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MORPHOLOGICAL DECOMPOSITION IN ARABIC: DISSOCIATION OF FORM AND SEMANTIC EFFECTS

By

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ABSTRACT

MORPHOLOGICAL DECOMPOSITION IN ARABIC: DISSOCIATION OF FORM AND SEMANTIC EFFECTS

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Traditional theories of Semitic morphology hold that two abstract morphemic units, the root (e.g., *k-t-b*) and the word pattern (e.g., *-i-aa-*), are the basis for word formation (e.g., *kitaab* [book]). Previous lexical processing studies in Hebrew and Arabic have confirmed the independent morphemic status of these two units, and the root in particular, whose existence was disputed under word-based theories. To further this line of investigation, the current study asks: (1) Is root priming in Arabic caused by form and semantic overlap or is it independent of these two factors? (2) Does the Arabic lexicon impose linearity constraints on the root consonants? (3) Does higher proficiency in a second language (English) have any consequences for lexical organization and processing in the first language (Arabic) of bilingual speakers?

In addressing these research questions (RQs), a masked priming experiment was designed using a within-target design. To get at RQ1, the priming effects between same-root word pairs with both decreased semantic and form overlap were compared to the priming between orthographic minimal pairs. With respect to positional coding constraints (RQ2), this study included transposed-letter (TL) existing words. RQ3 was investigated by comparing lexical processing in native speakers of Arabic who are highly proficient in English to processing in near monolingual speakers of Arabic.

Results show that for near monolingual speakers of Arabic, there were significant priming effects between same-root words and no orthographic or TL priming effects.

In contrast, native speakers of Arabic with high proficiency in English show numerical priming in the TL condition and no priming in the root condition. The results of the monolinguals are consistent with the morpheme-based/ decompositional view of Semitic morphology. On the other hand, the results of the bilinguals extend previous research on the effects of the second language on the first to the domain of lexical processing. The implications of these results are discussed.

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CHAPTER 1: INTRODUCTION

1.1 Overview

Human languages have many structural similarities and differences. In a linguist's eye, the structural features that distinguish one language from another are of great value. The primary way of structurally classifying the world's languages is based on the morphological systems of these languages. Different languages may vary with respect to the morphological rules or the rules employed for word formation. In Indo-European languages like English, simple words or free standing forms like *farm* are formed by linearly attaching phonemes or letters together. In Semitic languages such as Arabic, simple words like *zaraʕ* (to farm) are formed by the intercalation of two abstract morphemes: the root which consists of consonants e.g., *z-r-ʕ* (with the semantic field of farming) and the word pattern which consists of vowels but may also include certain consonants e.g., *-a- a* (active, perfective) or *ma--uu-* (passive, participle).

In English complex words are formed by appending morphemes, or minimal meaning-bearing units, one to the other in a linear fashion (e.g., *farmer*). This means that a complex word like *farmer* is derived by attaching the agentive suffix (-er) to the free standing form *farm*. In Arabic, derivationally related words are never derived from one another but are either derived from the same root or the same word pattern. For example, the word *muzaariʕ* (farmer) is morphologically related to the word *zaraʕ* (to farm) because both are derived from the same root and not because one form is derived from the other. Both words are derived from the same tri-consonantal root *z-r-ʕ*, which denotes the notion of farming. However, the root combines with a different word pattern in each case, namely, *mu-aa-i-* (a word pattern with an agentive meaning) in the first word and -*a-a* (active, perfective) in the second word. Words can also be morphologically related by virtue of sharing a word pattern. For example both the words *muzaariʕ* (farmer) and *muṣaariʕ* (wrestler) share the word pattern *mu-aa-i-*.

As far as meaning is concerned, root morphemes define a more uniform morphological family than a word pattern. Words sharing a root morpheme like *katab* (wrote), *kitaab* (book), *maktabah* (library), *maktab* (office), *kutayyib* (booklet) all embrace the notions of writing or book, albeit to various degrees. Semantic conformity is also possible in word pattern relatives but to a far lesser degree. For example, the words *maktaba* (library), *mazraʕa* (farm), *madrasa* (school) *maħkama* (courthouse), *maṭbaʕa* (publishing house) and *maʃnaqa* (gallows) all share the word pattern *ma--a-a*, which in these words denotes the meaning of a place. However, the word pattern *ma--a-a* is not reserved for this meaning as can be seen from other examples like *mahzala* (farce), and *masʔala* (problem/issue). Additionally, there are different word patterns which denote the meaning of a place like *ma--a-* and *ma--i-* as in *maṭʕam* (restaurant), *maktab* (office), *maṣnaʕ* (factory) *masraħ* (theatre), *masʤid* (mosque), and *maṣrif* (bank).

Due to the consonantal nature of the root morpheme, the root is always orthographically represented in writing. However, apart from long vowels and consonants, word pattern information is not represented as letters in print. Instead, it is indicated as diacritical marks which in fact are not included in most print. For example, one surface form like علم may be read as *ʕilm* (knowledge/science) *ʕalam* (flag), *ʕallam* (taught/educated), *ʕalim* (knew), or *ʕullim* (was taught) i.e. different readings in which the root is shared across all forms but the word pattern is variable. In these cases, the reader resorts to the context in order to disambiguate the surface form. All these differences between the root and the word pattern accord the former a more important role in lexical access and recognition at least in print.

The morpheme-based or word-and-pattern view of Semitic languages espoused by traditional Arab grammarians and the majority of western linguists (e.g., Cantineau, 1950a, b; McCarthy, 1981) was recently challenged by what came to be known as the word-based theories. Many word-based theories disputed the reality of the tri-consonantal root viewing it merely as a convenient tool that serves the purpose of lexicographers. In their analyses, linguists adopting the word-based view have banked on various theoretical frameworks like the Stem Modification analysis by Steriade (1988), Optimality Theory by Prince and Smolensky (1993), and the Distributed Morphology framework of Halle and Marantz (1993). The starting point of all word-based views of Semitic morphology is the observation of regular form and semantic relationships among certain classes of words. In the crossfire between the two views of Semitic morphology, there were moderate voices from the word-based camp arguing that some words are root-derived while others are word-derived (e.g., Arad, 2003: Ravid, 2006).

Each of the two views of Semitic morphology carries with it certain consequences for lexical organization and processing. The morpheme-based view is consistent with the decompositional hypothesis (e.g., Taft, 1981; Taft & Forster, 1975) which holds that words are decomposed into their constituent morphemes during lexical access. In contrast, word-based theories are along the lines of the full-listing account of lexical processing (e.g., Butterworth, 1983) which maintains that each word is independently listed in the lexicon and its access does not entail any decompositional process.

The claims of both the decompositional and non-decompositional accounts of Semitic morphology had to be put to the test. To that end, researchers used various experimental procedures including priming paradigms. In priming experiments, researchers measure the accuracy and the time it takes participants to recognize a target word or a nonword following the presentation of a word or a nonword stimulus known as the prime. Collectively, past priming studies in both Hebrew and Arabic have shown that morphologically-related word primes (particularly same-root primes e.g., ***taṣħiiħ*** [correction]) facilitated target recognition (e.g., ***ṣaħiiħ*** [correct]) whereas orthographically-related but morphologically unrelated primes (e.g., ***ṣaħiifah*** [newspaper]) did not produce such facilitation (e.g., Boudelaa & Marslen-Wilson, 2005). The root priming effects were obtained even in the absence of semantic support between the prime and target (e.g., ***ʕaðaab*** [torture]-***ʕaðb*** [sweet]) (e.g., Boudelaa &Marslen-Wilson, 2005). Finally, orthographically-related prime-target pairs failed to prime even when they were different in one root letter (e.g., ***tanḍiif*** [cleaning]-***tanḍiim*** [organizing]) whereas robust root priming effects were obtained even when the prime and target differed in more than one nonroot letter (e.g., ***munaḍḍamah*** [organization] - ***tanḍiim*** [organizing]) (Frost, Kugler, Deutsch, & Forster 2005).

These findings were taken as evidence for the decompositional view of lexical access and against the full listing hypothesis, and therefore lent support to the independent morphemic status of the root (and the word pattern) morpheme whose existence was disputed under the word-based approach to Semitic morphology. However, although studies that compared root effects with orthographic effects obtained priming for the former but not the latter type of relatedness, the comparison was not necessarily valid. Specifically, same-root prime-target words either had greater form overlap than orthographically-related pairs (e.g., Boudelaa & Marslen-Wilson, 2005) or had strong semantic overlap (e.g., Frost et al., 2005). Substantial support will be obtained for the decompositional view only when an evenhanded comparison between morphological and orthographic relatedness is conducted. One goal of the current study is to reevaluate the claims of the decompositional view of Semitic morphology by introducing stricter experimental manipulations which aim to render the comparison between root and orthographic similarity a fair one. For this reason, root priming will be compared to orthographic priming both in the absence of semantic support between same-root words and when form overlap is greater for the orthographically-related pairs than the same-root pairs.

In previous research, root similarity was defined as sharing the tri-consonantal root morpheme (e.g., the root *s-f-r* in the pair ***musaafir*** [traveler] - ***safar*** [travel]) whereas orthographic similarity was achieved if two words shared all but one root letter (e.g. ***siħr*** [magic]-***safar*** [travel]). These made two types of form relatives: morphological relatives and orthographic relatives. However, there is a third kind of form relative, namely a transposed root relative. An example pair reflecting this kind of form relation would be the words ***faras*** [horse] - ***safar*** [travel] in which the words have the exact same root consonants but which are ordered differently in each word, namely *f-r-s* in the first word and *s-f-r* in the second. In traditional grammar, transposed roots are treated as different roots, meaning that they are orthographically related but morphologically unrelated. However, since mental processing does not necessarily reflect the lexicographer or the grammarian's assessment, it may well be the case that transposed roots are processed more like morphological relatives than orthographic neighbors. To explore this, the second goal of the present study is to investigate transposed root effects in the context of real words. Investigating this type of form relatedness is important for knowing if Semitic languages impose any positional coding requirements with regard to the consonants of the root. Previous research on transposed-letter (TL) similarity in Semitic languages (e.g., Velan and Frost, 2009; Perea, Abu Mallouh, & Carreiras, 2010) shows no TL priming effects, which suggests that Semitic languages impose strict position coding requirements on the roots' consonants. However, in these studies either nonword primes were used (Velan and Frost, 2009) or the stimuli were severely confounded (Perea et al., 2010).

Past research in Semitic languages has investigated language processing in native speakers treating them indiscriminately and paying no attention to variables like knowledge or proficiency in a second language. Different languages seem to require the lexicon to be organized according to principles that derive from the structure of these languages. In Arabic, for example, lexical organization seems to be based on the concept of a discontinuous (root) morpheme while in English organizing of the lexicon seems to be based on the notion of a continuous morpheme. In addition, these two languages differ from each other in several respects particularly with regard to TL-effects. One question these differences raise is: how could two different lexical systems co-exist in the mind of one bilingual speaker? Would Arabic-English bilingual speakers, for example, use one system to organize their Arabic lexicon and another system to organize their English lexicon?

