naming across case: Mean response latencies (ms), number of valid observations, and error rates as a function of Gender Identity, Target Gender and Case Sequence (Experiment 6)

	Nominative-Accusative						Accusative-Nominative					
	masc			neut			masc			neut		
G-Ident	RT	n	e%	RT	n	e%	RT	n	e%	RT	n	e%
Same G	1173	240	16.7	1191	252	12.5	1207	198	31	1215	248	14.9
Diff G	1177	247	14	1165	245	15	1221	239	17	1233	225	21.9
G effect	4		-2.7	-26		2.5	14		-14	18		7

Note. masc = masculine; neut = neuter; G-Ident = gender identity; Same G = same gender; Diff G = different gender; G effect = gender effect.

The analyses of target-utterance onset latencies did not yield any significant results. Producing a gender-marked target response such as *πράσινος* 'green $_{\text{MASC}}$' was as fast after a same-gender prime response such as *μαγνήτης* 'magnet $_{\text{MASC}}$' as after a different-gender prime response such as *κύπελλο* 'medal $_{\text{NEUT}}$' ($Fs < 1$). The case manipulation did not appear to have any reliable effect either. In particular, the main effect of Case Sequence was significant in the items' analysis but non-significant in the participants' analysis, F_1 (1,35) = 2.77, MS_E = 47376, p = .105; F_2 (1,30) = 16.34, MS_E = 3676, p < .01. Similarly, the interaction between Case Sequence and Gender Identity was significant in the items' analysis but non-significant in the participants' analysis, F_1 (1,35) = 1.09, MS_E = 12287, p = .302; F_2 (1,30) = 4.38, MS_E = 4794, p = .045.

The corresponding error analyses showed a significant interaction between Gender Identity and Target Gender, F_1 (1,35) = 16.75, MS_E = 1.261, $p < .01$; F_2 (1,30) = 29.43, $p < .01$, a significant main effect of Case Sequence, F_1 (1,35) = 12.74, MS_E = 1.492, $p = .001$; F_2 (1,30) = 24.01, MS_E = 1.781, $p < .01$, and a significant three-way interaction between Case Sequence, Gender Identity and Target Gender, F_1 (1,35) = 6.66, MS_E = 1.302, $p = .014$; F_2 (1,30) = 4.94, $p = .034$. Further analyses of the conditions of occurrence of erroneous responses revealed that, unlike Experiment 5, type-2 errors, that is, the production of incorrectly inflected colour adjectives in the present experiment occurred more often after a same-gender prime both for masculine and neuter targets (n = 47 and n = 4, respectively) than after a different-gender prime (n = 37 and n = 2, respectively). Furthermore, as in Experiment 5, these errors were more frequent with nominative case responses (n = 53) than with accusative responses (n = 37).

As with Experiment 5, in order to examine potential effects from repetition of the target items the same analyses were carried out as before, now separately for the first and second presentation of items. Table 5.11 displays mean response latencies as a function of Gender Identity, Target Gender and Case Sequence, on first and second presentation of items.

Table 5.11

Mean response latencies (ms) in Experiment 6 as a function of Gender Identity, Target Gender and Case Sequence, on first and second presentation of items

	Nominative-Accusative				Accusative-Nominative			
	1st pres		2nd pres		1st pres		2nd pres	
G-Ident	masc	neut	masc	neut	masc	neut	masc	neut
Same G	1226	1260	1121	1122	1231	1199	1183	1231
Diff G	1268	1232	1085	1098	1246	1228	1197	1238
G effect	42	-28	-36	-24	15	29	14	7

Note. 1st pres = 1st presentation; 2nd pres = 2nd presentation; masc = masculine; neut = neuter; G-Ident = gender identity; Same G = same gender; Diff G = different gender; G effect = gender effect.

The analysis of first presentation of items did not yield any significant results. In the analysis of second presentation, the main effect of Case Sequence was shown to be significant in the items' analysis, but marginally significant in the participants' analysis, F_1 (1,34) = 3.43, MS_E = 118106, $p = .072$; F_2 (1,30) = 34.63, MS_E = 11167, $p < .01$. A comparison of the first with the second presentation of items, with Presentation Order treated as a within-items factor, showed a significant main effect of Case Sequence, F_1 (1,30) = 16.36, MS_E = 6806, $p < .01$,

and of Presentation Order, F_1 (1,30) = 37.46, MS_E = 9327, p < .01, and a significant interaction between the two, F_1 (1,30) = 26.18, MS_E = 11374, p < .01. The interaction between Gender Identity and Case Sequence was marginally significant, F_1 (1,30) = 3.58, MS_E = 9902, p = .068.

5.5.3 Discussion

In Experiment 6, none of the main effects or interactions reached statistical significance in the reaction time analyses. In particular, there was no evidence of a gender priming effect: participants were as fast to produce a gender-marked target response after having produced a bare noun of the same gender, as after having produced a bare noun of a different gender. As can be seen in Table 5.9, the numerical size of the priming effect was very small (an average of 2.5 ms). Given that gender priming has been obtained both with nominative and with accusative prime-target pairs, the present null results could be taken to support the feature clusters account according to which no gender priming should be obtained with different-case primes and targets.

As in Experiment 5, the main effect of Case Sequence was not reliable in this experiment either; it was significant in the items' analysis but non-significant in the participants' analysis. Inspection of Table 5.9 reveals a 42 ms advantage in mean response latencies for accusative targets preceded by nominative primes (1177 ms) as compared with nominative targets preceded by accusative primes (1219 ms). This advantage is observed both for masculine (39 ms) and neuter targets (46 ms), and is most pronounced for the neuter targets that are preceded by different-gender primes (68 ms). It is also observed in the analysis of the second presentation of items, where the main effect of Case Sequence was shown to be clearly significant in the analysis by-items, and approaching significance in the analysis by-participants. Although we did not expect such a systematic difference (at least numerically) between the production latencies for nominative and accusative targets when preceded by accusative and nominative primes respectively, this observation could provide insights into the representational and/or processing relationship of different-case words. In particular, if we assume that word retrieval is sensitive to, and hence can be modulated by, prior access to case information, then the present findings could be interpreted as evidence either that the nominative can prime more fully than can the accusative case, or that the accusative can be primed more fully than can the nominative. Recall here that such priming asymmetries between different case forms of a noun have also been reported in the recognition literature (e.g., Feldman and Fowler, 1987), and have been interpreted as reflecting the structure of the noun system. Critically, the afore-mentioned pattern was observed in both genders. Given

that neuter words, unlike masculine words, do not mark the nominative-accusative distinction formally, this strongly suggests that the selection of case occurs at an abstract syntactic level, and that this process need not be affected by the surface realisation of the to-be selected feature.

A related observation concerns the interaction between Gender Identity and Case Sequence. Although this effect was not reliable either (it was significant in the items' analysis but non-significant in the participants' analysis), there was a trend towards larger facilitation from advance access to gender information with nominative than with accusative targets. This trend was most noticeable with the neuter items where the 26 ms negative effect in the accusative case was reversed in an 18 ms positive effect in the nominative.

Combined with the results from Experiment 5, the present data suggest that the critical gender effect is affected by case manipulations; it dissipates when case is varied across the prime and target, and it becomes less stable when case is varied across experimental blocks. One possible account of the data could be that lexical selection does not involve the retrieval of independent lexical-syntactic features but rather the retrieval of feature combinations or clusters. A second possible account however, could be that there is some facet of performance peculiar to the processing of case, or to the processing relationship between case and gender, that renders gender priming weaker or even cancels it out. Thus, the implications of the results from Experiments 5 and 6 should be more limited in scope under this view, since it is questionable whether other properties such as number, should have the same effect on gender priming. In particular, our demonstration that case manipulations dirsupt gender priming does not necessarily entail that the manipulation of other syntactic properties should also have the same effect. Thus, it does not rule out the possibility that gender may in fact be independently processed. In order to explore further this possibility, gender priming is examined again in Chapter 6, this time with the added manipulation of number.

We conclude this section with a discussion of two non-trivial methodological problems of Experiments 5 and 6. The first concerns the validity of eliciting accusative-case responses in a picture naming task. In Greek, the accusative is not used for naming. Therefore, participants perform a rather unnatural task when they produce accusative-case responses as picture names. Furthermore, syntactically the accusative is used for the direct object of almost all transitive verbs and of most prepositions. Following traditional accounts of case we might say that transitive verbs and prepositions assign accusative case to the noun phrase

they govern. In the present task however, there is no explicit or implicit governing verb or preposition; what is more, the 'assignment' of accusative case to the target noun phrase does not mark any structural relation (e.g., direct object of verb or preposition) among constituents as is the case in natural speaking situations, hence rendering almost void and superfluous the nominative-accusative distinction in the present task.

The second methodological problem concerns the degree of morphological realisation of abstract case. As has been pointed out, masculine words in Greek have distinct forms for the nominative and accusative. Neuter words by contrast, do not distinguish between the nominative and accusative formally. Therefore, although participants were instructed to produce the target responses in one of the two cases, it is not possible to tell with certainty whether they did in fact produce accusative as opposed to nominative neuter words in the accusative-case trials. Thus, the lack of formal case distinctions in neuter words adds a non-trivial confound in the interpretation of the present findings. The two methodological issues, although left unresolved at present, definitely warrant further investigation in future explorations of case.

5.6 Summary

The results of Experiments 5 and 6 can be summarised in three points. First, there was a significant gender effect for accusative-case primes and targets. Second, the production of a target response did not benefit from a same-gender prime response when the prime and target differed in case. Third, the masculine and neuter words yielded comparable patterns of results. Our tentative explanation for the dissipation of the gender effect with different-case primes and targets was that gender may not contribute independently to lexical access, and that priming may occur only when the same feature cluster is implicated in the production of the prime and target. The experiments to be reported in the next chapter aim to test this account by examining the potential contribution of number information to lexical access, and by looking at the nature of the interaction between number and gender.

Chapter 6 Gender and Number

6.1 Introduction

In the previous chapter, we examined the effect of prior access to two types of lexical-syntactic information on subsequent word production. Specifically, given the intuitive plausibility of a relationship between the retrieval of gender and case in Greek, by virtue of the fused marking of the two categories, we tested two hypotheses about the way the different kinds of grammatical information are used by the production system during lexical access. The absence of a gender effect with different-case primes and targets was in line with the predictions derived by the feature clusters account, supporting the suggestion that lexical access involves the retrieval of an undifferentiated feature cluster rather than of independently represented features, and that priming occurs when the same feature cluster is implicated in the production of the prime and target. Proceeding in the same line, we now look at the relationship between gender and number and examine whether gender priming can be obtained with different-number primes and targets. Our aim is to evaluate further the independent features and the feature clusters accounts by discovering whether a manipulation of number, like the manipulation of case, will affect gender priming

The chapter is structured as follows. First I discuss some theoretical and empirical proposals concerning the representation and selection of number, and consider the operations involved in nominal plural formation in Greek. I then review some empirical findings on the relationship between gender and number in production. Finally, I report on two experiments in which number is systematically manipulated, that examine whether gender priming is in fact contingent upon the selection of the same feature cluster in the prime and target as suggested in the previous chapter, or whether it is contingent merely upon the gender relatedness between the two utterances.

6.2 Theoretical and empirical issues

6.2.1 Gender and number

As previously mentioned (3.2.3.3), number is the category most intimately bound up with gender (Corbett, 1991). Languages which show agreement in gender, may do so in one number only. Furthermore, while agreement classes which are based on a difference in agreement in one morphological case are not recognised as genders but as sub-genders, agreement classes based on a difference in number are treated as genders. This is so because the sets of agreements associated with number distinctions are not minimally different, as are those associated with case distinctions. That is, they do not differ only for a small proportion of the morphosyntactic forms of any of the targets, but for a half or a third of the forms. In Greek, the expression of number and gender is fusional: a single suffix marks both categories as well as case. A change in the value of one category induces a change of the suffix and therefore, a concomitant change in the morphophonological realisation of the other category.

Unlike case, which is a governed property (that is, it is imposed on the governed member of an expression, typically a complement or specifier, by the governing member, which however does not necessarily share this property), number information appears to be more intrinsic to nouns in the sense that nouns 'have' number wherever they appear, whether or not there is an agreeing expression. In the Levelt et al. framework, the number of a noun is set by copying the information of a concept classification node at the conceptual level to the number diacritic at the lemma level (with the exception of those nouns that are inherently specified for a particular number value). Despite the disparity in the source of the information (structural versus conceptual) that typically determines the case and number of a noun, what is important is that both properties are represented at the lemma level by diacritics whose values are set each time depending on the context. This entails that case and number, unlike gender, should be selected rather than merely activated even in bare noun production. For adjectives, both case and number are treated as agreement properties and therefore also have to be selected.

It should be noted here that within the domain of language comprehension and on the basis of simulation studies, Baayen, Dijkstra and Schreuder (1997) have suggested as optimal a different basic architecture for the representation and processing of plural words whereby plural forms have their own lemma representations. For one thing, this proposal is in line with the linguistic observation that nominal pluralisation entails some kind of concept formation. For some nouns, the changes in syntactic and semantic information may be

minimal, restricted to a change in number only. For other nouns however, the semantics of the plural are subtly different from those of the singular. For plural-dominant nouns, for example, such as *ears*, which denote natural pairs, the singular is marked in that it singles out one instance from the pair. Singular-dominant nouns by contrast, such as *mouth*, can be pluralised, but are semantically marked in the plural: mouths do not occur in natural groups. If a similar claim is made for production, and number is treated as an inherent property of noun lemmas, this would entail that number like gender is not selected during bare noun production. Although this is an interesting possibility, the postulation of a model with distinct lemmas for the different numbers of a noun appears less parsimonious.

Because in the Levelt et al. model, case and number are not inherent properties, number invites an experiment parallel to Experiment 6. As with case, the alternate predictions derived by the two accounts are as follows. If gender and number are independently represented and accessed (independent features account), then gender priming should in principle be obtained irrespective of the number value (same or different number) of the prime and target. If however, gender and number are linked in a single information chunk (feature clusters account) the constituent components of which are not visible to the language production system, and if lexical access involves the retrieval of such a chunk rather than of individual grammatical properties, then the production of a target utterance should be facilitated only if it involves the retrieval of the same information chunk as the prime. When gender or number is varied, this results in a different information chunk. Consequently, no gender priming should be obtained if the prime and target have a different number.

The issue of the role of gender and number in lexical access is related, at least in part, to the issue of the time course of the retrieval, and of the processing of singular and plural forms. That is, does the production of, for example, the singular word *κήπος* 'garden $_{\text{MASC, NOM, SING}}$' take as long as the production of the plural *κήποι* 'gardens $_{\text{MASC, NOM, PL}}$' or are there systematic differences in response latencies associated with the two numbers? And, are plural forms derived from the corresponding singular forms by the application of a rule, typically realised by the addition of an affix to the stem, or are the two forms stored and generated independently as two distinct lexemes with different frequencies and other form-level characteristics? Thus for example, given the robustness of the positive correlation effect between mean production latencies and the magnitude of gender priming, one could hypothesise that if singular target forms induce shorter production latencies than plural forms, then they should also yield weaker priming effects. On this account, the presence or the magnitude of a gender effect could be conditioned, at least in part, not by the processing

characteristics of lemma selection per se, but by the characteristics of form-level processes. With this issue as background, we turn to the next section where some empirical evidence on the production of plural words is briefly reviewed.

6.2.2 The production of plural forms

The empirical evidence on the production of plural forms is relatively scarce. In the Levelt et al. framework, regular plural words are taken to belong to the 'single-lemma-multiple-morpheme' category. Thus for example, the word *books* is generated from a single lemma *book* that is marked for +pl. It is only at the word-form level that two nodes are involved, one for *book* and the other for *s*. Overall, plural forms are expected to induce longer naming latencies than singulars because of their greater morphological and conceptual complexity. In an as yet unpublished study on singular and plural dominants by Baayen, Levelt, and Haveman reported in Levelt et al. (1999), it was shown first, that plurals were slower than singulars, and second, that both the plural dominant singulars (e.g. *eye*) and the plural dominant plurals (e.g., *eyes*) were significantly slower than the singular dominant words, although the stem frequency was controlled to be the same for the plural and the singular dominants. This was taken to suggest that plural formation may involve variable operations e.g., the selection of a distinct lexical concept and lemma depending on the case at hand. Furthermore, the absence of a surface frequency effect was accounted for by the fact that for both singular and plural dominants, the singular and plural forms converged on the same morpheme at the word-form level.

As noted earlier, a similar claim about plurals having their own lemma representations has been made in comprehension studies (e.g., Baayen et al., 1997; Laudanna & Burani, 1995). A critical finding in these studies has been that response latencies to singulars and plurals are determined by a number of parameters such as the distributional properties of affixes, the productivity, the semantic, phonological and/or orthographic transparency of forms, modality etc. For example, Baayen et al., who examined how regular Dutch plurals in *-en* and their singulars are processed, obtained a surprisingly high parse time of some 300 ms for noun plurals, from their mathematical formalisation of a parallel dual-route race model. This contrasted with a much shorter parse time of 90 ms calculated for some experimental results for Italian noun singulars and plurals (Baayen, Burani & Schreuder, 1996). The outcome of Baayen et al.'s (1997) model yielded a reliable fit to the empirical findings of their Experiment 1. In Dutch, *-en* occurs almost twice as often as a verbal inflection than as a nominal inflection. Because a noun stem and the default (most frequent) verbal reading of -

en create a subcategorisation conflict, the resolution of this conflict is time-costly and, apparently, underlies the long parse time.