Research on language processing has shown that monolinguals and bilinguals deviate in many areas of linguistic knowledge. Language processing in bilinguals shows many instances of interference and transfer effects. For late second language (L2) learners who are at the beginning stages of L2 acquisition, transfer and interference effects are more likely to be unidirectional going from the first language (L1) to the L2 (see Jarvis & Pavlenko, 2008 for a comprehensive review of crosslinguistic transfer in bilinguals and Qasem & Foote, 2010 for a review of literature on interference effects in low proficiency bilinguals). However, with increased proficiency in the L2, the direction of transfer may reverse particularly in areas where the L2 and the L1 clearly diverge. In most cases, transfer will be in areas of core grammar like syntax, phonology, and semantics (Su, 2001; Flege, 1987; Laufer, 2003 inter alia). In other cases, transfer will also leak into online processing (e.g., Dussias, 2004). While there is abundant evidence for the effects of L2 on the L1 in areas of core grammar, very little research has investigated these effects in online processing. The third goal of this research is therefore to investigate L1 lexical processing as it applies to near monolinguals and highly proficient L2 speakers.

To summarize, there are three goals in the present study. First, the current study aims to introduce stricter manipulations in reinvestigating the validity of two competing views of Semitic morphology: the root-based/decompositional view and the word-based/full listing view. The second goal of this study is to investigate whether or not Semitic languages (as represented by Arabic) impose any positional requirements with respect to the consonants of the root morpheme. Finally, the present study aims to examine if proficiency in L2 English has any consequences for lexical processing in L1 Arabic.

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1.2 Current Study

In pursuit of achieving the above research goals, an experiment was designed to answer three corresponding research questions: (1) Is root priming in Arabic caused by form and semantic overlap or is it independent of these two factors? (2) Does the Arabic lexicon impose linearity constraints on the root consonants? (3) Does higher proficiency in a second language (English) have any consequences for lexical organization and processing in the first language (Arabic) of bilingual speakers?

With regard to the first research question, the aim of the experiment is to investigate the effects of morphological similarity between same-root word pairs that are dissociated semantically and orthographically and to compare these effects to the effects of orthographic similarity between orthographic minimal pairs in L1 Arabic. In contrast to previous research (e.g., Boudelaa & Marslen-Wilson, 2005), the form overlap between the target words and the same-root primes was less than that between these targets and the orthographically-related primes. Additionally, the primes in the root condition had impoverished or no semantic relationships with their targets. All in all, the manipulations in this study ensured a fair comparison between the two types of primes (i.e. the morphologically related and the orthographically-related). If it turns out that Arabic native speakers process their L1 in accordance with the non-decompositional view of Semitic languages, then no root-priming effects are expected in this experiment. This will indicate that root-priming effects in previous research may have been due to form and/or semantic overlap between the same-root words. If, on the other hand, root priming effects are not caused by form and/or semantic similarity, there will be robust priming effects between same-root words.

To investigate the second research question, the experiment in this study included a transposed-letter (TL) condition. The TL condition was investigated in the context of real words. In addition, TL-priming effects were investigated using singular nouns; thus, avoiding all confounds in previous research. If it turns out that Arabic imposes strict positional constraints, then no priming effects shall be observed in this condition. Finally, in order to answer the third research question, native speakers of Arabic with high proficiency in L2 English were tested and compared with near monolingual speakers of Arabic. If knowledge and proficiency in a second language have any effects on L1 processing, then high proficiency bilinguals may show a pattern of results different from monolingual norms. Specifically, native speakers of Arabic who are highly proficient in English will show L2-like processing patterns in areas where the lexicon of the two languages differ. This L2-like processing pattern may be the consequence of the parser becoming adapted to the system of a second language which does not correspond, structurally speaking, to the first language.

The current study which employs a within-target design has two important implications for native language processing. First, the results of this study will cast light on lexical access and organization in a language with a discontinuous morphology. Specifically, the comparison of the three form relatives (root, orthographic, and TL) will provide important answers about the nature of the principles used in lexical access and organization and whether these principles agree with the linguistic analyses as suggested by formal theories of morphology.

Second, the present study has theoretical significance for L1 processing as it applies to different groups of native speakers. While a large body of research exists on L1 lexical processing particularly in monolinguals, no study has ever approached L1 lexical processing in Semitic languages factoring in the potential consequences of high proficiency in a second language. This study is the first that compares lexical processing in L1 by two groups of native speakers: those with little or no knowledge of a structurally different language and another group with high proficiency in a structurally different language. If L1 processing in bilinguals is found to be different from L1 processing in monolinguals, then this study extends findings of previous studies on the effects of the L2 on the L1 to the domain of lexical processing.

1.3 Organization of the Current Study

The current study will be organized as follows: Chapter 2 provides an overview of Semitic morphology both from the perspective of morpheme-based and word-based theories. This is followed by a body of experimental research that deals with lexical processing and organization in both Hebrew and Arabic. Chapter 3 reviews a selection of past research on lexical processing in English which is the second language of the bilingual participants in this study. There, I will highlight the differences between processing in English and Arabic. Chapter 4 addresses the effects of the L2 on the L1 in late L2 learners by presenting previous research on the topic. In chapter 5, I will present the results of an experiment designed to address all the research questions in this study. Chapter 6 offers a summary and a discussion of the results, including theoretical implications of the findings as well as directions for future research.

CHAPTER 2: LEXICAL ORGANIZATION IN SEMITIC LANGUAGES

2.1 Introduction

Unlike monomorphemic languages like Chinese or Vietnamese, many of the world's language are morphologically complex. Morphemes in Indo-European languages including English are formed by stringing together a sequence of letters/ phonemes in a linear order while morphologically complex words are formed by concatenating a sequence of morphemes in a linear fashion i.e. prefixing or suffixing a morpheme to a base morpheme. Accordingly, the orthographic integrity of the base form is preserved, e.g., un-**employ**-ment. Many morphologically complex languages, however, form words according to different principles. One language family in which words are formed nonlinearly is the Semitic language family.

2.2 Morphology of Semitic Languages

Traditional grammarians of Arabic and Hebrew as early as medieval times held that Semitic languages like Arabic and Hebrew possess nonlinear, non-concatenative morphological systems (also known as root-and-pattern morphology or introflection; Bauer, 2004). On this view, words in Arabic, for example, are formed by the interdigitation of two abstract morphemes: The consonantal root (e.g., *k-t-b* [write]), which carries semantic information, and the word pattern or the transfix (Bauer, 2004) (e.g., *faʕal* [active, perfective])[1], which assigns the morpho-syntactic specifications like *perfective*, *active*, or *causative* and phonological structure to the surface form (Boudelaa & Marslen-Wilson, 2004; Marslen-Wilson, 2001; Marslen-Wilson, 2007). The root (e.g.,

[1] The consonants /f, ʕ, l/ *does* (Hebrew /p, ʕ, l/) are conventionally used to represent the consonantal root such that the /f/ stands for the first root consonant, the /ʕ/ for the second, and the /l/ for the third.

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k-t-b) and the word pattern (*faʕala*) combine together to form a meaningful word (e.g., ***kataba*** [he wrote]).

It is possible for the same root to combine with various word patterns resulting in different, yet semantically related words. For example, the root ***k-t-b*** participates in other words such as ***kataba*** (he wrote), ***kitaab*** (book), ***maktaba*** (library). Moreover, the same word patterns can combine with different roots to form different and semantically unrelated words (e.g., ***darasa*** [he studied], ***kataba*** [he wrote], and ***zaraʕa*** [he planted]; or ***madrasa*** [school], ***maktaba*** [library], ***mazraʕa*** [farm]). As can be noted, the linear order of the root letters is preserved though their contiguity can be interrupted. It is worth mentioning that changing the order of the root letters results in a completely different root that has a completely different meaning.

In modern linguistics, the rudimentary version of the root-and-pattern approach witnessed several modifications. Additionally, alternative analyses of Semitic morphology were proposed by several linguists. In the next sections, an overview of these developments will be provided.

2.3 Theoretical Background

2.3.1 Morpheme-Based Analysis of Semitic Languages

The morphology of Semitic languages has served as the center stage for several linguists as it provides a fertile ground for a litmus test for two opposing word formation theories: morpheme-based and word-based theories. In classic morpheme based theories (e.g., Cantineau, 1950a, b), the analysis of words is based on roots and patterns. However, using autosegmental phonology (Goldsmith, 1976) as his theoretical framework, McCarthy (1981) proposed four separate tiers for morphemic units in Arabic:

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1) The prosodic template or the CV-skeleton which is composed of consonantal and vocalic slots, 2) the consonantal root, 3) the affixal consonants, if any, and 4) the vowels (or vowel melody) (See Figure 2.1). In addition, McCarthy (1981) postulated a set of association rules and conventions for mapping the consonants and vowels onto the CV-skeleton, which specifies the syllable pattern of a given form. At a later stage of word formation, the multi-tiered representation is linearized into a single segmental tier by means of a Tier Conflation operation (McCarthy, 1986).

It should be noted that McCarthy's (1981) analysis, although generally conforming to the root-and-pattern approach, broke down the pattern further into a vocalic melody, a CV-Skeleton, and affixal consonants. On this view, the word [katab][2] *wrote*, for example, is said to consist of the root *k-t-b*, the vocalic melody *a-a*, and the CV-Skeleton CVCVC as shown in Figure 2.1. The vocalic melody carries syntactic information like aspect (perfective/imperfective) and voice (active/passive). The CV-Skeleton specifies the phonological shape of the surface form. It also encodes a range of syntactic and semantic information. It is worth pointing out that unlike the vowel melody and the consonantal root, the CV-Skeleton is a phonologically unspecified morphemic unit that acts more like a placeholder for the root and vowel morphemes having no surface phonetic realization.

[2] Following McCarthy (1981), this form does not show mood, agreement, case, gender, or number marking.

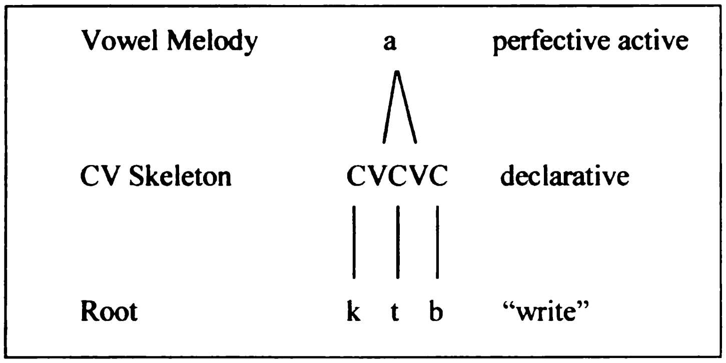

Figure 2.1: Representation of the word *katab*.
Representation of the word *katab* in accordance with McCarthy's (1981) autosegmental analysis (adapted from McCarthy & Prince, 1990).

The rationale behind McCarthy's (1981, 1982) distinction between the root, vowel melody, and the skeletal tier lies in the possibility to vary each morpheme independently of the others. For example, the pair *qaatal-qutil* [combat/battle-be killed] shares the root *q-t-l* with the semantic field of "kill". However, the two forms differ in their vocalic and skeletal tiers. In the first word, the vowel melody is the perfective active *a-a*, and the CV-Skeleton is the reciprocal sequence CVVCVC (i.e. a sequence indicating a reciprocal action) while in the second word, the vowel melody is the perfective passive *u-i*, and the skeletal tier is the declarative sequence CVCVC.

Now, considering the pair *katab-fakkar* [write-think], it can be noted that the two words diverge with respect to their root and skeletal morphemes but share the perfective active vocalic melody *a-a*. In *katab*, the root is *k-t-b* and the skeleton is CVCVC whereas in *fakkar*, the root is *f-k-r* and the skeleton is the extensive sequence CVCCVC. Finally, turning to pairs like *raasal-quutil* [correspond-be fought], the similarity between the two forms is in terms of the skeletal tier. Both forms share the reciprocal sequence CVVCVC but have different roots (*r-s-l* and *q-t-l*) and vocalic melodies (*a-a* and *u-i*). The traditional root-and-pattern analysis would have treated the aforementioned pairs as having different word patterns (e.g. *faaʕal* and *fuuʕil* for *raasal* and *quutil*) with no additional internal structures thus overlooking critical regularities and failing to capture the fact that pairs like these are systematically related (Boudelaa & Marslen-Wilson, 2004).

2.3.2 Word-Based Analysis of Semitic Morphology

The morpheme-based account of Semitic languages which recognized the consonantal root was embraced by the vast majority of Western linguists. Conversely, a word-based (or stem-based) view of Semitic does not acknowledge the existence of the consonantal root. Bat-El (1994), for example, adopts the Stem Modification analysis, first introduced in Steriade (1988) and in McCarthy and Prince (1990), as an alternative theoretical framework to account for morphologically conditioned alternations in Modern Hebrew. In her earlier work, Bat-El (1986) used an adaption of McCarthy's (1981) multi-tiered derivational model for her analysis of denominatives in Modern Hebrew. According to her adaptation, derivation for a fully specified base form involves two stages: (i) Extraction of the root consonants from the base form while maintaining linearity, and (ii) Root-to-Template Association whereby the extracted root consonants are associated with a given template along with the vowel pattern. However, the failure of the 'Root-to-Template Association' to account for the preservation of consonant adjacency in some derived forms led Bat-El (1994) to abandon her earlier position.

According to Bat-El (1994), it is not only the linear order of consonants that is preserved in derived forms but also the adjacency relationship between the consonants, i.e. whether or not they constitute a cluster (see example 1). Under the 'Extraction plus

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Root-to-Template Association' analysis, Bat-El (1994) argues, information about adjacency relations is lost once the root consonants are extracted. On the other hand, in Stem Modification analysis, adjacency information is never lost for there is direct access to the base form throughout the derivation (cluster transfer).

(1)	Base form	Derived form	Incorrect form
	praklit 'lawyer'	*priklet* 'to practice law'	*pirklet
	sandlar 'shoemaker'	*sindler* 'to make shoes'	*snidler

The Stem Modification analysis provides a solution for the adjacency problem but it comes with a high cost, namely, it strips the consonantal root of its morphemic status granted under McCarthy's (1981) multi-tiered account. As Bat-El (1994) puts it:

> When Stem Modification is adopted as the appropriate analysis of Modern Hebrew stem form, the peculiar notion of "consonantal root" is eliminated from the grammar. It is claimed here that there is no such formative as a consonantal root because there is no stage in the derivation where it can be referred to as a unit (p. 573).

As for the common core meaning that a given consonantal root carries in different words, Bat-El (1994) believes that meaning can only be attributed to the entire stem and not consonants and like cluster transfer, semantic properties of the base form are transferred to the derived form without the stipulation that these properties are associated with the transferred consonants.

Ussishkin (1999) furthered Bat-El's (1994) argument by providing an Optimality Theory-based analysis (Prince & Smolensky, 1993) for biliteral denominal verb formation in Modern Hebrew. Specifically, Ussishkin (1999) used the Correspondence Theory of McCarthy and Prince (1993) as his framework. Correspondence Theory is a formal mechanism that enforces identity relations between inputs and outputs and is expressed as follows:

(2) *Correspondence* (McCarthy & Prince 1995, p. 262)

> Given two related Strings S_1 and S_2, correspondence is a relation $\mathscr{R}$ from the elements of S_1 to those of S_2. Elements $\alpha \in S_1$ and $\beta \in S_2$ are referred to as correspondents of one another when $\alpha \mathscr{R} \beta$.

Ussishkin (1999) claims that the same type of correspondence relations which exist between base forms and reduplicated forms, and between inputs and outputs, also exist between surface or output and other output forms. This means that the correspondence relation involved in the derivation of Modern Hebrew denominal verbs is an output-output correspondence. This is so because it is the properties of a given base form that determine what the output looks like as the following diagram from Ussishkin (1999, p. 403) illustrates:

(3) *Correspondence relations in Modern Hebrew*

$$\begin{array}{l} \text{Base form} \\ \Big\updownarrow \ \textit{output-output correspondence} \\ \text{Denominal verb} \end{array}$$

In a similar vein, Benmamoun (1999) espoused the word-based analysis arguing that it generally provides a better account for nominal, imperative, and causative verb formation in Arabic. According to Benmamoun (1999), the imperfective verb, particularly the indicative mood, is the unmarked default form of the verb for being unspecified for tense and aspect unlike perfective verb forms. The special syntactic status of imperfectives therefore makes them better candidates for serving as input forms. To suppor

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support his argument, Benmamoun (1999, p. 191, ex. 33 & 34) cites the following examples from Arabic:

(4)

	Imperfective	*Nominal*	*Perfective*
a.	yu-ʕallim	mu-ʕallim	ʕallam
	3-teach	nom-teach	teach.3ms
	'He teaches'	'teacher'	'He taught'
b.	yu-saaʕid	mu-saaʕid	saaʕad
	3-assist	nom-assist	help.3ms
	'He assists'	'assistant'	'He assisted'
c.	ya-ʤlis	ma-ʤlis	ʤalas
	3-sit	nom-sit	sit.3ms
	'He sits'	'council'	'He sat'
d.	ya-ʕriḍ	ma-ʕriḍ	ʕaraḍ
	3-exhibit	nom-exhibit	exhibit.3ms
	'He exhibits'	'exhibition'	'He exhibited'
e.	ya-sbaħ	ma-sbaħ	sabaħ
	3-swim	nom-swim	swim.3ms
	'He swims'	'pool'	'He swam'

(5)

Imperfective	*Imperative*	*Perfective*	*Gloss*
ta-drus	ʔu-drus	daras-ta	'study'
ta-qraʔ	ʔi-qraʔ	qaraʔ-ta	'read'
ta-ʤlis	ʔi-ʤlis	ʤalas-ta	'sit

Benmamoun (1999) indicates that in the forms above only the nominal and the imperfective (example 4) or the imperative and the imperfective (example 5) forms have the same stem vowels. Consequently, the nominal and the imperative are derivatives of the imperfective rather than the perfective.

Arad (2003) adopts the word-based account of word formation for Hebrew denominal verbs. However, Arad's (2003) analysis is syntactically driven and it rests on the Distributed Morphology framework (Halle & Marantz, 1993). Under this view, roots are regarded as atomic lexical units that are syntactically and functionally devoid (category neutral), phonologically unpronounceable, and semantically without a fixed interp

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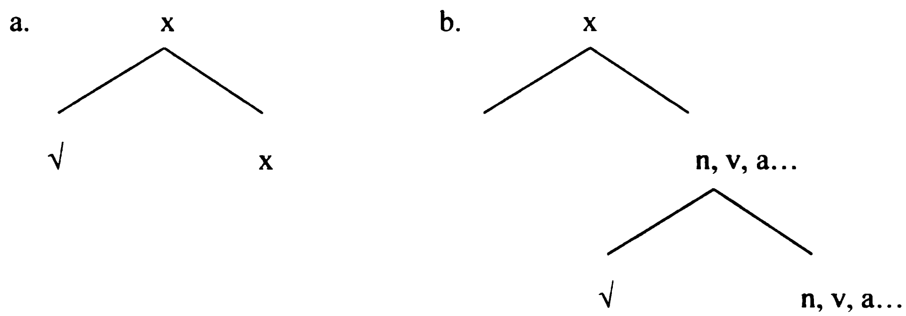
interpretation. Only when embedded in a nominal or verbal environment do roots become actual words i.e. pronounceable strings with a grammatical category. Crucially, words are built within syntax either from roots or from existing words (Figure 2.2).



word formation from roots   word formation from words

Figure 2.2: Word formation from roots and from words
(Arad, 2003, p. 741), x = category head.

Arad (2003) observes that the words in (6; Arad's ex. 9, p. 744) vary in their meanings to a large extent despite sharing the same root. Conversely, the verb in (7; Arad's ex. 11, p. 746) is morphophonologically similar to the noun in that both share the root consonants *sgr* as well as the prefix *m-*. In addition, the meaning of the verb in (7) is tied to the meaning of the noun.

(6) √qlt

a. CaCaC (v)	*qalat*	'absorb, receive'
b. hiCCiC (v)	*hiqlit*	'record'
c. miCCaC (n)	*miqlat*	'a shelter'
d. maCCeC (n)	*maqlet*	'a receiver'
e. taCCiC (n)	*taqlit*	'a record'
f. CaCCeCet (n)	*qaletet*	'a cassatte'
g. CeCeC (n)	*qelet*	'input'

(7) √sgr

a. miCCeCet	*misgeret*	'a frame'
b. CiCCeC	*misger*	'to frame'

Arad (2003) takes the difference between the words in (6) and (7) as a difference in word formation mechanisms. Specifically, the words in (6) are root-derived as evidenced by the variance in meaning which is a property reserved for roots occurring in different environments. On the other hand, the verb *misger* in (7) is derived from the noun *misgeret* i.e. it is word-derived. Arad (2003) assumes that denominal verbs are formed as follows: (1) the root consonants combine with a noun-creating morpheme (*sgr* + miCCeCet in 7); (2) the noun (*misgeret* in 7) is then embedded under a v head (see Figure 2.3). This way, the noun-derived verb inherits the meaning or the semantic interpretation of its head (as well as other content like affixes). In fact, Arad (2003, p.747) postulates the following condition to explain the semantic similarity between denominal verbs and the base nouns from which they are derived:

> Locality constraint on the interpretation of roots: roots are assigned an interpretation in the environment of the first category-assigning head with which they are merged. Once this interpretation is assigned, it is carried along throughout the derivation.

The crucial point of the locality constraint is that once the root and category merger takes place (which defines a phase), there will be a closed domain for interpretation i.e. fixed meaning. This means that any material above the closed domain is denied access to what is inside including the root itself and consequently further derivations cannot change the assigned interpretation. Instead the interpretation is carried upward with further derivations.