In a further experiment in which they compared noun plurals and singulars with verb plurals and singulars, Baayen et al. (1997) found that in contrast to the nouns, the verbs did not yield any significant difference in processing time between their singulars and plurals, even though the plurals were all lower in frequency than the singulars. On the basis of this pattern of results, Baayen et al. suggested that because for verbs there is no real subcategorisation conflict, their plurals are recognised on the basis of their stems and the suffix *-en*. It is only for noun plurals that full-form access representations are involved, the role of which is to speed up lexical processing which would otherwise be slowed down substantially by the subcategorisation conflict. Baayen et al. therefore concluded that any model of the processing of singulars and plurals would be severely limited unless the considerable cross-linguistic variation in word formation patterns and in the specific properties of affixes is taken into account.

Despite the basic disparities in the processes involved in word recognition and production, some of the issues addressed with respect to the comprehension of singulars and plurals may have ramifications for accounts of how these words are produced. If, for example, multi-functional plural suffixes such as the Dutch regular plural morpheme *-en*, induce considerably longer processing latencies compared to singular forms but also to the respective forms in other languages (Baayen et al., 1996), then the question arises as to whether the selection of a multi-functional (and potentially ambiguous) plural morpheme in production also induces longer latencies compared to a morpheme that does not create a subcategorisation conflict. This issue is particularly pertinent to the discussion of plural word-production in a highly inflected, fusional language such as Greek with a high degree of syncretism.

6.2.3 Effects of number manipulations on gender priming

The patterns of matching between singular and plural (3.2.3.3) have been shown to have consequences for the presence or not of a gender effect. In a study aimed to investigate the locus of the gender interference effect in German and Dutch, Schiller and Caramazza (2000) presented pictures of one or two objects paired with a gender-congruent or a gender-incongruent distractor word. The pictures had to be named in the singular or in the plural with the appropriate determiner. In the singular, both German and Dutch have different determiners associated with the different gender classes, while in the plural there is only one

determiner form to refer to all genders. Schiller and Caramazza made the following predictions: if the gender interference effect is genuinely due to the competition of abstract gender nodes at the lemma level, it should occur in the plural as well as in the singular. If by contrast, the effect is due to the competition of determiner forms, it should show up only in the singular but not in the plural. The latter prediction was borne out consistently: in both languages, the gender interference effect was restricted to the singular condition, where a selection had to be made between the different determiner forms conditioned by the target's gender. The effect was absent in the plural condition where the determiner form was identical for all genders.

Schiller and Caramazza's findings were taken to demonstrate that when different gender classes map onto the same determiner form, the effect of concurrent congruent or incongruent gender information is either absent or rendered invisible. At a more general level, these findings undermine a basic tenet of Levelt et al.'s model, namely that phonological processes do not feed back to the level of grammatical encoding. Particularly, if competition between determiners occurs at a phonologically specified level of representation as proposed by Schiller and Caramazza, these results suggest first, that phonological encoding can be initiated before gender selection and gender agreement have been completed at the lemma level, and second, that the gender-based phonological choice feeds back to the syntactic level. Such an account supports cascaded (e.g., Jescheniak and Schriefers, 1998; Peterson and Savoy, 1998) and interactive (e.g., Dell, 1986) models of lexical access. In the present context, the above findings could also be taken to indicate that the gender effect is dissipated when there is number variation between the distractor and target. Thus, they would tie in nicely with the predictions of the feature clusters account whereby priming should only be obtained when the same feature cluster is implicated in the processing of the prime (here the distractor) and target. In the Schiller and Caramazza study, because the number of the distractor and target is always different, their corresponding feature clusters differ and therefore, no gender effect is observed.

6.2.4 Nominal plural formation in Greek

Before turning to the experiments, I briefly introduce some characteristics of nominal plural formation in Greek, and consider the patterns of matching between the singular and plural. Apart from the addition of a suffix to the stem, nominal plural formation in Greek may also involve morphological or phonological operations at the stem level. The different types of plural formation are illustrated in the examples below. Examples a-d exhibit stem allomorphy between the two numbers. In examples e-f, there is a stem-final phonological,

but not orthographic, change conditioned by the presence of the plural morpheme; the stem-final letter *ί* is pronounced /i/ in the singular but /j/ in the plural. Finally, in examples g-i, the plural is formed by the addition of a suffix, with no morphological or phonological operation involved at the stem level.

(6.1)

a. *κύμ-α,*	*κύματ-α*	'wave $_{\text{NEUT, NOM/ACC/VOC, SING}}$,	waves $_{\text{PL}}$'
b. *σώμ-α,*	*σώματ-α*	'body $_{\text{NEUT, NOM/ACC/VOC, SING}}$,	bodies $_{\text{PL}}$'
c. *καφ-ές,*	*καφέδ-ες*	'coffee $_{\text{MASC, NOM, SING}}$,	coffees $_{\text{PL}}$'
d. *τενεκ-ές,*	*τενεκέδ-ες*	'tin $_{\text{MASC, NOM, SING}}$,	tins $_{\text{PL}}$'
e. *κλουβί,*	*κλουβι-ά*	'cage $_{\text{NEUT, NOM/ACC/VOC, SING}}$,	cages $_{\text{PL}}$'
f. *σφυρί,*	*σφυρι-ά*	'hammer $_{\text{NEUT, NOM/ACC/VOC, SING}}$,	hammers $_{\text{PL}}$'
g. *φύλλ-ο,*	*φύλλ-α*	'leaf $_{\text{NEUT, NOM/ACC/VOC, SING}}$,	leaves $_{\text{PL}}$'
h. *ώρ-α,*	*ώρ-ες*	'hour $_{\text{FEM, NOM/ACC/VOC, SING}}$,	hours $_{\text{PL}}$'
i. *νίκ-η,*	*νίκ-ες*	'victory $_{\text{FEM, NOM/ACC/VOC, SING}}$,	victories $_{\text{PL}}$'

With respect to the pattern of matching of genders between singular and plural, Greek exhibits the characteristics of both a 'parallel' and a 'convergent' (and less so of a 'crossed') system (3.2.3.3). That is, the mapping of the target genders in the singular onto the target genders in the plural may be of a one-to-one type (Table 6.1), of a many-to-one type (Table 6.2), or of a many-to-many type (Table 6.3). This entails that plural forms in Greek mark fewer gender distinctions than their singular counterparts (in line with Greenberg's universal which states that a language never has more gender categories in nonsingular numbers than in the singular).

Table 6.1

Examples of a one-to-one mapping of target genders in the singular onto target genders in the plural with the adjectives δυνατός,-η,-ο 'strong', and βαθύς,-ιά,ύ 'deep'

	Number	
Gender	singular	plural
masc	δυνατός	δυνατοί
fem	δυνατή	δυνατές
neut	δυνατό	δυνατά
masc	βαθύς	βαθιοί
fem	βαθιά	βαθιές
neut	βαθύ	βαθιά

Table 6.2

Example of a many-to-one mapping of target genders in the singular onto target genders in the plural with the definite determiner ο, η, το 'the'

	Number	
Gender	singular	plural
masc	ο	οι
fem	η	οι
neut	το	τα

Table 6.3

Example of a many-to-many mapping of target genders in the singular onto target genders in the plural with the adjective συνεχής,-ής,-ές 'continuous'

	Number	
Gender	singular	plural
masc	συνεχής	συνεχείς
fem	συνεχής	συνεχείς
neut	συνεχές	συνεχή

Note that in Greek, masculine and feminine words converge more on their plural forms than neuter words do with either of the two gender classes. In fact, the genitive plural form is the only point of convergence of neuters with masculine and feminine words.

On the assumption that the pattern of gender matching between singular and plural forms may affect gender priming (Schiller & Caramazza, 2000), the Greek data outlined above raise some interesting opportunities for further research. First, unlike the plural of German or Dutch, which is associated with a single type of mapping i.e., many-to-one, the plural of Greek is associated with two mapping types i.e., one-to-one and many-to-one (and arguably with a third, many-to-many type). Therefore, it provides the opportunity for testing the effect of mapping types within the same number rather than across numbers, thus controlling for the potentially confounding effect of number. It also provides the opportunity for testing whether the processes of gender selection and speech output preparation are the same for different plural target utterances e.g., adjectives such as *δυνατοί* 'strong $_{\text{MASC, NOM, PL}}$' and definite determiners such as *οι* 'the $_{\text{MASC/FEM, NOM, PL}}$' despite the fact that gender information guides in one case, the selection of a free-standing lexical element, and in the other, the selection of a bound morpheme. Thus, by comparing the patterns of results between the two plural target utterances, one can gain insight into some of the principles e.g., the optimisation of similarity of processes versus the optimisation of tailoring of processes to form-level characteristics, that govern the organisation of the production system. Furthermore, because the same type of gender mapping (one-to-one) can be found both in the singular and in the plural in Greek, by comparing gender priming in the two numbers it is possible to obtain evidence on the effect of prior access to number and on its interaction with gender on lexical access. In the following, I report two experiments that examine the nature of the relationship between gender and number, and establish the benefits from the two types of advance information for two types of prime noun phrases.

6.3 Experiment 7: (Bare noun) Primes – (Colour adjective) Targets across Number

The aim of Experiment 7 is to evaluate further the two accounts outlined in Chapter 5 regarding the way different types of grammatical information contribute to lexical access. The predictions derived from the two accounts are summarised as follows. If gender and number are independently represented and accessed (independent features account), then the effect of prior access to gender information on subsequent word retrieval should not depend on the number of the prime and target: the gender effect should be the same whether the

prime and target have the same number or a different number. If however, gender and number are not represented independently, but are linked in an undifferentiated information chunk (feature clusters account), then priming should be contingent upon the retrieval of the same information chunk in the prime and target. Because a difference in number results in a different information chunk altogether, no priming should be obtained with same-gender but different-number primes and targets.

Unlike Experiments 5 and 6, in which gender priming was examined relative to a structurally-conditioned grammatical property (case), the present experiment involves the manipulation of a primarily conceptually-conditioned, grammatical property (number). Given that participants produce singular or plural noun phrases in response to pictures of one or two objects respectively, the present task is quite a natural naming task in which the conceptual input determines the production of plural forms. This contrasts with the somewhat 'less natural' conditions under which non-nominative case forms had to be produced in the previous two experiments. Thus, although there is no a priori reason to expect a differential effect of case and number manipulation on gender priming, since both categories are treated in a unified manner by Levelt et al., a variable effect could nevertheless arise as a function of the difference in the source of information (structural versus conceptual) that triggers the selection of the two categories, and of the way this information is called upon during picture naming.

Given that, in the present experiment, the focus is not on plural word production per se but on the relationship between gender and number, plural responses are restricted to the prime condition. Target responses are always in the singular in order to avoid possible confounds in the critical naming trials from conceptual and morphological complexity typically associated with plural forms. Although in much of the discussion thus far it has been the number feature of the target and the corresponding surface realisation of gender that were shown to matter for the predicted pattern of results, a related issue is whether the number feature and the corresponding gender marking of the prime are also critical in conditioning the presence of a gender effect. For example, one could hypothesise that plural primes which are morphologically gender-ambiguous prime gender less strongly than their unambiguous singular counterparts.

In the present context, this is an unlikely outcome because the primes are nouns and have inherent gender. That is, they are uniquely associated with a particular gender irrespective of number. Furthermore, when producing language rather than comprehending it, the speaker

already knows what he is going to say. Thus, at least in principle, whether or not a given morpheme marks different meanings, as for example in the case of syncretism, should not matter for the way the morpheme is produced (although recall that the issue of inflectional homonymy and of the production of multi-functional morphemes has not been adequately explored in the Levelt et al. framework, and that Schiller and Caramazza's (2000) findings reported above suggested that form-level properties do have consequences for the way these forms are produced).

6.3.1 Method

Participants. Thirty-two volunteers, native speakers of Greek, from the University of Athens community, participated in this experiment. Their ages ranged from 18-26 years.

Materials. Two sets of pictures were selected: a set of experimental items and a set of filler items. The experimental set comprised a total of 64 pictures. Thirty-two pictures, 16 of which depicted masculine, and 16, neuter nouns, served as targets. Their distribution in the three AoA ranges was as follows: twelve masculine nouns were medium-acquired, two were low-acquired, and two were high-acquired. The distribution of the neuter nouns in the three AoA ranges was thirteen, three and zero, respectively. Targets were combined with the remaining 32 pictures of comparable objects, which served as primes. Half of the primes had masculine, and the other half had neuter names. Care was taken not to introduce unwanted phonological or semantic overlap between a prime and target response. Half of the prime trials involved the presentation of a single picture, and the other half involved the presentation of two identical pictures. Target pictures appeared in one of the following four colours: red, green, orange and light blue. Each picture appeared in one colour only. Prime pictures appeared in black-and-white only. See Table 6.4 for examples of the resulting prime-target combinations, and see the Appendix for a complete list of the materials used.

Table 6.4

Example materials from Experiment 7

P – T gender	Prime	Target
Same Number		
masc – masc	νιπτήρας (wash-basin) *niptiras*	πράσινος [καθρέφτης] (green [mirror]) *prasinos [kathreftis]*
neut – masc	σύννεφο (cloud) *sinefo*	πράσινος [καθρέφτης] (green [mirror]) *prasinos [kathreftis]*
neut – neut	σύννεφο (cloud) *sinefo*	πράσινο [κόκαλο] (green [bone]) *prasino [kokalo]*
masc – neut	νιπτήρας (wash-basin) *niptiras*	πράσινο [κόκαλο] (green [bone]) *prasino [kokalo]*
Different Number		
masc – masc	χάρακες (rulers) *harakes*	πράσινος [καθρέφτης] (green [mirror]) *prasinos [kathreftis]*
neut – masc	φορτηγά (lorries) *fortiga*	πράσινος [καθρέφτης] (green [mirror]) *prasinos [kathreftis]*
neut – neut	φορτηγά (lorries) *fortiga*	πράσινο [κόκαλο] (green [bone]) *prasino [kokalo]*
masc – neut	χάρακες (rulers) *harakes*	πράσινο [κόκαλο] (green [bone]) *prasino [kokalo]*

Note. P = prime; T = target; masc = masculine; neut = neuter. The words in square brackets are not overtly produced. The words in italics are broad phonological transcriptions of the Greek words.

Thirty-two pictures with feminine names were used as fillers in the trials preceding the prime-target pairs. Half of the filler pictures appeared in black-and-white, and the other half, in colour. Thus, the pre-prime naming response was either of the same type as the prime response i.e., bare noun, or of a different type i.e., gender-inflected colour adjective. Feminine nouns were of medium (n = 20) and low (n = 12) AoA. A further set of 15 pictures with names from the three gender classes was selected to serve in the practice trials. This resulted in a total of 111 pictures.

Design. Experiment 7 had eight experimental conditions, which resulted from the crossing of the factors Gender Identity (the prime had the same or a different gender from the target; within participants, within items), Target Gender (masculine or neuter; within participants, between items), and Number Identity (the prime had the same or a different number from the target; within participants, within items). Targets were always singular, as in all previous experiments. Primes could be either singular or plural. Four experimental lists were

constructed. Every list featured all 32 target pictures, 4 in each of the eight cells of the design. Across all four lists, every target item appeared in every priming condition. The order of trial presentation was randomised, with the constraint that a filler item would always intervene between two prime-target pairs, and that stimuli of the same experimental condition could not appear in consecutive trials. Order of picture presentation was also randomised. Experimental and filler items were presented once throughout the experiment. Each of the resulting eight randomisations contained 96 naming trials, presented in a single block.

Apparatus. The same apparatus was used as in the previous experiments.

Procedure. Each participant was randomly assigned to one of the eight experimental lists. Picture preview and trial structure were the same as in the previous experiments. All pictures were presented in black-and-white, as single objects. For the main experiment, participants were instructed to name single or double black-and-white pictures by means of singular or plural bare-noun NPs respectively, and coloured pictures by means of gender-inflected colour adjectives. They were asked to respond both accurately and quickly, and to try to use the picture names they had seen during the preview. The experimental session lasted approximately 25 minutes.

Analyses. As in earlier experiments, five types of responses were classified as errors (see 4.3.1). The reaction times of erroneous responses were excluded from further analyses. Responses that deviated by more than 2.5 SDs from a participant's (.013) or an item's (.011) mean were replaced by the overall participant or item mean +/- 2.5 SDs, respectively. ANOVAs were performed on error rates and response latencies, as a function of Gender Identity, Target Gender and Number Identity.

6.3.2 Results

Erroneous responses (12.5%) were distributed as follows: 1.4% for wrong prime-name production; 3.6% for incorrectly inflected adjectives; 1% for a wrong colour adjective; 2.7% for the production of a target noun instead of adjective; and 3.8% for verbal disfluencies, outlying responses and voice-key malfunctioning. Table 6.5 displays mean response latencies, number of valid observations, and error rates as a function of Gender Identity and Number Identity, collapsed over the two genders. The same information is given in Table 6.6 separately for the two target genders. Every mean shown is an average over the mean response time and percentage errors of 32 subjects, each responding to 32 items.

Table 6.5

Effects of bare noun prime gender on colour adjective target naming with same and different number: Mean response latencies (ms), number of valid observations, and error rates as a function of Gender Identity and Number Identity, collapsed over the two target genders (Experiment 7)

	Same Number			Different Number		
G-Ident	RT	n	e%	RT	n	e%
Same G	1134	218	14.8	1135.5	232	9.4
Diff G	1157	221	13.7	1089	225	12.1
G effect	23		-1.1	-46.5		2.7

Note. G-Ident = gender identity; Same G = same gender; Diff G = different gender; G effect = gender effect.

Table 6.6

Effects of bare noun prime gender on colour adjective target naming with same and different number: Mean response latencies (ms), number of valid observations, and error rates as a function of Gender Identity, Target Gender and Number Identity (Experiment 7)

	Same Number						Different Number					
	masc			neut			masc			neut		
G-Ident	RT	n	e%	RT	n	e%	RT	n	e%	RT	n	e%
Same G	1112	104	18.7	1156	114	11	1119	114	11	1152	118	7.8
Diff G	1137	111	13.3	1177	110	14.1	1092	112	12.5	1086	113	11.7
G effect	25		-5.4	21		3.1	-27		1.5	-66		3.9

Note. G-Ident = gender identity; Same G = same gender; Diff G = different gender; G effect = gender effect.

The analyses of target-utterance onset latencies did not provide evidence for gender priming (main effect of Gender Identity): producing a gender-marked target response such as *κόκκινος* 'red $_{\text{MASC}}$' was as fast after a same-gender bare noun prime such as *χάρτης* 'map $_{\text{MASC}}$' as after a different-gender prime such as *σύννεφο* 'cloud $_{\text{NEUT}}$' (F_1, $F_2 < 1$). The main effect of Target Gender was marginally significant in the participant analysis but non-significant in the item analysis, F_1 (1,31) = 3.79, MS_E = 13166, p = .061; F_2 (1,30) = 1.34, MS_E = 28710, p = .25, reflecting the overall difference in performance for masculine (1115 ms) and neuter (1143 ms) nouns. The analyses also revealed that the effect of Number Identity was not reliable. Particularly, the interaction between Gender Identity and Number Identity was significant in the participant analysis but non-significant in the item analysis, F_1

(1,31) = 5.17, MS_E = 14947, p = .030; F_2 (1,30) = 1.09, MS_E = 43924, p = .3. Similarly, the main effect of Number Identity was significant by participants but non-significant by items, F_1 (1,31) = 4.03, MS_E = 17567, p = .053; F_2 (1,30) = 1.54, MS_E = 13826, p = .22, reflecting the fact that overall, different-number responses were shorter (33 ms) than same-number responses. All other effects were non-significant ($Fs < 1$).

Although not reliably significant, the numerical reaction-time differences between the gender-primed and gender-unprimed responses in the two number-priming conditions reveal some interesting trends. First, although there is some indication of a processing advantage for gender-primed words in the same-number condition (23 ms), there is a systematic trend towards the opposite direction in the different-number condition (-47 ms). Second, the shortest response latencies for both masculine and neuter targets are obtained in the gender- and number-unprimed condition (1092 ms and 1086 ms, respectively). Gender- and number-unprimed words induce shorter response latencies than their gender-primed but number-unprimed counterparts. The reaction-time advantage is greater for neuter words (66 ms) and less so but in the same direction for masculine words (27 ms).

In the error analyses, the main effect of Gender Identity was not significant either (F_1, $F_2 < 1$) with participants making as many errors on a target response after a same-gender prime, as after a different-gender prime. Furthermore, the main effect of Number Identity was significant in the participant analysis but only marginally significant in the item analysis, F_1 (1,31) = 6.55, MS_E = .193, p = .016; F_2 (1,30) = 3.32, MS_E = .761, p = .078, reflecting the higher incidence of errors with the same-number than with the different-number prime-target pairs. The remaining analyses of errors did not show any systematic effects.

6.3.3 Discussion

The present experiment failed to provide any clear evidence on the effect of advance access to gender and number information on word production. Two aspects of the results are of main theoretical importance. First, we did not observe a general benefit from advance access to gender information (main effect of Gender Identity). Thus, unlike Experiments 1-3 and 5, the present experiment failed to provide converging evidence for the conclusion that overall, gender-marked target responses preceded by same-gender primes are produced faster than target responses preceded by different-gender primes. Second, there was no interaction between Gender Identity and the number match between the prime and target. That is, the type of number relationship (same number or different number) did not have consequences for the presence or the magnitude of the gender effect: Gender priming was absent both

when the prime and target had the same number and when they had a different number. Therefore, the present null results do not provide support for either of the accounts outlined in 5.2. However, they serve to add important constraints to the conditions under which gender priming can be obtained. In particular, our demonstration that gender priming dissipates entirely when the experiment involves the added manipulation of number, combined with a similar demonstration from Experiments 5 (gender priming lost with nominative case responses) and 6 that involved the added manipulation of case, require a production theory to account for why such a manipulation of other grammatical properties cancels out the effect of gender.

There are likely to be a number of possible answers to this issue. Here, I restrict my discussion to the findings of Experiment 7, and provide a tentative account in terms of the activation versus selection distinction of grammatical properties. On this account, the number of nouns is a non-inherent feature. Therefore, a number value has to be selected during production of the prime. The gender of nouns by contrast, is an inherent feature which, according to Levelt et al., need not be selected but merely activated during bare noun production. According to this view, it might be that the number of the prime is processed to a greater extent than the gender of the prime, and that drawing participants' attention to the possibility of number variation, hence to the number feature of the prime and target, weakens the effect of gender. That is, we might have a head start of the number retrieval process of the target lemma over the gender retrieval process such that would render invisible the effect of gender. If this is correct, then one would expect the gender effect to reappear in an experiment that would require the selection both of number and of gender in the production of the prime, and that would therefore ensure that both properties are processed to the same extent prior to being reaccessed.

Before moving to the last experiment, two further aspects of the results are discussed. The first concerns the indication that the presence of a gender effect may after all be contingent upon the number relationship between the prime and target. Some tentative support for such a possibility can be observed in the significant by-participants interaction between Gender Identity and Number Identity. The reaction-time difference between gender-primed and gender-unprimed responses was most notable in the number-mismatch condition. Interestingly however, this difference was not in the expected direction; gender-primed responses were longer than the gender-unprimed responses. This pattern was in the opposite direction from the descriptive pattern observed in the number-match condition where gender-primed responses were shorter than the gender-unprimed ones. Therefore, it could be the

case that number variation induces a reversal of the gender effect from facilitation to inhibition.

Interestingly also, our data revealed a descriptive, and significant by-participants, reaction-time difference between number-primed and unprimed responses, with the former being overall longer than the latter. Therefore, in line with what we suggested earlier, there might be an inhibitory rather than (or together with) a facilitatory component associated with repeated access to certain grammatical features. Specifically, it might be that prior access to some features e.g., gender, facilitates their reaccess, while prior access to other features e.g., number, inhibits their reaccess. Thus, according to this view, another possible account of the dissipation of gender priming in this experiment could be that the two effects from prior access to the two categories are in the opposite direction so that gender facilitation is cancelled out by number inhibition. Given the evidence thus far, both this and the previous account of our data are only suggestive at best because first, there is no clear and independent evidence on the role of number information in word production (i.e., whether reaccessing a same number node does in fact induce inhibition compared to a condition in which a different number node is accessed), and second, there is not, to my knowledge, any clear evidence that singular and plural words have indeed a single lemma representation as Levelt et al. assume, with number represented by a diacritic that has to be selected even in bare noun production, unlike gender that is only activated. Resolution of these issues will obviously require additional research that largely falls beyond the scope of this thesis. Therefore, although the next experiment also involves a manipulation of number, the focus is again on gender. In particular, I examine whether gender priming effects can be found in another context, between determiner + noun NPs and colour adjectives, in which unlike Experiment 7, production of the prime does involve gender selection.

6.4 Experiment 8: (Definite determiner + noun) Primes – (Colour adjective) Targets Across Number

Experiment 8 takes up from the previous experiment the issue of the effect of prior access to gender and number information on the time-course of target word retrieval; it aims to provide further evidence on the conditions under which gender priming can be obtained when other grammatical properties (here number) are manipulated. The results of Experiment 7 did not support either the independent features or the feature clusters account, but they also failed to replicate the gender effect of Experiments 1-3 and 5, in the same-number condition.

Before concluding that the effect of prior gender information is dissipated or rendered invisible when other grammatical properties are manipulated between the prime and target, we wanted to replicate the findings of the previous experiment for a different type of prime noun phrase, namely for a noun phrase of the form definite determiner + noun. The production of such a noun phrase involves the computation of gender agreement, hence the selection of the gender feature of the prime. By ensuring that a gender node is selected rather than merely activated during prime production, we hope to maximise the possibility of obtaining a gender effect. We now assume that the gender and number of the prime are processed to the same extent insofar as a definite determiner + noun NP involves the computation of both gender and number agreement, and that both features can have a head start in determining the retrieval process of the target lemma. As in the previous experiment, the prediction is that if gender and number contribute independently to lexical access, a gender effect will be found in both number-priming conditions. If by contrast, lexical access involves the retrieval of feature clusters, and priming is contingent upon successive retrieval of the same feature cluster in the prime and target, then a gender effect will be found in the same-number condition only.

6.4.1 Method

Participants. Thirty-six volunteers, native speakers of Greek, from the University of Athens community, participated in this experiment. Their ages ranged from 18-26 years.

Materials, Apparatus, Design, Analyses. Materials, Apparatus, Design and Analyses were identical to those of Experiment 7. See Table 6.7 for examples of the resulting prime-target combinations, and see the Appendix for a complete list of the materials used.

Table 6.7

Example materials from Experiment 8

P – T gender	Prime		Target	
Same Number				
masc – masc	ο νιπτήρας *o niptiras*	(wash-basin)	πράσινος [καθρέφτης] *prasinos [kathreftis]*	(green [mirror])
neut – masc	το σύννεφο *to sinefo*	(cloud)	πράσινος [καθρέφτης] *prasinos [kathreftis]*	(green [mirror])
neut – neut	το σύννεφο *to sinefo*	(cloud)	πράσινο [κόκαλο] *prasino [kokalo]*	(green [bone])
masc – neut	ο νιπτήρας *o niptiras*	(wash-basin)	πράσινο [κόκαλο] *prasino [kokalo]*	(green [bone])
Different Number				
masc – masc	οι χάρακες *i harakes*	(rulers)	πράσινος [καθρέφτης] *prasinos [kathreftis]*	(green [mirror])
neut – masc	τα φορτηγά *ta fortiga*	(lorries)	πράσινος [καθρέφτης] *prasinos [kathreftis]*	(green [mirror])
neut – neut	τα φορτηγά *ta fortiga*	(lorries)	πράσινο [κόκαλο] *prasino [kokalo]*	(green [bone])
masc – neut	οι χάρακες *i harakes*	(rulers)	πράσινο [κόκαλο] *prasino [kokalo]*	(green [bone])

Note. P = prime; T = target; masc = masculine; neut = neuter. The words in square brackets are not overtly produced. The words in italics are broad phonological transcriptions of the Greek words.

Procedure. The procedure was nearly identical to that of Experiment 7. In Experiment 8 however, participants were instructed to name black-and-white pictures by means of definite determiner + noun NPs. The experiment lasted approximately 25 minutes.

6.4.2 Results

Erroneous responses (15.5%) were distributed as follows: 1.2% for wrong prime-name production; 3.9% for incorrectly inflected adjectives; 1.4% for a wrong colour adjective; 2.8% for the production of a target noun instead of adjective; and 6.2% for verbal disfluencies, outlying responses, and voice-key malfunctioning. Responses that deviated by more than 2.5 SDs from a participant's or an item's mean were replaced by the overall participant (.009) or the overall item mean (.006) +/- 2.5 SDs, respectively. Table 6.8 displays mean response latencies, number of valid observations and error rates, as a function of Gender Identity and Number Identity, collapsed over the two genders. The same

information is given in Table 6.9 separately for the two target genders. Every mean shown is an average over the mean response time and percentage errors of 36 subjects, each responding to 32 items.

Table 6.8

Effects of determiner + noun prime gender on colour adjective target naming with same and different number: Mean response latencies (ms), number of valid observations, and error rates as a function of Gender Identity and Number Identity, collapsed over the two target genders (Experiment 8)

	Same Number			Different Number		
G-Ident	RT	n	e%	RT	n	e%
Same G	1220.5	237	17.7	1199.5	251	12.85
Diff G	1271.5	241	16.3	1231.5	244	15.3
G effect	51		-1.4	32		2.45

Note. G-Ident = gender identity; Same G = same gender; Diff G = different gender; G effect = gender effect.

Table 6.9

Effects of determiner + noun prime gender on colour adjective target naming with same and different number: Mean response latencies (ms), number of valid observations, and error rates as a function of Gender Identity, Target Gender and Number Identity (Experiment 8)

	Same Number						Different Number					
	masc			neut			masc			neut		
G-Ident	RT	n	e%	RT	n	e%	RT	n	e%	RT	n	e%
Same G	1205	114	20.8	1236	123	14.6	1179	123	14.6	1220	128	11.1
Diff G	1258	120	16.6	1285	121	16	1224	123	14.6	1239	121	16
G effect	53		-4.2	49		1.4	45		0	19		4.9

Note. G-Ident = gender identity; Same G = same gender; Diff G = different gender; G effect = gender effect.

Unlike the results of the previous experiment, the current results did provide evidence for gender priming (main effect of Gender Identity): producing a gender-marked target response such as *πράσινος* 'green $_{\text{MASC}}$' was faster after a same-gender definite determiner + noun prime such as *ο νιπτήρας* 'the wash-basin $_{\text{MASC}}$' than after a different-gender prime such as *το τόξο* 'the bow $_{\text{MASC}}$', F_1 (1,35) = 6.84, MS_E = 18279, p = .013; F_2 (1,30) = 4.24, MS_E = 19427, p = .048. However, as in the previous experiment, the analyses revealed a main effect of

Number Identity, clearly significant by participants but non-significant by items, F_1 (1,35) = 5.76, MS_E = 11665, p = .022; F_2 (1,30) = 1.67, MS_E = 9352, p = .205: different-number responses were shorter (31 ms) than same-number responses. The interaction between Gender Identity and Number Identity was non-significant ($Fs < 1$).

Inspection of Tables 6.8 and 6.9 reveals some trends in the descriptive pattern of results. Particularly, although the gender effect is in the expected direction in both number-priming conditions, that is, there is a processing advantage for gender-primed over unprimed words, the reaction-time difference is larger in the number-match condition (51 ms) than in the number-mismatch condition (32 ms). Given that overall, number-primed responses were longer than the unprimed responses, this could be taken as further indication that the gender effect becomes more notable at longer response-time ranges, as has already been pointed out on the basis of the repeatedly observed positive correlation between mean response latencies and the magnitude of gender priming. This observation receives additional support from a comparison of the present experiment with Experiment 7, which shows a clear increase in the difference in utterance onset latencies between gender-primed and unprimed words associated with an also clear increase in mean response latencies: Overall, response latencies in Experiment 8 (1231 ms) were 102 ms longer than the corresponding latencies in Experiment 7 (1129 ms). Finally, at least descriptively, as in Experiment 7, the longest response latencies collapsed over the two genders are obtained in the gender-unprimed but number-primed condition. The error analyses did not reveal any significant effects.

6.4.3 Discussion

Unlike the previous experiment, Experiment 8, which also involved a number manipulation, did provide evidence for gender priming: same-gender target responses were produced faster than different-gender responses. Gender priming was obtained both in the number-match and in the number-mismatch condition. Taken together, the present results deviate in two important aspects from the predictions of the feature clusters account, and from the results of Experiment 7. First, we obtained a reaction-time advantage from advance access to gender information in the number-mismatch condition. The prediction from the feature clusters account was that no priming should be obtained unless the prime and target involved the retrieval of the same feature values. In contrast to this prediction, it appears that prior access to a given grammatical property, here gender, leads to a reaction-time advantage in the production of a target utterance that involves the selection of the same gender value irrespective of whether the other feature values of the prime and target are shared or not. Precisely this pattern of effects is predicted from the independent features account.

Second, the processing advantage obtained for same-gender target responses was present in the number-match condition as well, and did not differ in magnitude between the two number priming conditions: The interaction between Gender Identity and Number Identity was by far non-significant. It appears therefore, that the relationship between the degree of feature overlap and priming is nonlinear insofar as an increase in the number of feature values that are shared between the prime and target does not result in an increase in priming (perhaps up to some ceiling level of priming). In other words, the gender effect in the gender- and number-match condition was not any more sizeable than the respective effect in the gender-match only condition. As with our discussion of the findings of Experiment 7, a potential caveat here concerns again the lack of independent evidence on the effect of prior access to number information on word production. After all, we do not know whether there is any such effect as number priming (comparable to gender priming), nor do we know what the relative direction of this effect could be i.e., facilitatory or inhibitory. It is therefore difficult to identify the precise nature of the processing relationship between gender and number, and further experimentation will be required before any strong claim on this issue can be made.