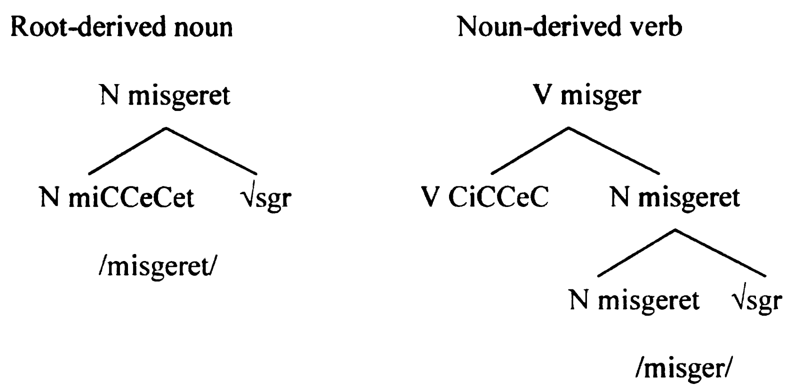


Figure 2.3: Derivation from roots and from words
(Arad, 2003, ex. 12, p. 747)

As can be noted, Arad (2003) does not reject the root-based account altogether. Rather, she argues that words in Hebrew are formed either by the combination of a root and a pattern (root-based account) or they are built from existing words (word-based account). This view is also shared by Ravid (2006) albeit to a lesser extent. Ravid (2006) distinguishes between two types of word formation processes in Modern Hebrew: 1) nonlinear root-and-pattern in which two discontinuous, sub-lexical morphemic units combine, and 2) linear stem-and-affix in which affixes combine with continuous morphemes that serve as the building blocks for other words.

For Ravid (2006), Hebrew verb morphology exclusively relies on root-and-pattern structure while the nominal class of nouns and adjectives makes use of both linear and nonlinear processes both derivationally and inflectionally (see example 8). Accordingly, nonlinear root-and-pattern morphology is the principal apparatus for building words in Hebrew while linear morphology is more or less a "latecomer." This is consistent with Schwarzwald's (2001, cited in Ravid, 2006) finding that half of the entries of Hebrew dictionaries and texts she examined were formed in accordance with the root-and-pattern account whereas linear stem-and-affix derivation accounted for less than 15% of them. The process involved in the formation of newly coined words, however, was found to be 15% linear and 15% nonlinear morphology.

(8)

enoš 'human'
enoš-ut 'humanity'
enoš-i 'humane'
enoš-iy-ut 'humaneness'
enoš-iy-ut-a 'her humaneness' (= Ravid, 2006, ex. 3)

Although word-based analyses were offered as alternative accounts for the root-and-pattern analysis of Semitic word formation, they only account for a limited set of data in these languages and they are often plagued with many exceptions unlike the root-and-pattern account which despite its shortcomings provides a unified account for the whole language. For example it is not hard to find exceptions like *ya-ktub* 'he writes' and *maktab* 'office' that serve as counter examples for Benmamoun's (1999) data presented in 4 above. Even Arad's (2003) view, which embraces both the root-and-pattern as well as word-based analyses and captures some regularities as far as consonantal prefixes and suffixes are concerned, cannot provide an analysis for consonantal infixes e.g. *ʔi-f-t-iʕaal* (fabrication). In addition, there is disagreement in the word-based analyses on the word class that serves as the outcome of word-based formation processes. For example, while Ussishkin (1999), Benmamoun (1999), and Arad (2003) argue that verbs (denominal, imperative, or causative) may be the output of word-based formation processes, Ravid (2006) states that all verbal morphology is based on the root-and-pattern process.

Another problem Arad (2006) notes with word-based accounts of Semitic word formation is determining which words in a given morphological family would serve as the base form or input from which other words are derived (also referred to as "directionality indeterminacy" by Prunet; 2006). As regards to Arad's (2003) argument which is built on the observation of meaning systematicity or variability among same-root words, Prunet (2006) remarks that word formation and semantic non-compositionality or meaning unpredictability are two unrelated issues. According to him, lack of meaning predictability is attested cross-linguistically as illustrated by semantically unrelated words derived from the same stem like the French noun *mont* (mount) e.g., *monter* (climb), *remonter* (go up again), *démonter* (unseat), *surmonter* (rise above), *montage* (hoisting, assembling), *démontage* (dismantling), the unrelated meanings of a single form like *page*, or idioms such as *fat cat* and so forth.

2.4 Implications of Morpheme-Based and Word-Based Approaches to Semitic

Like most previous research, the present work is based on the assumption that a word pattern is a unitary element with no underlying structure. Accordingly, the present study does not aim to seek evidence in favor of the multi-tier analysis of Semitic morphology over the classic root-and-pattern approach as the distinction is of no material interest in this study. Instead, the present study aims, among other things, to pit the root-and-pattern approach against the word-based approach to Semitic morphology and investigate the validity of each of them. For this reason, any support obtained for one approach will not be used in favor of any perspective within that approach but for the approach as a whole.

The controversy surrounding the root-and-pattern approach and the word-based approach has implications for lexical organization and processing. Specifically, the word-based account is consistent with the assumptions of the full-listing hypothesis of lexical processing (e.g., Butterworth, 1983). Under this view, morphologically complex words are listed in the lexicon independently of the base forms from which they are derived. This means that lexical access does not require the decomposition of words into their constituent morphemes. On the other hand, the root-and-pattern approach is in line with the tenets of the decompositional hypothesis (e.g., Taft, 1981; Taft & Forster, 1975). According to this view, (polymorphemic) words are decomposed into their constituent morphemes before lexical access and the entry for the base form is initially accessed during word recognition. In the following sections, a review of relevant psycholinguistic research is provided.

2.5 Psycholinguistic Evidence

Several measures can be used to tap into the human cognitive system including the language faculty. One measure that has been widely used in the psycholinguistic literature to get at the issues of lexical access, organization, and processing is the priming technique. Priming experiments involve the successive presentation of two stimuli, the first known as the prime and the second as the target and participants' task is to make a response of some sort (e.g. naming or lexical decision) to the target. Priming occurs when the response to the target is facilitated by a prime relative to a neutral baseline condition. There are several variants of the priming paradigm that range from the long-lag priming technique in which the prime and target may be temporally separated by an interval of several minutes, with many intervening items, to masked priming (Forster & Davis, 1984) in which the interstimulus interval is 0 ms, with no intervening items. Of the several priming techniques, the masked priming paradigm has been the most popular method among psycholinguists. The standard masked priming experiment involves three visual events: (1) A pattern mask which usually involves a series of hash marks (#####),

(2) A prime that is presented so briefly (from 20-67 milliseconds; ms) that the subject is not aware of its existence, and (3) The target which appears in a print physically different from that of the prime and to which subjects make a lexical decision. One often reported advantage of masked priming over other tasks is that it greatly minimizes the involvement of strategic and episodic memory effects that result from the conscious appreciation of the relationship between the prime and the target (Forster, Mohan & Hector, 2003).

Masked priming has mainly been used to investigate the effect of primes on the subjects' response (speed and accuracy) to an orthographically related target (e.g., *resign*-DESIGN). Priming in a given condition is gauged relative to the performance in a baseline condition in which the prime and target are orthographically unrelated (e.g. *theory*-DESIGN)[3] and to an identity condition in which the prime and target are identical (e.g., *design*--DESIGN). The strongest priming effects are obtained in the identity condition whereas no priming is obtained in the baseline condition. The presence of priming effects may be attributed to the access and activation of the prime which opens up the entry for related words including the presented target; thus reducing the time it takes to process and respond to that target. Crucially, no priming effects have been observed for nonword targets (e.g. *nakur*-NAJUR), which suggests that priming is lexical in nature i.e. it relies on the existence of a lexical representation (Forster, 1987; Forster & Davis, 1984; Forster, Davis, & Schoknecht, 1987)[4].

[3] It is a standard practice to match the primes in the control condition to the primes in the test condition in several attributes such as number of letters and frequency. In some studies, test primes and control primes are matched on form overlap with the target.
[4] It is important to note that priming effects may be obtained by nonword primes only when the targets are word primes. In other words, priming does not occur when the target is a nonword regardless of the linguistic status of the prime i.e. whether it is a word or a nonword.

Using masked priming, a group of researchers (Frost, Deutsch, & Forster, 1997) investigated priming effects in different types of related Hebrew nominal prime-target pairs: 1) pairs that shared word patterns but which were different with respect to the root, e.g., ***taklit-targil*** (exercise-record) (Exp. 1A & 1B), 2) root primes paired with word targets that were derivations of these roots and which also contained other non-root consonants, e.g. ***zmr-tizmoret*** (singer/song-orchestra) (Exp.2), 3) nonword legal roots paired with word targets that were derivations of these roots, e.g., ****tdm-tardemah*** ("sleep"-deep sleep)[5] (Exp.3), 4) semantically-related but morphologically unrelated pairs, e.g. ***ngn-tizmoret*** (instrument player-orchestra) (Exp.4). The results were as follows: no priming was obtained for targets that shared a word pattern (WP) with their primes (Exp. 1) or those that were semantically related (Exp. 4) whereas reliable priming was found for targets preceded by word roots and nonword legal roots (Exp. 2 & 3). The authors concluded that priming in Exp. 2 and Exp. 3 is evidence for the morphemic status of roots while its absence in Exp. 1 was interpreted to mean that word patterns do not play a critical role in lexical processing despite their independent morphemic status. In addition, the authors ruled out the possibility that prime-target semantic overlap in Exp. 2 and Exp. 3 was the reason behind the observed pattern of priming as no priming was obtained in Exp. 4 when the primes and targets were semantically related but morphologically unrelated.

Of particular interest was an experiment (Exp. 5) in which participants were presented with prime-target pairs that were derivations of the same root but which varied in the degree of semantic overlap, one being semantically related, e.g. ***rigul-meragel***

[5] Unlike the primes in (2), the primes in (3) were sequences of root letters that never existed as independent words in Hebrew. It is worth noting that short vowels do not show in Hebrew script except as diacritical marks.

(spying-a spy) and another being semantically unrelated, e.g. ***targil-meragel*** (an exercise-a spy) (all of which are derivations of the root ***rgl*** which denotes foot action). The researchers found comparable priming for targets by the two types of morphologically-related primes. All these findings led the authors to conclude that the abstract notion of underlying morphological units in Hebrew have a strong lexical reality. They also concluded that roots serve as lexical entities that facilitate lexical access to words derived from them. This means that the lexical space is organized in such a way that all same-root words are linked by virtue of a shared representation of the root morpheme. In addition, Frost et al. (1997) postulated a model of morphological processing for the Hebrew lexicon (Figure 2.4). According to this model, the Hebrew lexicon consists of two interconnected levels of representations: a level of lexical units or words and sublexical units of root morphemes. The critical point in this model is that processing of printed words involves both lexical retrieval and morphological decomposition which may occur in parallel in a noncompetitive way. Specifically, words undergo obligatory morphological decomposition whereby roots are extracted as a default process in reading (or that words are decomposed into their constituent morphemes). Consequently, all words containing the extracted root are activated. For example, when the word ***zimra*** (singing) is accessed, the tri-consonantal root *z-m-r* is identified and extracted. Then, this root activates other morphologically-related words such as ***zemer*** (song), ***zamarut*** (singing profession), ***zameret*** (female singer), and ***tizmoret*** (orchestra). The existence of a parsing process which is able to separate the root from the word pattern suggests that parser is able to distinguish between these two morphemes even though they appear as discontinuous and interposed units in the language (Frost, Kugler, Deutsch, & Forster, 2005). Processing of printed words is also simultaneously aided by the full form route in which the orthographic form is processed and identified as a full unit.

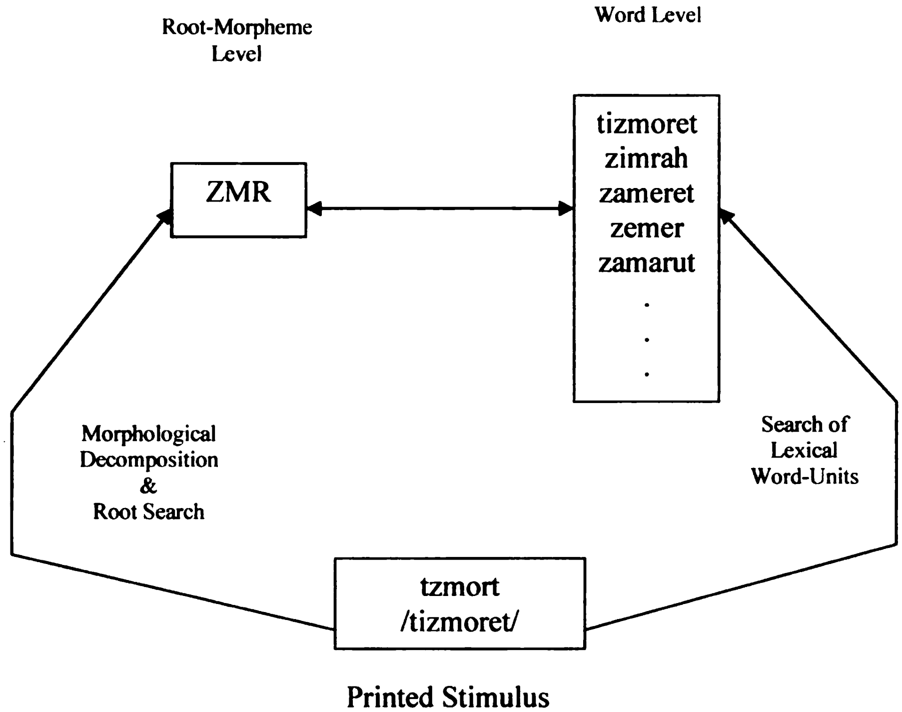


Figure 2.4: The obligatory morphological decomposition model. The model shows the processes involved in visual word recognition (Frost et al., 1997).

In a subsequent study, Deutsch, Frost, and Forster (1998) investigated the role of the root and word pattern in lexical access with the Hebrew verbal system (conjugated verbs). The prime-target pairs in the test conditions were forms with identical verbal word patterns but with different roots. However, in one experiment (Exp.1) the primes were existing words, e.g., ***huklat-hugdar*** (was defined-was recorded) while in another experiment (Exp. 2) the primes were pseudowords consisting of nonexistent combination of legal roots and legal word patterns, e.g., ****higmir-hilbif*** (he dressed). Deutsch et al. (1998) found reliable priming effects by both types of morphologically-related primes: the word and pseudoword primes. Additionally, the researchers found that prime-target pairs with a shared root but a different word pattern, e.g., ***hitlabeʃ-hilbiʃ*** (he dressed- he got dressed) also produced reliable priming effects (Exp.3). The authors concluded that morphological decomposition in which root morphemes are extracted off surface forms is a process that applies to both nominal and verbal forms in Hebrew. However, unlike with the nominal system, the processing of verbal forms involves the decomposition of both the root and the pattern morphemes. Furthermore, the priming obtained for roots and word patterns in the Hebrew verbal system proves the autonomous morphemic status of these two units. This suggests that conjugated verbs in Hebrew are organized and lexically accessed via a shared representation of root and word pattern morphemes alike. The contrasting role of word pattern in the verbal and nominal systems of Hebrew is explained on semantic and distributional grounds. Specifically: 1) there is limited number of verbal patterns compared to nominal patterns (7 vs. 100+), 2) verbal patterns are semantically more systematic than nominal patterns exhibiting meaning regularity within and across patterns, and 3) the verbal system is more of a grammatically closed system that does not often allow new members, and when it does, the new form must be adapted to fit one of the existing patterns; this is unlike the nominal system which forms an open class allowing new patterns to be added. All of these properties of the verbal system make the recognition of verbal patterns a simple computational process explaining the discrepancy in the role of the word pattern in the verbal and nominal systems. The findings from the nominal system (Frost et al., 1997) and those from the verbal system led Deutsch et al. (1998) to postulate a revised model for Hebrew word processing (Figure 2.5).

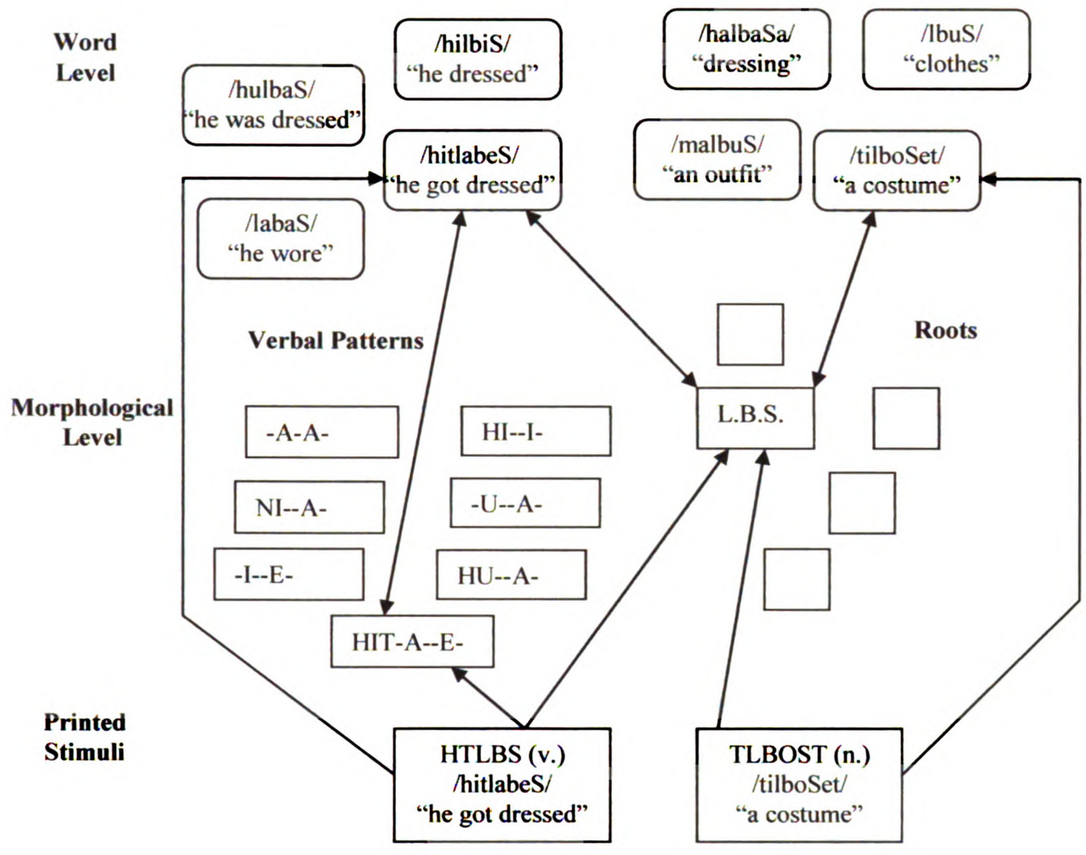


Figure 2.5: The extended obligatory morphological decomposition model. A model of Hebrew word recognition and lexical processing (adapted from Deutsch et al. 1998).

According to this extended model, both nouns and verbs have interconnected levels of lexical and sublexical representations. This means that the processing of verbs and nouns involves whole-word search and morphological decomposition whereby the root morpheme is extracted and identified. However, morphological decomposition in verbs but not nouns involves the extraction and identification of the verbal pattern as well implicating that the processing of the nominal patterns is only possible through the full-form route and only in the context of a whole word.

One characteristic of the Hebrew and Arabic orthographic systems is that short vowels are often not expressed in writing except as diacritical marks on consonants. Voweled script is usually restricted to some religious and highly literary texts. This means that in unvowelled script a lot of important information about the word pattern, which acts as the phonological template of surface forms, is unexpressed. Given that Frost et al.'s (1997) and Deutsch et al.'s (1998) stimuli were diacritically unmarked, it is possible to ascribe the lack of nominal pattern priming to the absence of phonological cues that characterize word patterns. In addition, the full contribution of phonological factors to morphological priming might be clouded by the masked priming paradigm which is a purely orthographic task.

It is an acknowledged fact that visual information is transcribed into phonological information (see Frost, 1998). However, there is no consensus as to the time-course of phonological activation especially when it comes to early stages of word processing. Some research (e.g., Shen & Forster, 1999) showed that phonological priming may be obscured under situations of brief exposure. According to Frost, Deutsch, Gilboa, Tennenbaum and Marslen-Wilson (2000), the very brief exposure of the prime in the above masked priming studies may not have provided enough time for the word's phonological structure to be fully processed. To this effect, these researchers decided to re-examine the role of nominal and verbal word patterns in lexical processing using the cross-modal priming technique (Marslen-Wilson, Waksler & Older, 1994). In a cross-modal priming task, the prime is presented auditorily and is then immediately followed by a visually presented target, to which participants make some sort of response (lexical decision or naming). This means that in a cross-modal priming task, participants are aware of both the prime and the target unlike the case in masked priming in which only the target is consciously perceived. Accordingly, the potential influence of semantic and phonological factors will emerge. However, cross-modal priming is likely to cause the participant to operate on a supra-modal level of representation as it engages both auditory and visual modalities as opposed to a purely visual or purely auditory modality (Boudelaa & Marslen-Wilson, 2001a; Prunet, 2006).

In the critical conditions, Frost et al. (2000) had nominal and verbal prime-target pairs that shared their word pattern, e.g., ***maqhela*** (a choir) - ***mazmera*** (a pair of pruning shears) and ***husbar*** (was explained) - ***hugdar*** (was defined). The results showed that there was reliable priming for verbal patterns but small and non robust priming for nominal patterns. Thus, a similar priming pattern was obtained for verbal and nominal word patterns in both masked and cross-modal priming tasks. This confirms that the observed masked priming effects were purely morphological in nature and rules out the contribution of any phonological factors to the presence of word pattern priming in the verbal domain or its absence in the nominal domain. Specifically, when the prime was auditorily presented, making phonological information directly accessible, no change in the pattern of priming for the nominal and verbal patterns was observed in the cross-modal task relative to the masked priming task in which phonological factors might be obscured. The results also suggest that for Hebrew, at least, verbal word patterns are cognitively more salient units than nominal word patterns.

In the same study and using the same task, Frost et al. (2000) reinvestigated the role of semantic transparency in priming between two types of morphologically-related (i.e. same-root) prime-target pairs: semantically transparent pairs (M+S+), e.g., ***madrix*** (a guide) – *hadraxa* (guidance), and semantically opaque pairs (M+S-), e.g., ***drixut*** (fancy)- *hadraxa* (guidance). Robust priming effects were obtained for both types of pairs though these effects significantly increased with semantic similarity. These findings come as no surprise for in the cross-modal task, the contribution of semantic factors facilitates responses for semantically-related pairs. All in all, Frost et al.'s (2000) findings suggest that morphological priming (for roots and patterns) in Hebrew cannot be reduced to phonological or semantic overlap between primes and targets.