This caveat notwithstanding, the results mentioned above provide confirmation of a critical assumption of the Levelt et al. model; namely, that gender selection, typically implicated in the production of gender-marked utterances, is qualitatively and/or quantitatively distinct from mere gender activation, that is typically implicated in the production of bare nouns, and as such, has differential effects on subsequent gender processing. Recall that according to Levelt et al., activation of a gender node during prime production can induce priming as long as a gender node has to be selected during production of the target. However, the present results suggest that the activation-selection distinction is critical not only in the production of the target but also in the production of the prime for the presence of a gender effect. In particular, it appears that when prime production involves gender selection as opposed to mere gender activation, this leads to a clearer and more reliable advantage for same-gender target NPs. This more sizeable effect is rendered visible in a condition in which the relatedness along more than one types of grammatical information is manipulated between the prime and target.

6.5 Summary

The results of Experiments 7 and 8 can be summarised as follows. First, no gender priming was obtained when the experiment involved a manipulation of number, and the prime

response consisted of a bare noun. Second, gender priming reappeared under the same experimental conditions when the prime NP involved the production of a definite determiner + noun. Third, in the latter case, there was no modulation of the magnitude of gender priming as a function of the number relatedness between the prime and target (i.e., gender priming was not any larger in the number-match condition than in the number-mismatch condition). These findings were taken to support the independent features account. They also provided confirmation of a critical assumption of the Levelt et al. model concerning the activation-selection distinction. Particularly, they suggested that when other grammatical properties are also manipulated, gender priming becomes contingent not only upon gender selection in the target but also upon gender selection in the prime.

Chapter 7 Conclusions

This thesis has been concerned with the representation and processing of grammatical gender. It has aimed to address two issues. The first concerns the conditions under which gender priming can be obtained; the second concerns the relationship between gender and other nominal categories, here case and number. These two issues bear upon the more general question of how lexical-syntactic properties are stored, retrieved and used during grammatical encoding, and how various consequences of the grammatical make-up of words are evident in the fluency of speech. Furthermore, inasmuch as grammatical gender constitutes a point of divergence across different languages, the results reported here from Greek also serve to examine the scope of a particular production theory originally developed for typologically distinct languages. In this final chapter, we provide a summary of the thesis thus far before discussing how the results bear on the word production theory that has been used as our framework, and how the theory can be modified to accommodate this pattern of data. In the final section, some more general conclusions are drawn and a new set of research questions is highlighted for future exploration.

7.1 Summary of findings

In Chapter 3, the psycholinguistic literature on the role of gender in language production was reviewed. Without claiming completeness in its description of the word generation process, the Levelt et al. model was adopted as the theoretical framework for this thesis. An important and attractive feature of this model compared to other models of language production has been that it makes highly articulated proposals about the content and the mechanisms of access to lemma level representations, and about the way a word's grammatical features are processed. Particularly relevant for our purposes were the model's claims about the distinction between inherent grammatical properties and diacritic parameters, and about the conditions under which these properties are selected or merely activated.

Table 7.1

Overview of Experiments 1-4 (Chapter 4)

Expmt	Gender relatedness	Example P – T utterance	Mean RT	Gender effect
1	primed	*ο χάρτης – πράσινος [τοίχος]* the map MASC – green MASC [wall]	1202	$F_1 = 12.09$ $F_2 = 12.22$
	unprimed	*το κλειδί – πράσινος [τοίχος]* the key NEUT – green MASC [wall]	1239	
2	primed	*χάρτης – πράσινος [τοίχος]* map MASC – green MASC [wall]	1138	$F_1 = 6.67$ $F_2 = 4.69$
	unprimed	*κλειδί – πράσινος [τοίχος]* key NEUT – green MASC [wall]	1179	
3	primed	*σωλήνας – ένας πίνακας* pipe MASC – a painting MASC	866	$F_1 = 8.32$ $F_2 = 4.66$
	unprimed	*σίδερο – ένας πίνακας* iron NEUT – a painting MASC	903	
4	primed	*σωλήνας – πίνακας* pipe MASC – painting MASC	874	$F_1 < 1$ $F_2 < 1$
	unprimed	*σίδερο – πίνακας* iron NEUT – painting MASC	865	

As Table 7.1 shows, Chapter 4 provided evidence for the effect of prior access to gender information on subsequent word retrieval, particularly for the linguistic contexts in which this effect can be obtained. In review, the first experiment, which employed Det + Noun primes and colour adjective targets, demonstrated a clear reaction-time advantage for target utterances preceded by same-gender primes as compared with utterances preceded by different-gender primes. This result replicates earlier production studies employing a different methodology (e.g., La Heij et al., 1998; Schriefers, 1993; Schriefers & Teruel, 2000) insofar as it shows that the gender relation between two noun phrases has a systematic effect on utterance onset latencies. Experiment 2 showed that the gender effect is also obtained when the prime involves the production of a bare noun, while Experiment 3 yielded the same result, that is, shorter response latencies for same-gender prime-target pairs as compared with different-gender pairs, employing bare noun primes and Indefinite Det + Noun targets. By contrast, the fourth experiment, which involved the production of bare nouns in both the prime and target utterances, failed to yield any evidence for gender priming.

Following this, the experimental evidence reported in Chapters 5 and 6 aimed at elaborating Levelt et al.'s account of gender by addressing the relationship between the representation and processing of two other nominal categories, case and number, relative to gender. Two possible accounts of this relationship were outlined. On the independent features account, gender is represented and processed independently of the other two grammatical categories, as in fact is postulated by Levelt et al. Consequently, other things being equal as, for example, the time-course of lexical access to different case forms or number forms, or the representational and/or processing relationship between any two of these forms, the gender effect should not be modulated by the case or number relation between the prime and target. Alternatively, the feature clusters account assumes that gender, case and number are inextricably intertwined in the form of a cluster. If lexical access involves the retrieval of such a cluster, a priming effect should be obtained only when the same feature cluster is retrieved in the production of the prime and target. In other words, the latter account predicts no priming unless the prime and target have the same gender but also the same case and number.

Table 7.2

Overview of Experiments 5-8 (Chapters 5 and 6)

Expmt	Gender relatedness	Example P-T utterance	Mean RT	Gender effect
5	primed $_{NOM}$	*χάρτης – πράσινος [κουβάς]* map $_{MASC}$ – green $_{MASC}$ [bucket]	1106	$F_1 = 5.34$ $F_2 = 6.74$
	unprimed $_{NOM}$	*σύννεφο – πράσινος [κουβάς]* cloud $_{NEUT}$ – green $_{MASC}$ [bucket]	1106	
	primed $_{ACC}$	*χάρτη – πράσινο [κουβά]* map $_{MASC}$ – green $_{MASC}$ [bucket]	1097	
	unprimed $_{ACC}$	*σύννεφο – πράσινο [κουβά]* cloud $_{NEUT}$ – green $_{MASC}$ [bucket]	1151	
6	primed $_{NOM\text{-}ACC}$	*χάρτης – πράσινο [κουβά]* map $_{MASC}$ – green $_{MASC}$ [bucket]	1182	$F_1 < 1$ $F_2 < 1$
	unprimed $_{NOM\text{-}ACC}$	*σύννεφο – πράσινο [κουβά]* cloud $_{NEUT}$ – green $_{MASC}$ [bucket]	1171	
	primed $_{ACC\text{-}NOM}$	*χάρτη – πράσινος [κουβάς]* map $_{MASC}$ – green $_{MASC}$ [bucket]	1211	
	unprimed $_{ACC\text{-}NOM}$	*σύννεφο – πράσινος [κουβάς]* cloud $_{NEUT}$ – green $_{MASC}$ [bucket]	1227	
7	primed $_{+NUM}$	*νιπτήρας – πράσινος [καθρέφτης]* wash-basin $_{MASC}$ – green $_{MASC}$ [mirror]	1134	$F_1 < 1$ $F_2 < 1$
	unprimed $_{+NUM}$	*σύννεφο – πράσινος [καθρέφτης]* cloud $_{NEUT}$ – green $_{MASC}$ [mirror]	1157	
	primed $_{-NUM}$	*χάρακες – πράσινος [καθρέφτης]* rulers $_{MASC}$ – green $_{MASC}$ [mirror]	1136	
	unprimed $_{-NUM}$	*φορτηγά – πράσινος [καθρέφτης]* lorries $_{NEUT}$ – green $_{MASC}$ [mirror]	1089	
8	primed $_{+NUM}$	*ο νιπτήρας – πράσινος [καθρέφτης]* the wash-basin $_{MASC}$–green $_{MASC}$ [mirror]	1221	$F_1 = 6.84$ $F_2 = 4.24$
	unprimed $_{+NUM}$	*το σύννεφο – πράσινος [καθρέφτης]* the cloud $_{NEUT}$ – green $_{MASC}$ [mirror]	1272	
	primed $_{-NUM}$	*οι χάρακες – πράσινος [καθρέφτης]* the rulers $_{MASC}$ – green $_{MASC}$ [mirror]	1200	
	unprimed $_{-NUM}$	*τα φορτηγά – πράσινος [καθρέφτης]* lorries $_{NEUT}$ – green $_{MASC}$ [mirror]	1232	

As Table 7.2 shows, the results of the two 'case' experiments, in which the prime response involved the production of a bare noun, demonstrated that although gender priming is not

restricted to nominative-case words only, it is restricted to same-case primes and targets. Thus, although the production latencies to accusative-case words yielded evidence for priming, this effect dissipated when the case value of the prime and target was varied. Experiment 7, which involved a gender and number manipulation, yielded the same result, that is, no priming when the number feature of the prime and target was varied but also, surprisingly, no priming even when the number feature of the prime and target was the same. Although these results appeared to confirm the predictions of the feature clusters account, a critical final experiment which involved the same gender and number manipulation as Experiment 7, but with a different type of prime noun phrase (Definite Det + Noun as opposed to bare noun) showed that the gender effect can also be obtained with different-number primes and targets.

7.2 General discussion and evaluation of findings

7.2.1 Experiments 1-4

First, and perhaps most importantly, the picture of grammatical gender that emerges from Experiments 1-4 is compatible with most current production models' treatment of gender as an abstract lexical-syntactic property: Gender priming occurred between primes and targets which had no lexical items in common, suggesting that the relationship which the production mechanism recognises between the two utterances is defined in terms of abstract syntactic properties. Furthermore, gender priming was shown not to be contingent upon repetition of the same utterance format between the prime and target, indicating that the relationship at issue between the two response types is not necessarily one of identity of gender-marking devices. Thus, gender priming was obtained with bare noun primes and either colour adjective or Indefinite Det + Noun targets as well as with Definite Det + Noun primes and colour adjective targets. Overall, these results suggest that, irrespective of whether the form of a word contains clues as to the gender class to which the word belongs, as is often the case in Greek, gender information is specified at an abstract level of representation independently of specific gender-marking devices and form-level characteristics.

Regarding the conditions under which gender priming is obtained, referring here to the type of prime and target utterance that has to be produced, the results of Experiments 1-4 are also in agreement with what was previously observed in other languages, particularly in Dutch and German. Thus, gender priming was obtained when the target utterance involved the production of a gender-marked word e.g., adjective, indefinite determiner, and therefore

gender agreement had to be computed. The latter process is held to trigger gender selection which, according to Levelt et al., is a necessary condition for the occurrence of gender priming. This is an important finding, given the fact that on several accounts of Greek nominal morphology the inflectional suffix of many nouns does constitute (among other things) an unambiguous gender marker as for example, was shown for the 'masculine' suffixes *-ας* and *-ης* in words such as *κουβάς* 'bucket' and *χάρτης* 'map'. One would therefore expect the production of such gender-marking devices to also trigger gender selection. Contrary to this claim, Experiment 4 demonstrated that there is no gender priming with bare noun targets. It appears therefore that the critical distinction is that between words with inherent gender and words with non-inherent gender, and that the critical operation for the presence of a gender effect is not the production of a gender marker per se in words with inherent gender, but the computation of agreement between a gender controller (a word with inherent gender) and an agreement target (a word with non-inherent gender). According to Levelt et al., it is only the latter process that triggers gender selection. Therefore, the results of Experiment 4 assert the fact that in Greek as in Dutch the activation-selection distinction roughly corresponds to the distinction between the processes underlying bare noun production, and the processes underlying other gender-marked utterances. As has been previously noted, the computation of gender agreement need not result in a gender marker surfacing in the eventual phonological form of an utterance for a gender effect to be obtained. This strongly suggests that agreement must be computed at an abstract level of processing that is largely blind to form-level characteristics of the target utterance.

7.2.2 Experiments 5-8

As already pointed out however, the above picture of grammatical gender carefully conceals a fundamental issue concerning the intuitive plausibility of a relationship between the different nominal categories and the formation of larger structural units. Specifically, the question that arises is whether repeated access to fusionally realised feature combinations results in the formation of new structural units or clusters at the lemma level such that would challenge widespread assumptions both about the representation of gender (as a unit or node at the lemma level), and about its processing (as the activation or selection of that single node). The postulation of clustered structures or clustered nodes at the lemma level would essentially challenge the very existence of a gender feature per se inasmuch as gender would become integrated with case and number in a single undifferentiated unit. The implication of this proposition is that the effect of prior gender information may not be distinguishable from the effect of other grammatical properties, and that the several phenomena of gender

facilitation or interference that arise from successive exposures to same- or different-gender words respectively, may be an artefact of regularly making gender contrasts and matches without contrasting any of the other properties that often vary between successive noun phrases in an inflected language.

In order, then, to examine whether gender priming reflected the cognitive consequences of gender processing alone rather than the consequences of the processing of other categories as well, we manipulated the case and number relatedness of the prime and target along with their gender relatedness. In this context, we sketched two broad accounts of lexical selection that differed in their assumptions about the contribution of the various grammatical properties. These two accounts, which constituted plausible yet extreme hypotheses about the structural and temporal characteristics of word retrieval processes, were meant to serve as reference points for conducting the research reported in Chapters 5 and 6. The results of this research further detailed the processes of word retrieval insofar as they showed that gender priming occurs not only when the other morphosyntactic properties are kept constant but also when they are systematically manipulated. This in turn was taken to suggest that, unlike their realisation at the form level, gender, case and number need not be fused at the lemma level so that each of the three categories can presumably make an independent contribution to the word retrieval process. However, apart from this finding, the key feature of the results was the observation of a far more intricate pattern of priming effects compared to the one obtained with the first four experiments when gender alone was manipulated.

More precisely, the constellation of conditions that yielded gender priming in Experiments 5-8 strongly suggested that when this effect is seen, it is associated with the kind of syntactic computation that is required for the production of a gender-marked utterance (i.e., the computation of gender agreement) and less so with the manipulation or not of other grammatical properties; recall that although gender priming was not obtained with different-number primes and targets when the prime was a bare noun, it was obtained under the same conditions when the prime was a Definite Det + Noun. Furthermore, several other facets of participants' performance raised a number of questions about the cognitive components of word production that are said to give rise to priming. Particularly, given the present data, two main facts had to be accounted for: First, on the occasions when an experiment involved both a gender and number manipulation and the prime was a bare noun, the gender effect dissipated not only, as one would expect, in the different-number condition but also in the same-number condition. Although there are good reasons to assume that the same would occur with the case manipulation, the two conditions, same-case and different-case, were not

included in a single experiment in the present work, and therefore could not be directly compared. Second, given the same experimental conditions, the gender effect reappeared both with same-number and different-number prime-target pairs when the prime was a noun phrase that involved the computation of gender agreement. Therefore, the two questions that have to be addressed are first, why gender priming dissipated in the former case, and second, why it reappeared in the latter case.

To address these questions, we examine in some detail two aspects of our data. First, in both Experiments 7 and 8, the effect of gender did not appear to be modulated by the type of number relatedness between the prime and target. Thus, in Experiment 7, gender priming was absent from both same-number and different-number responses while in Experiment 8 gender priming was observed with both response types. In keeping with the assumption that gender and number contribute separately to lexical access, there is good reason to assume that their effect should be additive so that the same-gender, same-number condition would yield shorter production latencies than the same-gender, different-number condition, and this in turn would yield shorter latencies than the different-gender, different-number condition. The fact that this is not what was empirically observed suggests that neither an account that attributes gender priming to repeated access to individual features nor an account that attributes it to repeated access to feature clusters fares well in capturing the nature of the relationship between the different grammatical properties. The second finding concerns the absence of a reliable number-relatedness effect comparable to the gender effect. That is, target responses preceded by same-number primes were not shorter than target responses preceded by different-number primes. And when there was some indication of a number effect (recall that both in Experiments 7 and 8, the main effect of number reached significance in the participants' analysis only), this appeared to be inhibitory rather than facilitatory in nature. Thus, participants seemed to take longer to produce number-primed responses as compared to number-unprimed ones, contrary to what is observed with gender priming. Here again, the two proposals invoked to account for the conditions under which gender priming is obtained do not provide a principled way of accounting for this unexpected effect.

Since neither the independent features account nor the feature clusters account provide an adequate explanation of the findings reported in Experiments 5-8, we may want to consider a modified account that integrates certain aspects of the two above mentioned proposals. Let us suppose that the selection process operates as postulated by the independent features account. That is, lexical selection of e.g., the adjective *κόκκινος* 'red MASC, NOM, SING' will

involve at least three independent selection processes: that of a gender value, that of a case value and that of a number value. Let us also assume that the time course of lexical selection is jointly determined by the time course of each of the three selection processes but also by the very number of selection processes that have to be carried out each time. If the prior activation of grammatical properties affects their subsequent selection, then a consequence of the above assumption is that not only the gender relatedness but also the case and number relatedness between successive words will affect the time course of their selection. Of course, because there have been no systematic investigations of these effects apart from the quite extensively studied effect of gender, it is not at all clear what the impact of case or number priming would be, when considered in isolation but also relative to each other, and what the limits may be to the role that repeated access to these properties can play during word production.