In Arabic, several priming studies were conducted to explore the lexical status of roots and patterns using both masked and cross-modal priming tasks. The findings from these studies provide substantial support for the distinctive morphemic status of roots and patterns and thus they generally converge with the earlier studies in Hebrew. For example, in one study Boudelaa and Marslen-Wilson (2000) used cross-modal priming to compare the priming effects produced by two types of deverbal noun primes sharing word patterns with their corresponding targets (Exp.1): ones that shared both phonological structure and syntactic meaning with their targets, e.g. - ***xuḍuuʕ*** (submission) -***ħuduuθ*** (happening) and others that shared phonological structure but differed from their target with respect to the syntactic meaning ***sudʒuun*** (prisons) - *ħuduuθ* (happening). In addition, the researchers had a third condition in which the prime and target words were related in orthographic form but did not share their roots or word patterns, e.g. *ʔittiħaad* (union)- *ħuduuθ* (happening)[6]. The first type of prime yielded robust facilitation effects. In contrast, the second type of prime showed a non-significant

[6] Previous research in Hebrew (i.e. Frost et al., 1997; Deutsch et al., 1998; Frost et al., 2000) included conditions similar to this but they were control conditions rather than test conditions. Nevertheless priming in these conditions was always the lowest.

tendency towards inhibition while the third type of prime produced significant inhibition effects. These findings suggest that shared phonological structure is a necessary but not sufficient condition for the emergence of word pattern priming effects. Word pattern facilitation effects are accordingly bound to the sharing of both the phonological structure and the syntactic specifications of the target's surface form. Moreover, pure orthographic or phonological form overlap (third condition) failed to produce priming. This clearly indicates that form overlap must be at the morphological level to guarantee facilitation effects. As can be noted these results conflict with the findings in Hebrew where no word pattern priming effects were obtained within the Hebrew nominal system.

Boudelaa and Marslen-Wilson (2000) conducted a second experiment in which they examined cross-modal priming effects within same-root prime-target pairs whose semantic relationship was co-varied. The word pairs either shared a root and a transparent semantic relationship, e.g., *ʔidxaal* (inserting)-*duxuul* (entering) or they shared a root and an opaque semantic relationship, e.g., *mudaaxala* (conference)-*duxuul* (entering). The priming effects in these two conditions were compared to the priming in a third condition in which the prime and target were semantically related but did not share a root or a word pattern, e.g., *manfað* (exit)-*duxuul* (entering). The researchers found an almost equal amount of priming in the same-root conditions. Additionally, the magnitude of priming in the two types of morphologically-related pairs was more than twice the priming effect in the semantically-related but morphologically unrelated pairs. This difference was significant. The robust morphological priming in the absence of semantic support together with the relatively smaller semantic priming indicated that morphological priming is irreducible to form or semantic overlap. The strong priming effects obtained for the roots and word patterns in this study provide further support for the lexical status of these units which confirms the root-and-pattern account of Semitic morphology and leaves the word-based account difficult to sustain.

The above priming studies have established that the root is a psychologically independent morphemic unit. It goes without saying that primes and targets sharing a root morpheme by definition have some degree of orthographic overlap. This inevitable orthographic overlap stems from the consonantal nature of root morphemes which in a writing system like Hebrew script are fully spelled-out. As mentioned above, information about the word pattern which mostly consists of vowels is not fully specified in Hebrew and Arabic script except infrequently in children's literature and religious scripture. Under these circumstances, root priming effects may derive from the large degree of orthographic overlap between morphologically related primes and targets relative to orthographic control pairs in which the amount of orthographic similarity is often smaller. To make up for this orthographic asymmetry, Frost et al. (2005) conducted a series of masked priming experiments which aimed to dissociate the potential contribution of orthographic form similarity from morphological root priming effects.

In their study, Frost et al. (2005) had different types of prime-target pairs: 1) orthographically-related but morphologically unrelated pairs which differed from each other by one root letter only, e.g., ***sidur*** (arrangement) - ***sipur*** (story), 2) orthographically related pairs like in those in (1) but in which the prime word contained a productive root, e.g., ***miklaxat*** (shower) – ***miflaxat*** (delegation), and 3) orthographically-related pairs in which the prime contained a nonproductive root, e.g., ***midron*** (slope) – ***mizron*** (mattress). Nonproductive roots are those which appear in a single word only. Words with nonproductive roots were included to see if they show a tendency towards orthographic priming due to the possibility that such roots may not undergo processing and thus inhibit morphological decomposition altogether. In all of the orthographically-related conditions no significant priming was obtained. Interestingly, the lack of orthographic priming effects was observed for both Hebrew native and nonnative speakers.

Frost et al. (2005) also directly compared morphological priming with orthographic priming effects in both Hebrew and Arabic (Exp. 4 & 5). They had target words paired with two types of related primes: 1) orthographically-related primes which differed from their targets by one root letter only (e.g., Hebrew: ***ripud*** 'upholstery' – ***rikud*** 'dance'; Arabic: ***kilaab*** 'dogs' – ***kitaab*** 'book') and 2) morphologically related primes which differed from their targets by 2 letters (e.g., Hebrew: ***hrkda*** 'lead to dance' – ***rikud*** 'dance'; Arabic: ***kaatib*** 'writer' – ***kitaab*** 'book'). In this respect, the orthographic distance between morphologically related pairs was greater than the orthographic distance between the orthographically related pairs. The results showed that there was significant priming in the morphological form condition (Hebrew = 13 ms; Arabic = 21 ms) but not in the orthographic form condition (Hebrew = 6 ms; Arabic = 8 ms).

Although there is agreement between the findings in Hebrew and Arabic with respect to the morphemic status of the triconsonantal root as well as the verbal pattern, different findings were obtained for the nominal word pattern. As mentioned earlier, Frost et al. (1997) did not find priming effects for Hebrew nominal word patterns. In contrast, Boudelaa and Marslen-Wilson (2000) obtained significant facilitation effects for deverbal noun targets primed by words with which they shared word pattern. This apparent discrepancy was investigated in Arabic by Boudelaa and Marslen-Wilson

(2005). In this work, the researchers used the masked priming paradigm to examine the contribution of morphological, orthographic, and semantic factors over four different Stimulus Onset Asynchronies (SOAs) or prime display durations: 32, 48, 64, and 80 ms.

In Experiment 1, the researchers co-varied the morphological, orthographic, and semantic relationship between deverbal noun primes and targets to create six experimental conditions: 1) the word pattern condition (WP), e.g., *xaalidun* (eternal) - *ħaarisun* (guard), where pairs shared their word pattern {viz., faaʕilun}, 2) the word pattern control condition which included primes and targets that were morphologically unrelated but had an orthographic overlap similar to that in the word pattern condition, e.g., *saħaabatun* (cloud) - *ţalaaqun* (divorce)[7], 3) A root plus semantics condition in which primes and targets shared their root morpheme and had a semantically transparent relationship, e.g., *riʔaasatun* (presidency) - *raʔiisun* (president), 4) a root minus semantics condition in which the test pairs shared the root morpheme but bore an opaque semantic relationship, e.g., *ʃarţun* (condition) - *ʃurţatun* (police), 5) a root control condition where the pairs were orthographically related (chiefly in consonants) but morphologically unrelated, e.g., *sulaħafaatun* (turtle) – *silaaħun* (weapon), and 6) a semantic condition in which prime and target words overlapped in meaning only but were otherwise unrelated, e.g., *qitaalun* (fight) - *ħarbun* (war). The main findings were as follows: 1) significant priming was found for the two root conditions (i.e. root plus semantics and roots minus semantics) across all the four SOAs, 2) WP priming was only obtained at SOAs 48 and 64 ms, 3) semantically related pairs (condition 6) yielded

[7] Note that since short vowels were not used in the form of diacritics, the overlap here is partly implicit.

significant priming only at 80 ms SOA, 4) there was significant priming at 32 ms SOA for the word pattern control condition and at 80 ms SOA for the root control condition.

Boudelaa and Marslen-Wilson (2005) conducted a second experiment that paralleled their first but this time with verb stimuli. Like in Experiment 1, there were six conditions: 1) the word pattern condition (WP), e.g., *laxxaṣa* (sum up) - *fakkara* (think), 2) the word pattern control condition, e.g., *qamarun* (moon) - *nasaʤa* (weave), 3) A root plus semantics condition, e.g. *ʔanzala* (cause to go down) - *nazala* (go down), 4) a root minus semantics condition, e.g., *xallafa* (leave behind) - *ʔixtalafa* (disagree), 5) a root control condition, e.g., *ʕafanun* (decay) – *ʕafaa* (forgive), and 6) a semantic condition, e.g., *ʔalaqaa* (throw) - *ramaa* (fling). Significant priming was found for the following conditions: 1) the word pattern condition at SOA 48 ms, 2) the two root conditions across all four SOAs, 3) root control and the semantic conditions at SOA 80 ms. Overall, root priming, whether in the nominal or verbal system, seems to be strong and steady persisting throughout online lexical processing which suggests a dominant role of the root morpheme in lexical processing. On the other hand, word pattern priming seems to be short-lived and shows a delayed onset relative to root priming. Such results were corroborated in other studies. For example, Mahfoudhi (2007) found facilitation for verb targets preceded by primes with which they shared the root irrespective of the semantic relationship. However, unlike Boudelaa and Marslen-Wilson (2005), Mahfoudhi (2007) reported no priming effects at SOA 50 ms between verb prime-target pairs with a similar word pattern, e.g., *ʔistaʕmara* (colonized) - *ʔistaqbala* (received) It could be argued that the secondary role of word patterns in lexical processing is just a consequence of the unvowelled script which does not fully spell out the word pattern. In addition, since the word patterns act as the phonological make-up of surface forms, their processing may entail the access of phonology which explains the relatively delayed onset of word pattern effects. Boudelaa and Marslen-Wilson (2005) add that since words sharing a root morpheme constitute a more uniform morphological family compared to words with shared word patterns, earlier onset of root effects seems to be a reasonable outcome.

Based on the outcome of their experiments, Boudelaa and Marslen-Wilson (2005) concluded that root and word priming in Arabic is a genuine morphological effect that cannot be attributed to pure form or semantic overlap. They also explained the early onset of morphological priming and the late emergence of orthographic and semantic effects in reference to Frost el al.'s (1997) dual route model (see Figure 2.4). Specifically, the authors argue that the parsing route or the morphological decomposition path may be faster as a result of the nature of Arabic words which are composed of identifiable roots and patterns. Pure semantic and/or orthographic form effects emerge only when orthographic inputs have had sufficient time to be processed through the full-form route or the whole word search path.

A less researched type of form-based priming in Semitic is Transposed-Letter (TL) priming. Is this form similarity at an orthographic level of representation only, or is it at a morphological level of representation as well? In the next section, I will review some of the studies that dealt with this topic.

2.6 Letter Transposition

The studies above have shown that word pairs that were orthographically similar except for one root letter failed to yield facilitation for lexical recognition. The conclusion was that orthographic similarity between different roots does not entail lexical neighborhood for words derived from these roots irrespective of the minimal difference e.g., *k-t-b* (write) and *k-s-b* (gain). It seems accordingly that sharing the root is a prerequisite for morphological priming effects to occur. But, what does it mean to share a root morpheme? The answer is that sharing the root morpheme means sharing the same three (or four) root consonants. However, does language stipulate any sequential requirement for these root consonants or is it sufficient for the parsing system to verify the identity of these consonants irrespective of their order or relative position? In other words, would the nonword ****tabaka*** prime the target word ***kataba*** (write) as effectively as the word ***kaatib*** (writer)? If morphological decomposition stripped out the pseudo-root **t-k-b* from the nonword **takaba*, could that pseudo-root activate words derived from the root *k-t-b*? What about word primes such as ***kabata*** (inhibit)? Would this be treated as an orthographically similar to the word ***kataba*** (write) or would it be considered another member of its morphological family?

To investigate these issues, Velan and Frost (2007) used rapid serial visual presentation (RSVP; Potter 1984) to examine the effects of letter transposition on Hebrew-English bilinguals in both of their languages. In the task, participants were presented with 20 sentences, 10 of which had three transposed-letter words. Participants were notified in advance that some sentences may involve words with transposed letters. The sentences were presented one word at a time and each word appeared for 200 ms. The task required of the participants was to verbally reproduce the entire sentence (while) undoing/fixing the transpositions following the presentation of the final word. They were also asked to identify the sentences that involved transposed-letter words. The variable of interest was the participants' performance on sentences which contained transpositions compared to the sentences that contained no transpositions. All transpositions resulted in nonwords which were a combination of non-existing roots with existing word patterns. In the Hebrew version of the task, subjects' ability to correctly reproduce all the words and identify the transposed-letter words dropped down dramatically for sentences involving transposed-letter words. In addition, the participants' sensitivity to detect transposition was very high for the Hebrew material compared to the English material.

In a subsequent study, Velan and Frost (2009) conducted a series of three experiments using masked priming to investigate transposed letter effects (TL) on lexical decisions in Hebrew. In Experiment 1, target words were paired with several types of primes creating several conditions. For each target word, e.g., *maxʃava* (thought), there were two test conditions: the root condition and TL-root condition. In the root condition, the primes were the three root consonants from which the target word was derived, e.g., *xʃb* (to think) while in the TL-root condition, the primes were the target's root letters appearing in a different sequence but nevertheless were existing roots, e.g., *xbʃ* (to bandage). The letter combinations that appeared as the primes did not necessarily make up a meaningful word. Additionally, the prime was always shorter than the target in number of letters. Results show that TL-root primes produced significant inhibitory effects whereas root primes produced the expected significant facilitatory priming effects. In the second experiment, the priming effects for target words, e.g., ***hadbaka*** (gluing) by TL-existing-root primes, e.g., *bdk* (examine) were compared to TL-nonsense-root primes i.e. a nonexisting root created by the transposition of the target's root letters e.g., **dbk*. Like in Experiment 1, TL-existing-root primes yielded inhibitory effects by slowing lexical decision to their corresponding targets. On the other hand, TL-nonsense-root primes did not have any effect i.e. neither facilitatory nor inhibitory priming effects.

As observed, the primes in both Experiments 1 and 2 constituted a subset of the target's letters. In other words, the primes and targets were not equated in number of letters. For this reason, Velan and Frost (2009) conducted a third experiment in which the TL root primes were embedded in word patterns similar to the ones belonging to their corresponding targets. Thus, for each target word such as *havtaxa* (promise) there were two types of test TL-nonword primes: (1) nonwords that resulted from the illegal combination of an existing TL-root and existing word pattern, e.g., **hatvaxa* (*tvx* means massacre) and 2) nonwords formed from an illegal combination of a non-existing TL-root and existing word pattern, e.g., **havxata*[8]. Similar to Experiment 2, the results of Experiment 3 showed inhibitory effects by nonword primes with existing TL-roots but no effect by nonword primes with illegal TL-roots. Based on these findings, the authors suggested that the inhibitory effects might have come from lexical competition between roots and they concluded that the language imposes a strict positional coding on root morphemes as a requirement for activating these units.

More recently, Perea, Abu Mullouh, and Carreiras (2010) investigated TL-effects in Arabic using real words for their primes and targets. The transposed letters were always adjacent letters but in one experiment (Exp. 1), they were two root letters (e.g., *damaar-madaar* 'destruction-orbit') and in another experiment (Exp. 2), one was a root letter and the other was a nonroot (i.e. WP) letter (e.g., *riʕaaja-raaʕija* 'care-

[8] Like most previous research in Indo-European languages (see chapter 3), Velan and Frost (2009) used a letter substitution/replacement condition as their control condition in this experiment. Thus, TL priming effects are measured against a condition in which the primes differed from their targets by two root letters. In the first two experiments, however, the control condition involved primes that shared all letters with their targets but with two of these letters at most being root letters.

carer/sponsor [f.]'). Accordingly, transposition yielded morphologically related (i.e. same-root) pairs in the second but not in the first experiment. In both experiments, the transposed letters were in the word initial, medial, or final position. Significant facilitation effects were obtained for the morphologically related pairs in the second experiment while no priming effects were observed for the morphologically unrelated pairs in the first experiment. These results were not moderated by the site of transposition.

2.7 Summary and Critique of Previous Studies

The morphemic status of roots and word patterns has been extensively investigated in both Hebrew and Arabic using masked and crossmodal priming. Other studies obtained similar findings using different methodologies like eyetracking (e.g., Deutsch, Frost, Pelleg, Pollatsek, & Rayner, 2003; Deutsch, Frost, Pollatsek, & Rayner, 2005), fMRI (e.g., Bick, Frost, & Goelman, 2009), EEG (Boudelaa, Pulvermüller, Hauk, Shtyrov, & Marslen-Wilson, 2010), and analysis of data collected from aphasic patients suffering selective language impairments (e.g., Prunet, Béland, & Idrissi, 2000; Idrissi, Prunet, & Béland, 2008) . In all of these studies, strong evidence was obtained for the autonomous morphemic status of roots and the decompositional nature of word processing in these languages. Specifically, strong priming effects were observed for prime-target pairs that shared the same root (Deutsch et al., 1998; 2003; Frost et al., 1997; 2000; 2005). Morphological priming was obtained even when the meaning relationship between the same-root primes and targets was semantically opaque (Frost et al., 2000; 1997; Boudelaa & Marslen-Wilson, 2000; 2005; Mahfoudhi, 2007). The observed morphological priming effects for roots and verbal patterns in these studies were argued to be irreducible to form-based (i.e. orthographic and/ or phonological) similarity (Frost et al., 1997; 2000; 2005; Deutsch et al., 1998; 2003; 2005; Boudelaa & Marslen-Wilson, 2000; 2005) or to semantic effects (Frost et al., 1997; 2000; Deutsch et al., 2005; Boudelaa & Marslen-Wilson, 2000; 2005; Mahfoudhi, 2007).

As regards to the word pattern, there were robust priming effects by verbal primes that shared their word pattern with their targets (Deutsch et al., 1998; 2005; Frost et al., 2000; Boudelaa & Marslen-Wilson, 2005). For nominal word patterns, however, strong priming effects were observed in Arabic when the overlap occurred at a morpho-syntactic level (Boudelaa & Marslen-Wilson, 2000; 2005) but not in Hebrew (Frost et al., 1997; 2000; Deutsch et al., 2005). Finally, it appears that both Arabic and Hebrew impose a strict positional requirement with regard to the consonants of trilateral roots such that any change in the order of the target's consonants in the prime results in the loss of priming effects observed for morphologically-related pairs (Velan & Frost, 2009; Perea et al., 2010).

The work of Boudelaa and Marslen-Wilson (2005) and Frost et al. (2005) provide valuable insights into the nature of lexical processing in Arabic. Collectively, these and other scholarly works have obtained significant morphological masked priming effects between same-root, opaque prime-target pairs which had minimal orthographic overlap. Boudelaa and Marslen-Wilson (2005), for instance, cleverly co-varied the prime-target relationship to disentangle morphological, semantic and orthographic effects in lexical processing. However, I argue that although the contribution of semantic factors were successfully separated out from morphological processing, it is not clear that possible effects of orthographic form similarity were satisfactorily manipulated. Specifically, the orthographic form overlap in the nominal and verbal root conditions was always higher than the form overlap in their corresponding root control conditions. On average, the number of shared letters across primes and targets in the nominal version of the study was 3.4 letters in both the root plus semantics and root minus semantics conditions while it was 2.4 letters in the root control condition. In the verbal version of the study, the primes and targets shared 3.1 letters in the root plus semantics condition and 3.3 in the root minus semantics condition whereas the average orthographic overlap in the root control condition was 2.1 letters. Likewise, the orthographic distance between targets and their morphologically related (i.e. same-root) primes in Mahfoudhi (2007) was smaller than that between these targets and the orthographic control primes (3.13 letters vs. 2.87 letters on average). According to these figures, it may still be argued that the stronger morphological priming effects in the root conditions relative to their orthographic control conditions can be attributed to the higher degree of orthographic form overlap.

Apart from Frost et al. (2005), no study has compared morphological priming to orthographic priming when form overlap was greater for the orthographically-related prime-target pairs than for the morphologically-related (i.e. same-root) prime-target pairs. Although this limitation was presumably attended to by Frost et al. (2005), the researchers in this study failed to observe several issues when constructing their stimuli. First, the morphologically related stimuli were semantically-transparent. Even though semantic effects are generally not observed at short SOAs, some studies found semantic priming effects between associative pairs (e.g. Lukatela & Tuvey, 1994; Sereno, 1991; Fischler & Goodman, 1978; Perea & Gotor, 1997). In fact, in an earlier cross-modal priming study, Frost et al. (2000) found that morphological (root) priming effects significantly increased with semantic transparency. Second the stimuli were unmatched on frequency (or familiarity). The authors have repeatedly argued that frequency effects are attenuated in masked priming; nevertheless, I contend that the contribution of frequency factors cannot be entirely ruled out. In fact, matching test and related control primes on frequency (or familiarity/ frequency estimations when word counts are unavailable) has become a standard practice in masked priming and most other psycholinguistic research.

Additionally, Frost et al.'s (2005) stimuli suffered other serious flaws and confounds. First, the stimuli were unmatched on grammatical category within and across prime-target pairs. For example, a singular noun target is sometimes paired with a plural noun prime e.g., ***kitaab*** (book) – ***kilaab*** (dogs), a verb with a noun, e.g., ***ʔiʕtadaa*** (assaulted) - ***ʕadaawa*** (enmity), a noun with a conjugated verb, e.g., ***maqaala*** (article) - ***jaquuluun*** (they say), or an adjective and a noun, e.g., ***ʕaniid*** (stubborn) - ***ʕinaad*** (stubbornness). Such mismatches in grammatical class introduce unnecessary confounds. Second, fifteen primes out of the 64 total primes used in the morphological root condition were different from their corresponding targets in only one letter and not two as intended by the authors. Orthographic similarity was verified using Levenshtein Edit Distance. The problem with the Levenshtein algorithm, however, is its sensitivity to the position of letters within a given string. For example, it would treat pairs such as كتاب ***kitaab*** (book) and كاتب ***kaatib*** (writer) as different in two letters rather than one, even though they contain the exact same string with two letters transposed. Similarly for pairs which have a net difference of only one letter, such as سريع ***sariiʕ*** (fast) and مسرع ***musriʕ*** (accelerated), it would also treat them as if they differed in two letters. Given that many of Frost et al.'s

(2005) morphologically related pairs were similar to these pairs, the observed morphological root priming effects could still be accounted for on the basis of orthographic similarity. Finally, the stimuli contained several repeated items, misspelled words in addition to a few unnoticed mistakes like different-root prime-target pairs in the morphological condition or primes that were two letters different from their corresponding targets in the orthographic condition.