With this issue as background and looking back at the two sets of experiments, one can note that a critical difference between Experiments 1-4 and Experiments 5-8 concerns the extent to which other grammatical properties apart from gender had to be selected or not during prime and target production. Specifically, with respect to Experiments 1-4, there is good reason to assume that gender was the only property that had to be selected on-line, that is, during production of the prime or target, whereas case and number could well have been preselected insofar as particular values had been set for the entire experiment (see Figure 7.1). In other words, because participants knew in advance that all responses had to be in the nominative singular, the appropriate feature values could be set each time prior to stimulus presentation, or could even be set once at the beginning of the experiment and kept constant until its completion. On this account, there was only one selection process (i.e., gender selection) that was carried out during naming, and it was the time course of this process alone, at the lemma level, that conditioned the relative speed with which the prime or target response was produced. As a consequence, only the gender relatedness between the prime and target mattered for the predicted pattern of results since the case and number relatedness did not affect any selection process.

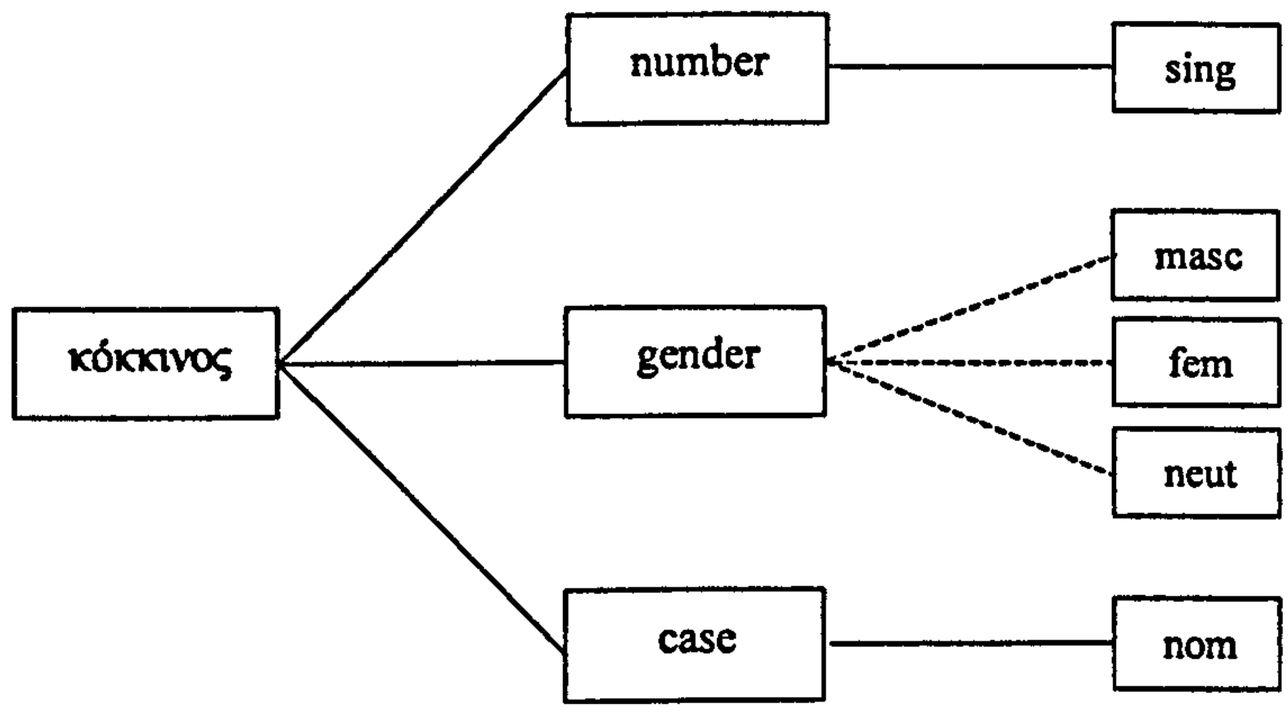

Figure 7.1. The selection processes hypothesised to support retrieval of gender-marked target utterances in Experiments 1-3. Gender selection is assumed to be computed on-line, while number and case selection are assumed to be completed prior to naming (preselection).

By contrast, in Experiments 5-8, more than one selection processes were implicated during naming. That is, because not only gender but also case or number were varied across trials, the appropriate feature values could not be preselected or preset for the entire experiment. Thus, in Experiments 5 and 6, gender and case had to be selected in each naming trial, while in Experiments 7 and 8, gender and number had to be selected (see Figure 7.2). The complexity that is added to the production system by the two (instead of one) selection processes stems first, from the particular characterisitcs of each selection process and second, from the way the two processes may interact. With respect to the first point, it has already been noted that unlike the effect of gender relatedness between successive words that is fairly well understood, the effect of case or number relatedness has not been systematically investigated. Thus for example, it is not clear whether repeated exposure to same-case or same-number words would yield evidence for priming comparable in magnitude and/or direction, to the priming that is typically observed with same-gender words. Likewise, it is not clear how the mechanism responsible for lexical selection deals with multiple selection operations, that is, whether it follows some hierarchical or temporal order, or whether it can compute several selection processes in parallel. For example, one could hypothesise that because number is typically specified at the conceptual level, the corresponding diacritic of the lemma at hand could be selected earlier than for example, the appropriate case value, which has to await structural assignment.

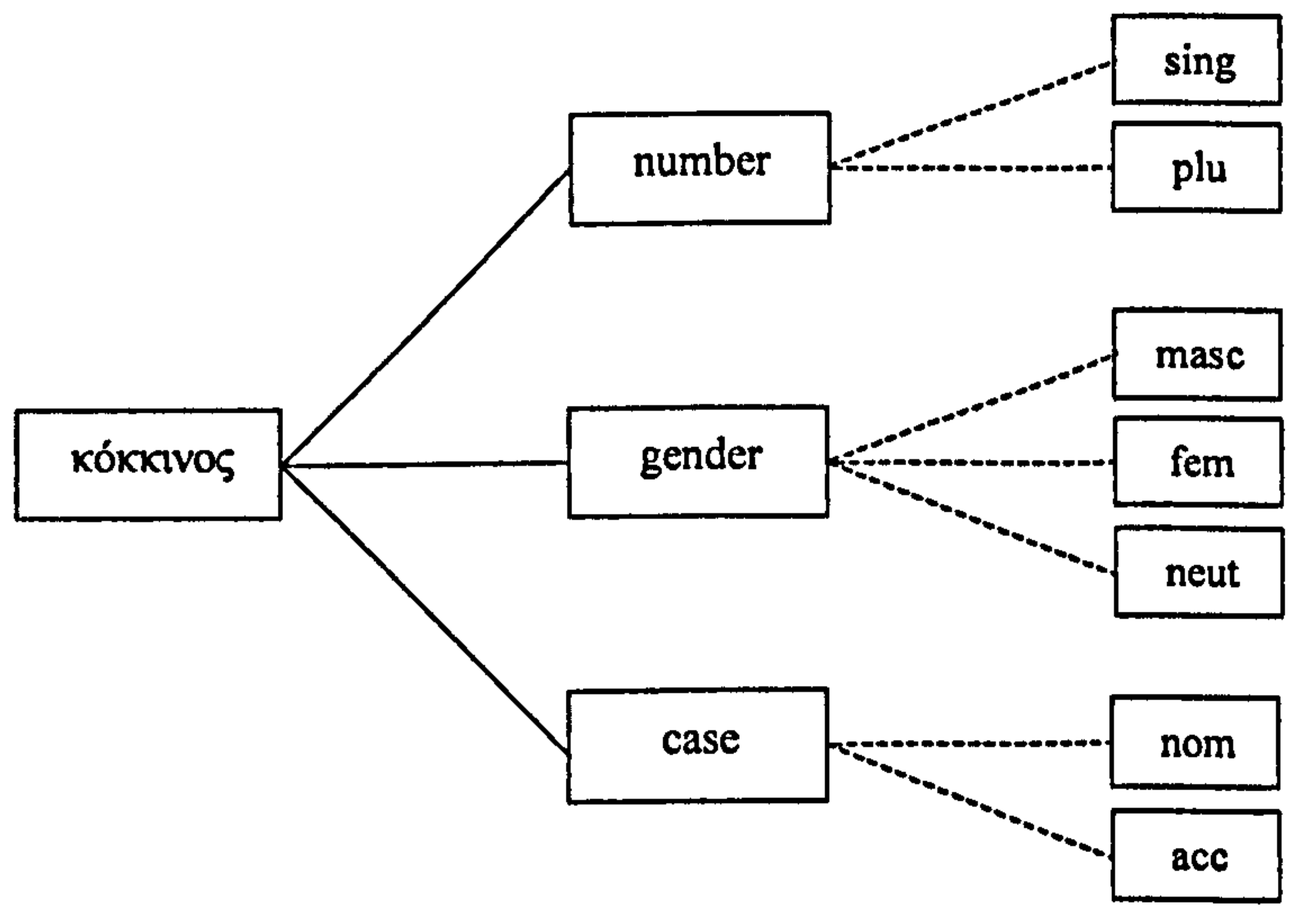

Figure 7.2. The selection processes hypothesised to support retrieval of gender-marked target utterances in Experiments 5-8. In Experiments 5-6, gender and case are assumed to be selected on line, while in Experiments 7-8, gender and number are assumed to be selected on line.

The question of how different selection processes are coordinated and carried out during word production is something that definitely warrants further investigation. In the present context, what is important is that multiple selection processes seem to add noise to the production system, and therefore render invisible the effect of gender. Critically, the noise from case and number variation appears to be overcome when gender is not merely activated but is also selected during production of the prime, as observed in the last, 'number' experiment. Therefore, whether selection means quantitatively more activation or (which amounts to the same relative thing) whether it means stronger suppression of the competitors, it is that relative boost which is needed to make gender priming apply.

At a more general level now, the above findings illustrate how the 'simple' kinds of production processes that experimental subjects are involved in can be different in some fundamental ways from word production in natural speaking situations. Thus, although in a laboratory task that involves consecutive elicitations of a single type of target utterance certain grammatical properties of words may be selected in advance, this is not likely to occur in spontaneous speech where more often than not, different types of 'target utterances' have to be consecutively produced (e.g., a noun phrase followed by a verb phrase followed by a prepositional phrase etc.) in order to convey the intended meaning. Likewise, it would be difficult to fully understand or explain the effect of certain combinatorial or structural properties of words such as case, in their normal use, unless the experimental task requires

that the target words be integrated in connected speech. Critical therefore to the assumption that laboratory tasks replicate natural behaviours is the understanding first, of the task requirements relative to the requirements that underlie normal speech, and second, of the way experimental subjects control their responses and carry out the tasks they are assigned.

7.3 Possibilities for future research

The present work concentrated on basic issues concerning the representation and processing of grammatical gender. Although many of the findings were in line with the assumptions of the Levelt et al. model, they were also in line with the assumptions of alternative models of language production e.g., of Caramazza (1997). Therefore, the present results cannot make a case in favour of the one or the other account. However, as must have become apparent by now, the study of gender in Greek provides a promising testing ground for examining several contentious issues in the production literature, most notably the issue of the processing relationship between the stages of lemma and lexeme retrieval.

As pointed out in section 7.2.1, although the present work suggested that the activation-selection distinction is not sensitive to the presence of a gender marker on the noun but only to the processes that involve the computation of agreement, this does not constitute clear evidence that lemma retrieval is blind to, or unaffected by, lexeme properties. Particularly in the case of nouns, it is reasonable to assume that because they have inherent gender, there is no competition between different gender nodes nor between different inflectional suffixes at the level of morphophonological encoding. Therefore, the process of activation of the appropriate gender node is a fairly simple one, triggered upon selection of the noun lemma. By contrast, in the case of words with non-inherent gender, it is conceivable that there must be competition both during the selection of the appropriate gender node and during the selection of the appropriate inflectional suffix. The question, then, that arises is whether in this context, various properties of the gender-marking inflectional suffix such as its frequency, functionality or distribution, do matter for the selection of the appropriate gender node. For example, one could compare the production of words like *συνεχής* 'continuous MASC/FEM, NOM, SING' in which the suffix is ambiguous with respect to the gender it realises, and words like *μόνιμος* 'permanent MASC, NOM, SING' in which the suffix is unambiguous, and examine whether similar patterns of results will be obtained in the two cases. In addition, one could use the same two types of words i.e., gender-ambiguous and unambiguous, as primes in order to compare their relative efficiency in priming the subsequent production of same-gender words. It should be noted however, that an extension of the present work along these

lines requires first and foremost a satisfactory definition of what is gender-ambiguous and what is not, and possibly a characterisation of different degrees of ambiguity.

A different question that this research has raised concerns the representation and processing of the other nominal categories, particularly of case and number. Further work perhaps employing different experimental techniques could examine whether, and if so how, speakers can benefit from different types of advance grammatical information, and how the findings from the manipulation of these categories relate to the findings from gender. For example, one could examine whether preactivation of a word's number feature leads to facilitation in the retrieval of that word when the same feature has to be selected or conversely, whether preactivation of a different number feature leads to inhibition.

7.4 Conclusion

This thesis was concerned with the representation and processing of grammatical gender. By extending the already large body of research in this field with evidence from a typologically distinct language, namely Greek, it aimed to test some widespread assumptions about the architecture of the production lexicon as well as to clarify the complex empirical picture that surrounds research on lexical priming. The constellation of conditions that yielded gender priming illustrated how the processes of production can be influenced first, by the type of syntactic computation that has to be carried out during naming (e.g., here by the computation or not of gender agreement), and second, by the way speakers prepare and control their responses within experimental tasks or within natural speaking situations. On the positive side, the theoretical framework used in this study, although tentative in several respects as for example, in its treatment of the relationship between different nominal categories, proved detailed enough to derive predictions for most of the experiments presented in this thesis, and, given certain modifications in its processing assumptions, well suited in capturing the full range of the empirical results.

References

Akhutina, T., Kurgansky, A., Polinsky, M., & Bates, E. (1999). Processing of grammatical gender in a three-gender system: experimental evidence from Russian. *Journal of Psycholinguistic Research, 28 (6),* 695-713.

Alario, F. X., & Caramazza, A. (in press). The production of determiners: evidence from French. *Cognition.*

Alario, F. X., Costa, A., & Caramazza, A. (2001, September). *The frequency effect in noun phrase production and its implications for models of lexical access.* Paper presented at the XII ESCOP and XVIII BPS Cognitive Section Conference, Edinburgh, UK.

Alegre, M., & Gordon, P. (1999). Frequency effects and the representational status of regular inflections. *Journal of Memory and Language, 40,* 41-61.

Baayen, H., Burani, C., & Schreuder, R. (1996). Effects of semantic markedness in the processing of regular nominal singulars and plurals in Italian. In G.E. Booij, & J. v. Marle (Eds.), *Yearbook of morphology, 1996.* Dordrecht: Kluwer.

Baayen, H., Dijkstra, T., & Schreuder, R. (1997). Singulars and plurals in Dutch: evidence for a parallel dual-route model. *Journal of Memory and Language, 37,* 94-117.

Badecker, W., & Caramazza, A. (1991). Morphological composition in the lexical output system. *Cognitive Neuroscience, 8 (5),* 335-367.

Badecker, W., Miozzo, M., & Zanuttini, R. (1995). The two-stage model of lexical retrieval: evidence from a case of anomia with selective preservation of grammatical gender. *Cognition, 57,* 193-216.

Bates, E., Devescovi, A., Hernandez, A., & Pizzamiglio, L. (1996). Gender priming in Italian. *Perception and Psychophysics, 58 (7),* 992-1004.

Bates, E., Devescovi, A., Pizzamiglio, L., D'Amico, S., & Hernandez, A. (1995). Gender and lexical access in Italian. *Perception and Psychophysics, 57 (6),* 847-862.

Bates, E., & MacWhinney, B. (1989). Functionalism and the Competition Model. In B. MacWhinney & E. Bates (Eds.), *The cross-linguistic study of sentence processing* (pp. 3-73). New York: Cambridge University Press.

Berg, T. (1992). Prelexical and Postlexical feature in language production. *Applied Psycholinguistics 13,* 199-235.

Besner, D. & Humphreys, G. (Eds.). (1991). *Basic processes in reading: Visual word recognition*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Bloomfield, L. (1933). *Language*. New York: Holt, Rinehart and Winston.

Bock, K. J. (1982). Toward a cognitive psychology of syntax: information processing contributions to sentence formulation. *Psychological Review, 89 (1),* 1-47.

Bock, K. J. (1986). Syntactic persistence in language production. *Cognitive Psychology, 18,* 355-387.

Bock, K. J. (1989). Closed-class immanence in sentence production. *Cognition, 31,* 163-186.

Bock, K. J. (1995). Sentence production: from mind to mouth. In J. L. Miller, & P. D. Eimas (Eds.), *Handbook of perception and cognition: Vol. 11. Speech, language, and communication* (pp.181-216). San Diego, CA: Academic Press.

Bock, K. J. (1996). Language production: methods and methodologies. *Psychonomic Bulletin and Review, 3,* 395-421.

Bock, K. J., & Cutting, C. (1992). Regulating mental energy: performance units in language production. *Journal of Memory and Language, 31,* 99-127.

Bock, K. J., & Eberhard, K. M. (1993). Meaning, sound and syntax in English number agreement. *Language and Cognitive Processes, 8,* 57-99.

Bock, K. J. & Griffin, Z. M. (2000). Producing words: How mind meets mouth. In L. Wheeldon (Ed.), *Aspects of Language Production* (pp. 7-47). Hove, East Sussex: Psychology Press.

Bock, K. J., & Levelt, W. J. M. (1994). Language production: grammatical encoding. In M. A. Gernsbacher (Ed.), *Handbook of Psycholinguistics* (pp. 945-984). Orlando, FL: Academic Press.

Bock, K., & Miller, C. A. (1991). Broken agreement. *Cognitive Psychology, 23,* 45-93.

Bock, K. J., Nicol, J., & Cutting, C. (1999). The ties that bind: creating number agreement in speech. *Journal of Memory and Language, 40,* 330-346.

Booij, G., & van Marle, J. (1995). *The Yearbook of Morphology*. Dordrecht: Kluwer.

Brooks, P., Braine, M. D. S., Catalano, L., Brody, R. E., & Sudhalter, V. (1993). Acquisition of gender-like subclasses in an artificial language: the contribution of phonological markers to learning. *Journal of Memory and Language, 32,* 76-95.

Butterworth, B. (1983). Lexical representation. In B. Butterworth (Ed.), *Language production, Vol. II: Development, writing and other language processes*. London: Academic Press.

Caramazza, A. (1997). How many levels of processing are there in lexical access? *Cognitive Neuropsychology, 14(1),* 177-208.

Caramazza, A., & Hillis, A. (1989). The disruption of sentence production: some dissociations. *Brain and Language, 36,* 625-650.

Caramazza, A., Laudanna, A., & Romani, C. (1988). Lexical access and inflectional morphology. *Cognition, 28,* 297-332.

Carello, C., Lukatela, G., & Turvey, M. T. (1988). Rapid naming is affected by association but not by syntax. *Memory and Cognition, 16(3),* 187-195.

Carstairs-McCarthy, A. (1998). Paradigmatic Structure: Inflectional Paradigms and Morphological Classes. In A. Spencer, & A. M. Zwicky (Eds.), *The handbook of morphology* (pp. 322-334). Oxford: Basil Blackwell.

Clashen, H. (1999). Lexical entries and rules of language: a multi-disciplinary study of German inflection. *Behavioral and Brain Sciences, 22(6),* 991-1013.

Clahsen, H., & Dalalakis, J. (1999). Tense and agreement in Greek SLI: A case study. *Essex Research Reports in Linguistics, 24,* 1-25.

Clashen, H., Sonnestuhl, I., Hadler, M., & Eisenbeiss, S. (2000). *Morphological Paradigms in Language Processing and Language Disorders.* Unpublished manuscript.

Cohen, J., MacWhinney, B., Flatt, M., and Provost, J. (1993). PsyScope: A new graphic interactive environment for designing psychology experiments. *Behavior Research Methods, Instruments and Computers, 25,* 257-271.

Cole, P., & Segui, J. (1994). Grammatical incongruency and vocabulary types. *Memory and Cognition, 22(4),* 387-394.

Cole, P., Segui, J., & Taft, M. (1997). Words and morphemes as units for lexical access. *Journal of Memory and Language, 37,* 312-330.

Corbett, G. (1991). *Gender.* Cambridge: Cambridge University Press.

Costa, A., Sebastian-Galles, N., Miozzo, M., & Caramazza, A. (1999). The gender congruity effect: evidence from Spanish and Catalan. *Language and Cognitive Processes, 14(4),* 381-391.

Cutting, J. C. (1997). *The production and comprehension lexicons: What is shared and what is not.* Unpublished doctoral dissertation. University of Illinois.

Cutting, J. C., & Ferreira, V. (1999). Semantic and phonological information flow in the production lexicon. *Journal of Experimental Psychology: Learning, Memory and Cognition, 25 (2),* 318-344.

Dahan, D., Swingley, D., Tanenhaus, M., & Magnuson, J. (2000). Linguistic gender and spoken word recognition in French. *Journal of Memory and Language, 42,* 465-480.

Damian, M., & Martin, R. (1999). Semantic and phonological codes in single word production. *Journal of Experimental Psychology: Learning, Memory and Cognition, 25(2),* 345-361.

Dell, G. (1986). A spreading-activation theory of retrieval in sentence production. *Psychological Review, 93(3),* 283-321.

Dell, G. (1990). Effects of frequency and vocabulary type on phonological speech errors. *Language and Cognitive Processes, 5,* 313-349.

Dell, G., Chang, F., & Griffin, Z. (1999). Connectionist models of language production: lexical access and grammatical encoding. *Cognitive Science, 23(4),* 517-542.

Dell, G. & O'Seaghdha, P. (1991). Mediated and Convergent Lexical Priming in Language Production: A Comment on Levelt et al. (1991). *Psychological Review, 98(4),* 604-614.

Dell, G., Schwartz, M. F., Martin, N., Saffran, E., & Gagnon, D. A. (1997). Lexical access in aphasic and nonaphasic speakers. *Psychological Review, 104,* 801-838.

Deutsch, W., & Wijnen, F. (1985). The article's noun and the noun's article: explorations into the representation and access of linguistic gender in Dutch. *Linguistics, 23,* 793-810.

Deutsch, A., & Bentin, S. (1994). Attention mechanisms mediate the syntactic priming effect in auditory word identification. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 20,* 595-607.

Drews, E., & Zwitserlood, P. (1995). Morphological and orthographic similarity in visual word recognition. *Journal of Experimental Psychology: Human Perception and Performance, 21(5),* 1098-1116.

Farrar, W. (1998). Investigating single-word syntactic primes in naming tasks: a recurrent network approach. *Journal of Experimental Psychology: Human Perception and Performance, 24(2),* 648-663.

Feldman, L. B. (Ed.). (1995). *Morphological aspects of language processing.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Feldman, L. B., & Fowler, C. (1987). The inflected noun system in Serbo-Croatian: Lexical representation of morphological structure. *Memory and Cognition, 15(1),* 1-12.

Ferrand, L., Humphreys, G., & Segui, H. (1998). Masked repetition and phonological priming in picture naming. *Perception and Psychophysics, 60(2),* 263-274.

Forster, K. (1976). Accessing the mental lexicon. In R. J. Wales & E. Walker (Eds.), *New approaches to language mechanisms* (pp. 139-174). Amsterdam: North-Holland.

Forster, K. (1979). Levels of processing and the structure of the language processor. In W. W. Cooper, & E. Walker (Eds.), *Sentence processing: Psycholinguistic studies presented to Merrill Garrett* (pp. 27-85). Hillsdale, NJ: Lawrence Erlbaum Associates.

Forster, K. (1999). The microgenesis of priming effects in lexical access. *Brain and Language, 68,* 5-15.

Frauenfelder, U., & Tyler, L. K. (Eds.). (1987). *Spoken word recognition.* Cambridge, MA: MIT Press/Bradford Books.

Friederice, A. (1995). The Time Course of Syntactic Activation during Language Processing: A Model Based on Neuropsychological and Neurophysiological Data. *Brain and Language, 50,* 259-281.

Friederici, A., & Jacobsen, T. (1999). Processing grammatical gender during language comprehension. *Journal of Psycholinguistic Research, 28(5),* 467-484.

√Friederice, A., Steinhauer, K., & Frisch, S. (1999). Lexical integration: Sequential effects of syntactic and semantic information. *Memory and Cognition, 27(3),* 438-453.

Frigo, L., & Mc Donald, J. (1998). Properties of phonological markers that affect the acquisition of gender-like subclasses. *Journal of Memory and Language, 39,* 218-245.

Garfield, J. (Ed.). (1987). *Modularity in Knowledge Representation and Natural-Language Understanding.* Cambridge, MA: MIT Press.

Garrett, M. F. (1976). Syntactic processes in sentence production. In R. Wales & E. Walker (Eds.), *New approaches to language mechanisms* (pp. 231-256). Amsterdam: North Holland.

Garrett, M. F. (1988). Processes in language production. In E. F. J. Newmeyer (Ed.), *Language: Psychological and biological aspects. Linguistics: The Cambridge Survey* (Vol. 3, pp. 69-96). Cambridge, England: Cambridge University Press.

Gilhooly, K. J., & Logie, R. H. (1980a). Age-of-acquisition, imagery, concreteness, familiarity, and ambiguity measures for 1,944 words. *Behavior Research Methods & Instrumentation, 12,* 395-427.

Gilhooly, K. J., & Logie, R. H. (1980b). Meaning-dependent ratings of imagery, age of acquisition, familiarity, and concreteness for 387 ambiguous words. *Behavior Research Methods and Instrumentation, 12,* 428-450.

Glaser, W. R. (1992). Picture naming. *Cognition, 42,* 61-105.

Greenberd, J. H. (1966). *Language Universals: with Special Reference to Feature Hierarchies.* The Hague: Mouton.

Griffin, Z., & Bock, K. J. (1998). Constraint, word frequency and the relationship between lexical processing levels in spoken word production. *Journal of Memory and Language, 38,* 313-338.

Grosjean, F., Dommergues, J. Y., Cornu, E., Guillelmon, D., & Besson, C. (1994). The gender marking effect in spoken word recognition. *Perception and Psychophysics, 56(5),* 590-598.

Gurjanov, M., Lukatela, G., Lukatela, K., Savic, M., & Turvey, M. T. (1985). Grammatical Priming of Inflected Nouns by the Gender of Possessive Adjectives. *Journal of Experimental Psychology: Learning, Memory and Cognition, 11(4),* 692-701.

Hagoort, P., & Brown, C. M. (1999). Gender Electrified: ERP Evidence on the Syntactic Nature of Gender Processing. *Journal of Psycholinguistic Research 28 (6),* 715-728.

Hockett, C. F. (1958). *A Course in Modern Linguistics.* New York: Macmillan.

Householder, F., Kazazis, K., & Koutsoudas, A. (1964). *Reference Grammar of Literary Dhimotiki*. Indiana University, Bloomington: Mouton & Co.

Jacobsen, T. (1999). Effects of grammatical gender on picture and word naming: evidence from German. *Journal of Psycholinguistic Research, 28(5)*, 499-514.

Jackendoff, R. (1997). *The architecture of the language faculty*. Cambridge, MA: MIT Press.

Jackendoff, R. (1999). The representational structures of the language faculty and their interactions. In P. Hagoort, & C. Brown (Eds.), *The neurocognition of language* (pp. 37-71). Oxford University Press.

Jakubowicz, C., & Faussart, C. (1998). Gender agreement in the processing of spoken French. *Journal of Psycholinguistic Research, 27(6)*, 597-617.

Janssen, D. (1999). *Producing past and plural inflections*. Nijmegen: MPI Series in Psycholinguistics.

Janssen, D., Roelofs, A., & Levelt, W. J. M. (2001). Inflectional frames in language production. *Language & Cognitive Processes, 17*, 209-236.

Jescheniak, J.-D. (1999). Gender priming in picture naming: modality and baseline effects. *Journal of Psycholinguistic Research, 28(6)*, 729-737.

Jescheniak, J.-D., & Levelt, W. J. M. (1994). Word frequency effects in speech production: retrieval of syntactic information and of phonological form. *Journal of Experimental Psychology: Learning, Memory and Cognition, 20(4)*, 824-843.

Jescheniak, J,-D., & Schriefers, H. (1998). Discrete serial versus cascaded processing in lexical access in speech production: further evidence from the coactivation of near-synonyms. *Journal of Experimental Psychology: Learning, Memory and Cognition, 24(5)*, 1256-1274.

Jescheniak, J.-D., & Schriefers, H. (1999). In search of gender recency: evidence from the production of pronouns. *Journal of Psycholinguistic research, 28(6)*, 739-745.

Jonides, J. & Mack, R. (1984). On the Cost and Benefit of Cost and Benefit. *Psychological Bulletin, 96(1)*, 29-44.

Katz, L., Boyce, S., Goldstein, L., & Lukatela, G. (1987). Grammatical information effects in auditory word recognition. *Cognition, 25*, 235-263.

Kehayia, E. (1995). Morphological representation and processing of inflected and derived words in Greek-speaking individuals. *Greek Linguistics*, Vol.1., 165-175.

Kelly, M. (1999). Indirect representation of grammatical class at the lexeme level. *Behavioral and Brain Sciences, 22(1)*, 49-50.

Kempen, G., & Huijbers, P. (1983). The lexicalisation process in sentence production and naming: indirect election of words. *Cognition, 14*, 185-209.

Kostic, A. (1995). Information load constraints on processing inflected morphology. In L. B. Feldman (Ed.), *Morphological aspects of language processing* (pp. 317-344). Hillsdale, NJ: Lawrence Erlbaum Associates.

La Heij, W., Mak, P., Sander, J., & Willeboordse, E. (1998). The gender-congruency effect in picture-word tasks. *Psychological Research, 61,* 209-219.

Lapointe, S. (1985). A theory of verb form use in the speech of agrammatic aphasics. *Brain and Language, 24,* 100-155.

Lapointe, S., & Dell, G. (1989). A synthesis of some recent work in sentence production. In G. N. Carlson, & M. K. Tanenhaus (Eds.), *Linguistic structure in language processing* (pp. 107-156). Dordrecht, The Netherlands: Kluwer.

Laubstein, A.S. (1999). Lemmas and lexemes: the evidence from blends. *Brain and Language, 68,* 135-143.

Laudanna, A., Badecker, W., & Caramazza, A. (1992). Processing inflectional and derivational morphology. *Journal of Memory and Language, 31,* 333-348.

Laudanna, A., & Burani, C. (1995). Distributional properties of derivational affixes: Implications for processing. In L. B. Feldman (Ed.), *Morphological aspects of language processing* (pp. 345-364). Hillsdale, NJ: Erlbaum.

Levelt, W. J. M. (1983). Monitoring and self-repair in speech. *Cognition, 14,* 41-104.

Levelt, W. J. M. (1989). *Speaking: From intention to articulation.* Cambridge, MA: MIT Press.

Levelt, W. J. M., Roelofs, A., & Meyer, A. (1999). A theory of lexical access in speech production. *Behavioural and Brain Sciences, 22,* 1-75.

Love, T., & Swinney, D. (1996). Coreference processing and levels of analysis in object-relative constructions; Demonstration of antecedent reactivation with the cross-modal priming paradigm. *Journal of Psycholinguistic Research, 25 (1),* 5-24.

Lukatela, G., Gligorijevic, B., Kostic, A., & Turvey, M. T. (1980). Representation of inflected nouns in the internal lexicon. *Memory and Cognition, 8(5),* 415-423.

Lukatela, G., Kostic, A., Feldman, L., & Turvey, M. T. (1983). Grammatical priming of inflected nouns. *Memory and Cognition, 11(1),* 59-63.

Lukatela, G., Kostic, A., Todorovic, D., Carello, C., & Turvey, M. T. (1987). Type and number of violations and the grammatical congruency effect. *Psychological Research, 49,* 37-43.

Lukatela, G., & Turvey, M. T. (1990). Phonemic similarity effects and prelexical phonology. *Memory and Cognition, 18,* 128-152.

Mackridge, P. (1985). *The Modern Greek language: A descriptive analysis of standard Modern Greek.* Oxford: Clarendon.

MacWhinney, B. & Bates, E.A. (1989). *The cross-linguistic study if sentence processing.* New York: Cambridge University Press.

Maratsos, M., & Chalkley, A.M. (1980). The internal language of children's syntax: the ontogenesis and representation of syntactic categories. In K. E. Nelson (Ed.), *Children's Language,* II (pp. 127-214). New York: Gardner Press.

Marslen-Wilson, W. (1987). Functional parallelism in spoken word-recognition. *Cognition, 25,* 71-102.

Marslen-Wilson, W. (1989). Access and integration: Projecting sound onto meaning. In W. Marslen-Wilson (Ed.), Lexical representation and process (pp. 1-24). Cambridge, MA: MIT Press.

Marslen-Wilson, W. (1990). Activation, competition, and frequency in lexical access. In G. T. M. Altmann (Ed.), *Cognitive models of speech processing* (pp. 148-172). Cambridge, MA: MIT Press.

Marslen-Wilson, W. (2000). Organising principles in lexical access and representation? A view across languages. Proceedings of SWAP 2000, Nijmegen, 19-22.

Marslen-Wilson, W., & Tyler, L. K. (1980). The temporal structure of spoken language understanding. *Cognition, 8,* 1-71.

Marslen-Wilson, W., Tyler, L. K., Waksler, R., & Older, L. (1994). Morphology and meaning in the English mental lexicon. *Psychological Review, 101(1),* 3-33.

Marx, E. (1999). Gender processing in speech production: evidence from German speech errors. *Journal of Psycholinguistic Research, 28(6),* 601-621.

McDonald, J., & Plauche, M. (1995). Single and correlated cues in an artificial language learning paradigm. *Language and Speech, 38(3),* 223-236.

Meyer, A. (1996). Lexical access in phrase and sentence production : Results from picture-word interference experiments. *Journal of Memory and Language, 35,* 477-496.

Meyer, A., & Bock, K. J. (1999). Representations and Processes in the production of pronouns: some perspectives from Dutch. *Journal of Memory and Language, 41,* 281-301.

Meyer, A., & Schriefers, H. (1991). Phonological facilitation in picture-word interference experiments: Effects of stimulus onset asynchronies and types of interfering stimuli. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 17,* 1146-1160.

Miozzo, M., & Caramazza, A. (1997). Retrieval of lexical-syntactic features in Tip-of-the-Tongue States. *Journal of Experimental Psychology: Learning, Memory and Cognition, 23(6),* 1410-1423.

Miozzo, M., & Caramazza, A. (1999). The selection of determiners in noun phrase production. *Journal of Experimental Psychology: Learning, Memory and Cognition, 25(4),* 907-922.

Morrison, C., Ellis, A., & Quinlan, P. (1992). Age of acquisition, not word frequency, affects object naming, not object recognition. *Memory and Cognition, 20(6),* 705-714.

Napps, S. (1989). Morphemic relationships in the lexicon: Are they distinct from semantic and formal relationships? *Memory and Cognition, 17(6),* 729-739.

Neely, J. H. (1991). Semantic priming effects in visual word recognition: A selective review of current findings and theories. In D. Besner & G. Humphreys (Eds.), *Basic processes in reading: Visual word recognition* (pp. 264-336). Hillsdale, NJ: Lawrence Erlbaum Associates.

√Panara-Apostolou, A. (2001). *Language change in Modern Greek: The morphological integration of English loanwords.* Athens: Parousia.

Perez-Pereira, M. (1991). The acquisition of gender: what Spanish children tell us. *Journal of Child Language, 18,* 571-590.

Peterson, R., & Savoy, P. (1998). Lexical selection and phonological encoding during language production: evidence for cascaded processing. *Journal of Experimental Psychology: Learning, Memory and Cognition, 24(3),* 539-557.

Pickering, M., & Branigan, H. P. (1998). The representation of verbs: Evidence from syntactic priming in language production. *Journal of Memory and Language, 39,* 633-651.

Radeau, M., & van Berkum, J. J. A. (1996). Gender decision. *Language and Cognitive Processes, 11(6),* 605-610.

√Ralli, A. (1994). Feature Representations and Feature-passing Operations in Greek Nominal Inflection. *Proceedings of the 8th Symposium on English and Greek Linguistics.* Thessaloniki: English Dept. Aristotle University of Thessaloniki.

√Ralli, A. (2000). A feature-based analysis of Greek nominal inflection. *Glossologia, 11-12,* 201-227.

Roelofs, A. (1992). A spreading-activation theory of lemma retrieval in speaking. *Cognition, 42,* 107-142.

Roelofs, A. (1996a). Serial order in planning the production of successive morphemes of a word. *Journal of Memory and Language, 35,* 854-876.

Roelofs, A. (1996b). Morpheme frequency in speech production: Testing WEAVER. In G.E Booij and J. van Marle (Eds.), *Yearbook of Morphology* (pp. 135-154). Dordrecht: Kluwer Academic Publishers.

Roelofs, A. (1998). Rightward incrementality in encoding simple phrasal forms in speech production: Verb-particle combinations. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 24,* 904-921.

Roelofs, A., Meyer, A., & Levelt, W. J. M. (1998). A case for the lemma/lexeme distinction: Comment on Caramazza and Miozzo (1997). *Cognition, 69,* 219-230.

Sandra, D. (1994). The Morphology of the Mental Lexicon: Internal Word Structure Viewed from a Psycholinguistic Perspective. *Language and Cognitive Processes, 9(3),* 227-269.

Schiller, N. O., & Caramazza, A. (2000). *Gender or determiner selection interference? Evidence from noun phrase production in German and Dutch.* Manuscript submitted for publication.

Schmitt, B., Meyer, A., & Levelt, W.J.M. (1999). Lexical access in the production of pronouns. *Cognition, 69,* 313-335.

Schreuder, R., Grendel, M., Poulisse, N., Roelofs, A., & van de Voort, M. (1990). Lexical processing, morphological complexity and reading. In D.A. Balota, G. B. Flores d'Arcais, & K. Rayner (Eds.), *Comprehension processes in reading* (pp. 125-144). Hillsdale, NJ: Lawrence Erlbaum Associates.

Schriefers, H. (1993). Syntactic processes in the production of noun phrases. *Journal of Experimental Psychology: Learning, Memory and Cognition, 19(4),* 841-850.

Schriefers, H., Friederici, A., & Graetz, P. (1992). Inflectional and derivational morphology in the mental lexicon: symmetries and asymmetries in repetition priming. *The Quarterly Journal of Experimental Psychology, 44A (2),* 373-390.

Schriefers, H., Friederici, A., & Rose, U. (1998). Context effects in visual word recognition: Lexical relatedness and syntactic context. *Memory and Cognition, 26(6),* 1292-1303.

Schriefers, H., & Jescheniak, J. (1999). Representation and processing of grammatical gender in language production: a review. *Journal of Psycholinguistic Research, 28(6),* 575-600.

Schriefers, H., Meyer, A., & Levelt, W. J. M. (1990). Exploring the time course of lexical access in language production: Picture-word interference studies. *Journal of Memory and Language, 29,* 86-102.

Schriefers, H., de Ruiter, J.P., & Steigerwald, M. (1999). Parallelism in the Production of Noun Phrases: Experiments and Reaction Time Models. *Journal of Experimental Psychology: Learning, Memory and Cognition, 25(3),* 702-720.

Schriefers, H., & Teruel, E. (1999). *The production of noun phrases: A cross-linguistic comparison of French and German.* Proceedings of the 21st Annual Conference of the Cognitive Science Society.

Schriefers, H., & Teruel, E. (2000). Grammatical Gender in Noun Phrase Production: The Gender Interference Effect in German. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26 (6),* 1368-1377.

Schriefers, H., Zwitserlood, P., & Roelofs, A. (1991). The identification of Morphologically Complex Spoken Words: Continuous Processing or Decomposition? *Journal of Memory and Language, 30,* 26-47.

Seidenberg, M., Waters, G., Sanders, M., & Langer, P. (1984). Pre- and postlexical loci of contextual effects on word recognition. *Memory and Cognition, 12(4),* 315-328.

Shapiro, L. P., & Hestvik, A. (1995). On-line comprehension of VP-ellipsis: Syntactic reconstruction and semantic influence. *Journal of Psycholinguistic Research, 24 (6),* 517-532.

Simner, J., & Smyth, R. (1999). Phonological activation in anaphoric lexical access. *Brain and Language, 68*, 40-45.

Slobin, D.I. (Ed.). (1997). *The crosslinguistic study of language acquisition.* London: Lawrence Erlbaum Associates.

Smith, M., & Wheeldon, L. (1999). High level processing scope in spoken sentence production. *Cognition, 73*, 205-246.

Spencer, A., & Zwicky, A. M. (Eds.). (1998). *The handbook of morphology.* Oxford: Basil Blackwell.

Starreveld, P., & La Heij, W. (1995). Semantic interference, orthographic facilitation and their interaction in naming tasks. *Journal of Experimental Psychology: Language, Memory, and Cognition, 21*, 686-698.

Starreveld, P., & La Heij, W. (1996). Time-Course analysis of semantic and orthographic context effects in picture naming. *Journal of Experimental Psychology: Learning, Memory and Cognition, 22(4)*, 896-918.

Steele, S. (1978). Word order variation: a typology study. In J. Greenberg, C. Ferguson, & E. Moravcsik (Eds.), *Universals of Human Language, IV: Syntax* (pp. 585-623). Stanford: Stanford University Press.

Stephany, U. (1997). The acquisition of Greek. In D. I. Slobin (Ed.), *The crosslinguistic study of language acquisition* (pp. 183-333). London: Lawrence Erlbaum Associates.

Stemberger, J. P. (1985). An interactive activation model of language production. In A. Ellis (Ed.), *Progress in the psychology of language* (Vol. 1, pp. 143-186). London: Lawrence Erlbaum.

Stemberger, J. P., & MacWhinney, B. (1986). Frequency and the lexical storage of regularly inflected forms. *Memory and Cognition, 14(1),* 17-26.

Sullivan, M., & Riffel, B. (1999). The nature of phonological encoding during spoken word retrieval. *Language and Cognitive Processes, 14(1),* 15-45.

Taft, M. (1988). A morphological-decomposition model of lexical representation. *Linguistics, 26*, 657-667.

Tanenhaus, M., & Lucas, M. (1987). Context effects in lexical processing. In U. Frauenfelder, & L. K. Tyler (Eds.), *Spoken word recognition* (pp. 213-234). Cambridge, MA: MIT Press/Bradford Books.

Tanenhaus, M., Dell, G., & Carlson, G. (1987). Context Effects and Lexical Processing: A Connectionist Approach to Modularity. In J. Garfield (Ed.), *Modularity in Knowledge Representation and Natural-Language Understanding* (pp. 83-108). Bradford: MIT Press.

Taraban, R., & Roark, B. (1996). Competition in learning language-based categories. *Applied Psycholinguistics, 17*, 125-148.

Todorovic, D. (1988). Hemispheric differences in case processing. *Brain and language, 33*, 365-389.

Triantaphyllidis, M. (1941/1978). *Neoelliniki grammatiki (tis dimotikis).* Athens: Organismos Ekdoseos Scholikon Vivlion. (Reprinted with corrections in Thessaloniki, 1978)

Tyler, L. K., & Marslen-Wilson, W. D. (1986). The effects of context on the recognition of multimorphemic words. *Journal of Memory and Language, 25*, 741-752.

Tyler, L. K., & Frauenfelder, U. (1987). The process of spoken word recognition: An introduction. In U. Frauenfelder, & L. K. Tyler (Eds.). *Spoken word recognition* (pp. 1-20). Cambridge MA: MIT Press/Bradford Books.

Van Berkum, J. J. A. (1996). *The psycholinguistics of grammatical gender.* Nijmegen: Nijmegen University Press.

Van Berkum, J. J. A. (1997). Syntactic processes in speech production: the retrieval of grammatical gender. *Cognition, 64,* 115-152.

Van Turennout, M., Hagoort, P., & Brown, C. M. (1997). Electrophysiological evidence on the time course of semantic and phonological processes in speech production. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23*, 787-806.

Varlokosta, S., Vainikka, A., & Rohrbacher, B. (1996). Root infinitives without infinitives. In A. Stringfellow (Ed.), *Proceedings of the 20th Boston University Conference on Language Development* (pp. 816-827). Boston: Cascadilla Press.

Vigliocco, G., Antonini, T., & Garrett, M. F. (1997). Grammatical gender is on the tip of Italian tongues. *Psychological Science, 8,* 314-317.

Vigliocco, G., Butterworth, B., & Garrett, M. F. (1996a). Subject-verb agreement in Spanish and English: Differences in the role of conceptual factors. *Cognition, 51*, 261-298.

Vigliocco, G., Butterworth, B., & Semenza, C. (1995). Constructing subject-verb agreement in speech: the role of semantic and morphological factors. *Journal of Memory and Language, 34,* 186-215.

Vigliocco, G., & Franck, J. (1999). When sex and syntax go hand in hand: gender agreement in language production. *Journal of Memory and Language, 40*, 455-478.

Vigliocco, G., Hartsuiker, R. J., Jarema, G., & Kolk, H. H. J. (1996b). How many labels on the bottles? Notional concord in Dutch and French. *Language and Cognitive Processes, 11,* 407-421.

Vigliocco, G., Vinson, D., Martin, R., & Garrett, M. (1999). Is 'count' and 'mass' information available when the noun is not? An investigation of Tip of the Tongue states and Anomia. *Journal of Memory and Language, 40*, 534-558.

De Vincenzi, M. (1999). Differences between the morphology of gender and number: evidence from establishing coreferences. *Journal of Psycholinguistic Research, 28(5),* 537-553.

West, R., & Stanovich, K. (1986). Robust effects of syntactic structure on visual word processing. *Memory and Cognition, 14(2),* 104-112.

Wheeldon, L. (1999). Competitive processes during word-form encoding. *Behavioral and Brain Sciences, 22(1),* 59-60.

Wheeldon, L. (Ed.). (2000). *Aspects of Language Production.* Hove, East Sussex: Psychology Press.

Wheeldon, L., & Monsell, S. (1994). Inhibition of spoken word production by priming a semantic competitor. *Journal of Memory and Language, 33,* 332-356.

Wright, B., & Garrett, M. (1984). Lexical decision in sentences: Effects of syntactic structure. *Memory and Cognition, 12,* 1931-1945.

Wunderlich, D. (1996). Minimalist Morphology: the role of paradigms. In G. Booij & J. van Marle (Eds.), *Yearbook of Morphology* (pp. 93-114). Dordrecht: Kluwer.

Zubin, D. A., & Köpcke, K. M. (1981). Gender: a less than arbitrary grammatical category. In R. Hendrick, C. Masek, & M. Miller (Eds.), *Papers from the Seventeenth Regional Meeting, Chicago Linguistic Society* (pp. 439-449). Chicago: Chicago Linguistic Society.

Zubin, D. A., & Köpcke, K. M. (1984). Affect classification in the German gender system. *Lingua, 63,* 41-96.

Zwitserlood, P. (1989). The locus of the effects of sentential-semantic context in spoken-word processing. *Cognition, 32,* 25-64.

Zwitserlood, P., Bolte, J., & Dohmes, P. (2000). Morphological effects on speech production: Evidence from picture naming. *Language and Cognitive Processes, 15(4/5),* 563-591.

Appendix Lists of Materials

Most of the items used in Experiments 3-8 are used in Experiments 1 and 2. Therefore their characteristics (AoA, number of syllabes and number of letters) are given in the Materials Tables of Experiments 1 and 2 only. Where additional items have been used, this is indicated by an asterisc (*) and their characteristics are given seperately.

A.1 Materials for Experiments 1 and 2

Table A1

Masculine Items: Primes

Greek	English	AoA	Number of syllables	Number of letters
αναπτήρας	lighter	3,30	4	9
ανεμόμυλος	windmill	3,74	5	10
βάτραχος	frog	2,38	3	8
γύψος	plaster cast	4,09	2	5
διαβήτης	compass	4,53	3	8
δίσκος	tray	3,42	2	6
εκτυπωτής	printer	5,94	4	9
κάβουρας	crab	3,17	3	8
καναπές	sofa	2,45	3	7
καρχαρίας	shark	3,09	4	9
κίονας	pillar	5,43	3	6
κόκορας	cock	2,19	3	7
κύκνος	swan	3,40	2	6
λαγός	hare	2,34	2	5
οδοστρωτήρας	road-roller	5,02	5	12
παπαγάλος	parrot	2,68	4	9
πλάστης	rolling-pin	4,06	2	7
πύραυλος	rocket	3,91	3	8

πυροσβεστήρας	fire-extinguisher	4,47	5	13
σκαντζόχοιρος	hedgehog	3,09	4	13
σκίουρος	squirrel	3,36	3	8
στόχος	target (mark)	3,96	2	6
τενεκές	bin	3,30	3	7
τρίφτης	grater	3,92	2	7
τροχός	wheel	3,77	2	6
υπολογιστής	computer	5,19	5	11
φάκελος	envelope	3,49	3	7
φάρος	light-house	3,45	2	5
φιόγκος	bow	3,08	2	7
φοίνικας	palm-tree	3,72	3	8
χάρακας	ruler	2,91	3	7
χαρταετός	kite	2,62	4	9

Table A2

Masculine Items: Targets

Greek	English	AoA	Number of syllables	Number of letters
αετός	eagle	2,68	3	5
ανανάς	pineapple	3,51	3	6
ανεμιστήρας	fan	3,64	5	11
αστακός	lobster	4,00	3	7
γάντζος	hook	4,21	2	7
γερανός	crane	3,98	3	7
γιακάς	collar	3,49	2	6
ελέφαντας	elephant	2,40	4	9
έλικας	propeller	4,38	3	6
θησαυρός	treasure	3,08	3	8
ιστός	web	4,53	2	5
καθρέφτης	mirror	2,51	3	9
κάκτος	cactus	3,70	2	6
καπνός	smoke	2,77	2	6
κεραυνός	thunder	3,17	3	8
κόμπος	knot	3,38	2	6
κορμός	trunk	3,34	2	6
κουβάς	bucket	2,68	2	6

κουμπαράς	money-box	2,87	3	9
μαγνήτης	magnet	4,04	3	8
νιπτήρας	wash-basin	2,98	3	8
πελαργός	stork	2,70	3	8
πίνακας	picture	2,89	3	7
πλανήτης	planet	3,85	3	8
σκελετός	skeleton	3,77	3	8
σταυρός	cross	2,34	2	7
συνδετήρας	paper-clip	3,96	4	10
σωλήνας	pipe	3,42	3	7
τοίχος	wall	2,36	2	6
φακός	torch	3,11	2	5
φράχτης	fence	3,19	2	7
χάρτης	map	3,25	2	6

Table A3

Neuter Items: Primes

Greek	English	AoA	Number of syllables	Number of letters
αχλάδι	pear	2,00	3	6
βάζο	vase	2,32	2	4
βιολί	violin	3,38	2	5
γραφείο	desk	2,70	3	7
δαχτυλίδι	ring	2,66	4	9
δόντι	tooth	1,81	2	5
θερμόμετρο	thermometer	3,02	4	10
κάστρο	castle	2,92	2	6
κεράσι	cherry	2,60	3	6
κλειδί	key	2,68	2	6
κλουβί	cage	3,23	2	6
κρεββάτι	bed	1,77	3	8
κρίνο	lily	3,83	2	5
λεμόνι	lemon	2,25	3	6
μανιτάρι	mushroom	3,57	4	8
μπουκάλι	bottle	2,45	3	8
παγωτό	ice-cream	1,98	3	6
παράθυρο	window	2,13	4	8

πηγάδι	well	3,04	3	6
πινέλο	paint-brush	3,02	3	6
πιστόλι	pistol	2,94	3	7
πρόβατο	sheep	2,23	3	7
σαξόφωνο	saxophone	4,57	4	8
σταχτοδοχείο	ash-tray	3,57	5	12
σύννεφο	cloud	2,40	3	7
τιμόνι	steering-wheel	2,66	3	6
τύμπανο	drum	3,00	3	7
φαράσι	dustpan	3,15	3	6
φορτηγό	lorry	2,75	3	7
φτερό	feather	2,83	2	5
φύλλο	leaf	2,34	2	5
ψαλίδι	scissors	2,75	3	6

Table A4

Neuter Items: Targets

Greek	English	AoA	Number of syllables	Number of letters
βαρέλι	Barrel	2,68	3	6
δελφίνι	dolphin	2,74	3	7
έλατο	fir-tree	2,70	3	5
ελικόπτερο	helicopter	3,81	5	10
ηφαίστειο	volcano	3,77	4	9
καλαμπόκι	corn (cob)	3,06	4	9
κανόνι	cannon	3,21	3	6
καρότο	carrot	2,58	3	6
κόκαλο	bone	2,68	3	6
κουμπί	button	2,62	2	6
κοχύλι	shell	2,98	3	6
κρανίο	skull	4,28	3	6
κύπελλο	cup (medal)	2,91	3	7
λουκέτο	padlock	3,98	3	7
μαξιλάρι	pillow	2,09	4	8
μικρόφωνο	microphone	3,81	4	9
μυρμήγκι	ant	2,28	3	8
παγόνι	peacock	3,36	3	6

πλυντήριο	washing-machine	3,21	4	9
πόμολο	(door-) knob	3,57	3	6
πριόνι	saw	3,75	3	6
ρόπαλο	cudgel (club)	3,72	3	6
σαλιγκάρι	snail	2,79	4	9
σίδερο	iron	2,83	3	6
σκιάχτρο	scare-crow	3,58	2	8
σκοινί	rope	2,66	2	6
σπίρτο	match	2,68	2	6
συντριβάνι	fountain	3,26	4	10
τούβλο	brick	2,77	2	6
τσεκούρι	axe	3,23	3	8
φτυάρι	spade	2,91	2	6
χωνί	funnel	3,47	2	4

Table A5

Feminine Items (Distractors): Black-and-White

Greek	English	AoA	Number of syllables	Number of letters
αγελάδα	cow	2,02	4	7
άγκυρα	anchor	3,04	3	6
αλυσίδα	chain	3,19	4	7
άμαξα	carriage	3,13	3	5
αρκούδα	bear	2,19	3	7
άρπα	harp	4,34	2	4
βόμβα	bomb	3,58	2	5
βούρτσα	paint-brush	3,02	2	7
γραβάτα	tie	3,19	3	7
εκκλησία	church	2,79	4	8
κάλτσα	sock	2,13	2	6
καμήλα	camel	2,79	3	6
κανάτα	jug	2,77	3	6
καρδιά	heart	2,53	2	6
καρέκλα	chair	2,04	3	7
κατσαρόλα	kettle	2,83	4	9
κιθάρα	guitar	3,23	3	6
μασέλα	dentures	4,02	3	6

μάσκα	mask	3,15	2	5
μέλισσα	bee	2,21	3	7
μπάλα	ball	1,64	2	5
μπανιέρα	bath-tub	2,36	3	8
μπότα	boot	3,06	2	5
παγίδα	trap	3,47	3	6
πένα	pen	3,92	2	4
πεταλούδα	butterfly	2,47	4	9
σημαία	flag	2,64	3	6
σκάλα	ladder	2,30	2	5
σκούπα	broom	2,43	2	6
τούρτα	cake	2,09	2	6
φράουλα	strawberry	2,68	3	7
χελώνα	tortoise	2,43	3	6

Table A6

Feminine Items (Distractors): Coloured

Greek	English	AoA	Number of syllables	Number of letters
Αντλία	Hose	4,91	3	6
βάρκα	boat	2,26	2	5
βίδα	screw	3,19	2	4
βρύση	tap	2,11	2	5
ζώνη	belt	3,00	2	4
θηλιά	noose	4,40	2	5
καμπάνα	bell	2,42	3	7
καραμέλα	candy	1,83	4	8
κασέτα	cassette	3,15	3	6
κεραία	aerial	3,72	3	6
κλεψύδρα	hourglass/sand-glass	5,00	3	8
κολοκύθα	pumpkin	2,96	4	8
κουρτίνα	curtain	2,43	3	8
κουτάλα	ladle	2,36	3	7
κρεμάστρα	hanger	2,94	3	9
λάμπα	lamp	2,43	2	5
μπανάνα	banana	2,19	3	7
μπρίζα	plug	2,98	2	6

μύτη	nose	1,62	2	4
νότα	music-note	3,77	2	4
νυχτερίδα	bat	3,79	4	9
ομπρέλα	umbrella	2,85	3	7
πάπια	duck	2,17	2	5
πυραμίδα	pyramid	3,92	4	8
σέλα	saddle	3,42	2	4
σκηνή	tent	3,60	2	5
σφεντόνα	sling	3,43	3	8
σφραγίδα	stamp	4,09	3	8
σφυρίχτρα	whistle	2,98	3	9
τσαγιέρα	tea-pot	3,83	3	8
φωτιά	fire	2,25	2	5
χτένα	comb	2,23	2	5

A.2 Materials for Experiments 3 and 4

Table A7

Masculine Items: Primes and Targets

Greek	English	Greek	English
ανανάς	pineapple	γιακάς	collar
αναπτήρας	lighter	διαβήτης	compass
ανεμιστήρας	fan	εκτυπωτής	printer
καναπές	sofa	ελέφαντας	elephant
κίονας	pillar	έλικας	propeller
κουμπαράς	money-box	κάβουρας	crab
νιπτήρας	wash-basin	καθρέφτης	mirror
οδοστρωτήρας	road roller	καρχαρίας	shark
πλάστης	rolling pin	κόκορας	cock
πυροσβεστήρας	fire-extinguisher	κουβάς	bucket
συνδετήρας	paper-clip	μαγνήτης	magnet
σωλήνας	pipe	πίνακας	picture
τενεκές	bin	πλανήτης	planet
φοίνικας	palm-tree	τρίφτης	grater
φράχτης	fence	υπολογιστής	computer
χάρακας	ruler	χάρτης	map

Table A8

Neuter Items: Primes and Targets

Greek	English	Greek	English
βάζο	vase	αυγό	egg
δώρο	present	γραφείο	desk
ελικόπτερο	helicopter	δάχτυλο	finger
θερμόμετρο	thermometer	έλατο	fir tree
καπέλο	hat	ηφαίστειο	volcano
παγωτό	ice-cream	καρότο	carrot
παλτό	coat	κόκαλο	bone
παράθυρο	window	κρανίο	skull
πρόβατο	sheep	κύπελλο	cup (medal)
σαξόφωνο	saxophone	λουκέτο	padlock
σίδερο	iron	μικρόφωνο	microphone
σκιάχτρο	scare-crow	πλυντήριο	washing machine
σύννεφο	cloud	ποδήλατο	bicycle
τόξο	bow	πόμολο	door knob
φορτηγό	lorry	ρόπαλο	cudgel
φύλλο	leaf	τύμπανο	drum

Table A9

Feminine Items (Distractors): Black-and-White and Coloured

Black-and-White		Coloured (Experiment 3)	
Greek	English	Greek	English
φωτιά	fire	μέλισσα	bee
κασέτα	cassette	μάσκα	mask
μπρίζα	plug	σημαία	flag
ομπρέλα	umbrella	κάλτσα	sock
πάπια	duck	γραβάτα	tie
σφεντόνα	sling	εκκλησία	church
βρύση	tap	άμαξα	carriage
λάμπα	lamp	άγκυρα	anchor
κουρτίνα	curtain	μπότα	boot
κρεμάστρα	hanger	άρπα	harp
νότα	music note	μπανιέρα	bath-tub
πυραμίδα	pyramid	τούρτα	cake
σφραγίδα	stamp	χελώνα	tortoise

τσαγιέρα	tea-pot	καμήλα	camel
βίδα	screw	καρέκλα	chair
μύτη	nose	σκηνή	tent

Table A10

Practice Items

Masculine		Feminine		Neuter	
Greek	English	Greek	English	Greek	English
ανεμόμυλος	windmill	σκάλα	ladder	φαράσι	dustpan
χαρταετός	kite	σκούπα	broom	κερί	candle
φιόγκος	bow	κατσαρόλα	kettle	κλουβί	cage
σκίουρος	squirrel	θηλιά	noose	κλειδι	key
βάτραχος	frog	κουτάλα	ladle	ψαλίδι	scissors

* Table A11

Added Items in Experiments 3 and 4

Greek	English	AoA	Number of syllables	Number of letters
δώρο	present	2,09	2	4
καπέλο	hat	2,08	3	6
παλτό	coat	2,4	2	5
τόξο	bow	3,08	2	4
αυγό	egg	1,53	2	4
δάχτυλο	finger	1,83	3	7
ποδήλατο	bicycle	2,36	4	8
κερί	candle	2,81	2	4

A.3 Materials for Experiments 5 and 6

Table A12

Masculine Items: Prime and Targets

Primes		Targets	
Greek	English	Greek	English
ανανάς	pineapple	αναπτήρας	lighter
γιακάς	collar	ανεμιστήρας	fan
εκτυπωτής	printer	διαβήτης	compass
καναπές	sofa	ελέφαντας	elephant
κουμπαράς	money-box	έλικας	propeller
νιπτήρας	wash-basin	κάβουρας	crab
οδοστρωτήρας	road-roller	καθρέφτης	mirror
πίνακας	picture	καρχαρίας	shark
πλάστης	rolling-pin	κίονας	pillar
πυροσβεστήρας	fire-extinguisher	κόκορας	cock
σωλήνας	pipe	κουβάς	bucket
τενεκές	bin	μαγνήτης	magnet
τρίφτης	grater	πλανήτης	planet
υπολογιστής	computer	συνδετήρας	paper-clip
χάρακας	ruler	φοίνικας	palm-tree
χάρτης	map	φράχτης	fence

Table A13

Neuter Items: Primes and Targets

Primes		Targets	
Greek	English	Greek	English
βάζο	vase	αυγό	egg
γραφείο	desk	δάχτυλο	finger
δώρο	present	έλατο	fir-tree
θερμόμετρο	thermometer	ελικόπτερο	helicopter
κρανίο	skull	ηφαίστειο	volcano
λουκέτο	padlock	καπέλο	hat
παγωτό	ice-cream	καρότο	carrot
παλτό	coat	κόκαλο	bone
παράθυρο	window	κύπελλο	cup (medal)

πρόβατο	sheep	μικρόφωνο	microphone
σαξόφωνο	saxophone	πλυντήριο	washing-machine
σύννεφο	cloud	ποδήλατο	bicycle
τόξο	bow	πόμολο	door knob
τύμπανο	drum	ρόπαλο	cudgel (club)
φορτηγό	lorry	σίδερο	iron
φύλλο	leaf	σκιάχτρο	scare crow

Table A14

Feminine Items (Distractors): Coloured

Greek	English	Greek	English
άγκυρα	anchor	αλυσίδα	chain
άμαξα	carriage	άρπα	harp
βρύση	tap	βίδα	screw
γραβάτα	tie	καμήλα	camel
κάλτσα	sock	κανάτα	jug
κασέτα	cassette	καρέκλα	chair
λάμπα	lamp	κουρτίνα	curtain
μάσκα	mask	κρεμάστρα	hanger
μέλισσα	bee	μπανιέρα	bath-tub
μπάλα	ball	μπότα	boot
μπρίζα	plug	νότα	music note
ομπρέλα	umbrella	πυραμίδα	pyramid
πάπια	duck	σκηνή	tent
σημαία	flag	σφραγίδα	stamp
σφεντόνα	sling	τούρτα	cake
φωτιά	fire	τσαγιέρα	tea-pot

Table A15

Feminine Items (Distractors): Black-and-White

Greek	English	Greek	English
αρκούδα	bear	αγελάδα	cow
βάρκα	boat	αντλία	hose
βόμβα	bomb	θηλιά	noose
εκκλησία	church	καραμέλα	candy

ζώνη	belt	καρέκλα	chair
καμπάνα	bell	κουκουβάγια	owl
κατσαρόλα	kettle	κουτάλα	ladle
κεραία	aerial	μύτη	nose
κιθάρα	guitar	πεταλούδα	butterfly
κλεψύδρα	hourglass	σέλα	saddle
κολοκύθα	pumpkin	σκάλα	ladder
μασέλα	dentures	σφυρίχτρα	whistle
μπανάνα	banana	τούρτα	cake
νυχτερίδα	bat	τσάντα	hand bag
σκούπα	broom	χελώνα	tortoise
φράουλα	strawberry	χτένα	comb

Table A16

Practice Items

Block A		Block B	
Greek	English	Greek	English
ανεμόμυλος	windmill	κλειδί	key
φαράσι	dustpan	ανεμόμυλος	windmill
δαχτυλίδι	ring	κρεββάτι	bed
κρεββάτι	bed	γάντζος	hook
φιόγκος	bow	σκελετός	skeleton
ψαλίδι	scissors	σκίουρος	squirrel
κερί	candle	φαράσι	dustpan
κλουβί	cage	πηγάδι	well
μανιτάρι	mushroom	κάκτος	cactus
κάκτος	cactus	ιστός	web

* Table A17

Added Items in Experiments 5 and 6

Greek	English	AoA	Number of syllables	Number of letters
κουκουβάγια	owl	2,85	4	11
τσάντα	bag	2,34	2	6

A.4 Materials for Experiments 7 and 8

Table A18

Masculine Items: Primes (Singular and Plural)

Singular		Plural	
Greek	English	Greek	English
ανεμιστήρας	fan	ανανάς	pineapple
καναπές	sofa	αναπτήρας	lighter
κίονας	pillar	κουμπαράς	money-box
νιπτήρας	wash basin	συνδετήρας	paper-clip
οδοστρωτήρας	road roller	σωλήνας	pipe
πλάστης	rolling pin	φοίνικας	palm-tree
πυροσβεστήρας	fire-extinguisher	φράχτης	fence
τενεκές	bin	χάρακας	ruler

Table A19

Masculine Items: Targets

Greek	English	Greek	English
πλανήτης	planet	ελέφαντας	elephant
μαγνήτης	magnet	τρίφτης	grater
καρχαρίας	shark	διαβήτης	compass
κουβάς	bucket	υπολογιστής	computer
εκτυπωτής	printer	κάβουρας	crab
χάρτης	map	γιακάς	collar
κόκορας	cock	έλικας	propeller
πίνακας	picture	καθρέφτης	mirror

Tabel A20

Neuter Items: Primes (Singular and Plural)

Singular		Plural	
Greek	English	Greek	English
βάζο	vase	ελικόπτερο	helicopter
δώρο	present	παγωτό	ice-cream
θερμόμετρο	thermometer	παλτό	coat
καπέλο	hat	σαξόφωνο	saxophone

παράθυρο	window	σίδερο	iron
πρόβατο	sheep	σκιάχτρο	scare-crow
σύννεφο	cloud	φορτηγό	lorry
τόξο	bow	φύλλο	leaf

Table A21

Neuter Items: Targets

Greek	English	Greek	English
ηφαίστειο	volcano	μικρόφωνο	microphone
ρόπαλο	cudgel	αυγό	egg
έλατο	fir tree	γραφείο	desk
κόκαλο	bone	κύπελλο	cup (medal)
ποδήλατο	bicycle	πλυντήριο	washing machine
κρανίο	skull	καρότο	carrot
τύμπανο	drum	δάχτυλο	finger
λουκέτο	padlock	πόμολο	door knob

Table A22

Feminine Items (Distractors): Black-and-White and Coloured

Black-and-White		Coloured	
Greek	English	Greek	English
φωτιά	fire	μέλισσα	bee
κασέτα	cassette	μάσκα	mask
μπρίζα	plug	σημαία	flag
ομπρέλα	umbrella	κάλτσα	sock
πάπια	duck	γραβάτα	tie
σφεντόνα	sling	εκκλησία	church
βρύση	tap	άμαξα	carriage
λάμπα	lamp	άγκυρα	anchor
κουρτίνα	curtain	μπότα	boot
κρεμάστρα	hanger	άρπα	harp
νότα	music note	μπανιέρα	bath-tub
πυραμίδα	pyramid	τούρτα	cake
σφραγίδα	stamp	χελώνα	tortoise
τσαγιέρα	tea-pot	καμήλα	camel

βίδα	screw	καρέκλα	chair
μύτη	nose	σκηνή	tent

Table A23

Practice Items

Masculine		Feminine		Neuter	
Greek	English	Greek	English	Greek	English
ανεμόμυλος	windmill	σκάλα	ladder	φαράσι	dustpan
χαρταετός	kite	σκούπα	broom	κερί	candle
φιόγκος	bow	κατσαρόλα	kettle	κλουβί	cage
σκίουρος	squirrel	θηλιά	noose	κλειδι	key
βάτραχος	frog	κουτάλα	ladle	ψαλίδι	scissors