In light of the shortcomings of previous research, one goal of the current paper is to investigate masked priming effects between same-root primes and targets when they are different from each other by a minimum of two (non-root) letters. In addition, the prime-target word pairs in the root condition in the present study were semantically unrelated. This ensured that the orthographic distance between the primes and their corresponding targets in the root condition would always be greater than the orthographic distance between the primes and their corresponding targets in the orthographic condition and that the role of semantics would not tip the scale in favor of the morphologically-related pairs. To my knowledge, this study is the first attempt to compare morphological and orthographic priming in Arabic in such a highly controlled context.

Regarding letter transposition effects, the findings of Velan and Frost (2009) are certainly enlightening. Nevertheless, a complete picture could be formed only if the primes in Experiment 3 were actual words instead of being nonsense words. Given that nonwords and non-existing roots do not have lexical entries in the mental lexicon, it could be argued that the unavailability of a lexical entry will not cause activation transfer to other overlapping entries; hence the lack of any priming effect. Consider the pair *kabata* (inhibit) and *kataba* (write). Both of these words have lexical entries in the mental lexicon. In addition, these two words have the same number of letters as well as the same root consonants. Using word stimuli like these as opposed to nonwords will be more telling because the entry of a given word when presented as a prime will necessarily be activated and as such it will be possible to determine if these words are grouped together by virtue of sharing the root consonants despite the obvious difference in semantics and in the relative position of these consonants. If orthographic and semantic similarity is what defines morphological kinship irrespective of any positional coding for root consonants, then how does the parser treat words that share their root consonants and semantically overlap with each other e.g., ***ħamd*** (magnify/ praise God) and ***madħ*** (praise) or *tawassul* (entreaty) and *tasawwul* (begging)? Are these words morphologically-related or are they orthographically-related only? In the current research, TL effects will be investigated when both primes and targets are real words.

Although Perea et al. (2010) tried to address the limitations by Frost et al. (2009) by using TL-word primes that matched targets on number of letters, their study suffered serious flaws. One problem in Perea et al. relates to their choice of stimuli. Specifically, the vast majority of target words and TL-primes (an average of 109 targets out of a total of 120) in Perea et al. were multimorphemic words (e.g., conjugated verbs inflected for tense, person, number or gender)[9]. In addition, Perea et al.'s stimuli in both the test and control conditions were characterized by prime-target mismatch whether in word category, number, voice, tense, and possibly case marking. Also, several pairs in this study were allomorphic. Last but not least, Perea et al. used unrelated primes for their control conditions. It is customary, however, to include a substitution-letter condition

[9] For verbs, the third person masculine singular perfective past is argued to be a neutral form (see Mahfoudhi, 2007).

and/or an identity condition to precisely gauge the priming effects in the TL condition. All of these issues have clouded the picture and severely confounded the study.

Finally, one of the issues that deserves special attention in any investigation of lexical access is the effect of a second language on native language processing. Results from the above studies in which bilingual speakers were tested (viz., Frost et al., 2005; Velan & Frost, 2007) seem to suggest that nonnative language processing is exactly the same as native language processing. This means that the bilingual's two languages operate independently of one another and that bilinguals are able to function like the monolingual native speakers of each of their languages. However, there is a growing body of research that suggests that native language processing mechanisms undergo a noticeable shift as a function of proficiency in a second language in areas where the two languages employ different processes or in areas where the systems of the two languages diverge. This issue is of great importance given the difference between Arabic and English morphological systems and word formation processes. In the next chapter, I am going to review research about lexical processing in English. Chapter 4 presents relevant research that deals with the effects of the second language on the first and discusses the implications this issue has on lexical processing in Arabic-English bilinguals.

CHAPTER 3: LEXICAL ORGANIZATION IN ENGLISH AS A FIRST LANGUAGE

3.1 Morphological Priming

One issue in highly concatenative languages like English is determining whether the lexicon is organized according to the morphological principle of a shared root or according to orthographic form similarity. Unlike the case in Semitic languages in which the contribution of semantic, orthographic, and morphological factors are readily dissociable, the nature of English morphology makes it difficult to separate these factors. Specifically, it may be unclear if morphological effects in English are caused by orthographic form similarity, semantic relatedness, or the added sum of these two factors. The reason is that in most cases, morphologically related words in English are also orthographically and semantically related. A number of studies showed that orthographic form similarity alone was not sufficient to yield priming effects. In one study Emmorey (1989) used an auditory lexical decision task to compare the priming effects between words like *conceive-deceive* or *submit-permit* which are morphologically related (by virtue of sharing a bound morpheme e.g., -ceive and –mit) but semantically unrelated to the priming between phonologically related words such as *balloon-saloon* (Experiment 1). The results showed a strong priming effect between the morphologically related pairs but nonsignificant priming for the phonologically related words, suggesting that morphological relatedness is independent of semantic and phonological similarity.

Other studies in which masked priming was used demonstrated that earlier in visual access, morphological decomposition is independent of the effects of form or meaning overlap between the prime and the target. In one masked priming study, for example, Forster and Azuma (2000) obtained results similar to those by Emmorey (1989). Specifically, the researchers found priming effects (Experiment 1) for morphologically related words like *submit-PERMIT* which have no semantic relationship[10]. In fact, the magnitude of priming between bound-stem pairs was found to be comparable to that between pairs that have a transparent semantic relationship, e.g. *happy-UNHAPPY*. When the overlap between the prime and target was based on orthography alone, e.g. *singer-ANGER* (Experiment 3), priming effects disappeared at longer SOAs[11]. It is worth noting that semantically-related bound-stem pairs (e.g., *virus-VIRAL, final-FINISH, female-FEMININE*) were also found to produce reliable masked priming effects whereas form-related but semantically unrelated pairs (e.g., *future-FUTILE, labour-LABEL, saliva-SALAD*) or semantically-related pairs (e.g., *pursue-FOLLOW*) failed to yield such effects (Taft & Kougious, 2004).

In another study, Rastle, Davis and Marslen-Wilson (2000) who varied the prime-target relationships along three dimensions: morphology, semantics, and orthography found robust masked priming effects for morphologically related English words, e.g. *government-GOVERN* as well as compositionally-unrelated (but historically-related) words, e.g. *apartment-APART* at an SOA of 43 ms. This priming effect was shown not to be the result of the combined effects of semantic and orthographic priming because unlike the priming between morphologically-related pairs like *bakery-BAKER*, the priming between pairs like *evil-DEVIL* that are only orthographically and semantically

[10] This is true for some of their stimuli. However, as Rastle and Davis (2003) observe, many prime-target pairs in that study were actually semantically-related (e.g., *survive-REVIVE, inhibit-PROHIBIT, pronounce-ANNOUNCE*).

[11] It is noteworthy that orthographic overlap between prime and target tends to be facilitatory in the early stages of the lexical recognition process (i.e. when the prime is masked) (Forster, Davis, Schoknecht, & Carter, 1987) and inhibitory in later stages (i.e. when the prime is overt) (Colombo, 1986; Grainger, 1990; Boudelaa and Marslen-Wilson, 2001).

related was found only at an SOA of 230 ms. By the same token, Feldman and Soltano (1999) and Feldman, Soltano, Pastizzo, and Francis (2004) found that semantically transparent (e.g., *casually-casualness*) and opaque (e.g., *casualty-casualness*) morphological relatives produced equal facilitation at short prime durations (48 ms)[12] when the visual prime was presented unmasked. Equal facilitation was also found by both types of morphological relatives in masked priming at an SOA of 83 ms (Feldman et al., 2004).

In a later study, Rastle, Davis and New (2004) found priming effects for pseudo-derived pairs, e.g. *corner-CORN* which could mistakenly be analyzed into *corn* + *er*. The authors, however, reported no priming effects for form-related pairs like *dialog-DIAL*, which have the same amount of orthographic overlap as the morphological condition but where *-og* is not a derivational suffix in English. These findings were replicated in French by Longtin, Segui, and Hallé (2003) who found that in masked priming, morphologically transparent pairs (e.g., *gaufrette-GAUFRE* [wafer-waffle]), morphologically opaque pairs (e.g., *fauvette-FAUVE* [warbler-wildcat]), and pseudo-derived pairs (e.g., *baguette-BAGUE* [little stick-ring]) all produced robust priming in comparison to orthographically related but morphologically unrelated pairs (e.g., *abricot-ABRI* [apricot-shelter]). However, only the morphologically transparent pairs produced strong priming effects when the task was cross-modal priming. Similar findings were obtained by Rastle and Davis (2003), who used a within-target comparison (i.e. when different types of primes like *departure* and *department* are paired with the same target word, e.g., *DEPART*).

[12] According to Marslen-Wilson, Tyler, Waksler, & Older (1994) and Marslen-Wilson and Zhou (1999), derived pairs should produce reduced facilitation or null effects due to the lexical competition between the different suffixes attached to the same stem in the prime and the target. Specifically, the facilitation produced by the shared stem is cancelled out by the suffix suppression or inhibition process.

Using a 52 ms SOA, Rastle and Davis found equally strong priming effects for stem targets e.g., *NUMB* both by semantically transparent and morphologically-related primes, e.g. *numbness* as well as semantically opaque, morphologically unrelated pseudoaffixed primes, e.g. *number*. The authors also found numerical (i.e. statistically nonsignificant) facilitation for stem targets, e.g. *BUTT* by pseudoaffixed primes, e.g. *butter* (which could be parsed into butt + er) but not by form related, morphologically unstructured primes, e.g. *button*.

More recently, Marslen-Wilson, Bozic, and Randall (2008) used an incremental masked priming task similar to Boudelaa and Marslen-Wilson (2005) in an attempt to track the time-course of morphological, orthographic, and semantic effects during word recognition and lexical access and to obtain unequivocal support for the distinctive role of morphology unadulterated by semantic and orthographic impurities. In their study, Marslen-Wilson et al. (2008) had several prime-target pairs where the target was embedded in the prime: 1) word pairs that shared a stem but without any morphological or semantic relations, e.g. *scandal-SCAN* (where *–dal* is not a derivational suffix in English), 2) word pairs that shared a stem and were potentially but not actually morphologically-related, e.g. *archer-ARCH* (where *archer* could be parsed into *arch* and *–er*, which is a productive derivational suffix), 3) morphologically related and semantically transparent pairs, e.g. *bravely-BRAVE*, 4) morphologically related pairs with a moderate semantic relationship, e.g. *barely-BARE*. In addition, there were two semantic conditions that mimicked the strength of meaning relations among the pairs in 3 and 4 but without any morphological relation, namely, semantically transparent pairs, e.g. *accuse-BLAME* and intermediately semantically related pairs, e.g. *attach-GLUE*. The priming effects of these pairs were probed across three different SOAs (36, 48, 72 ms). Consistent with a "blind" morphological decomposition account, primes that were decomposable into a stem and a recognizable affix (2, 3, and 4) produced significantly larger facilitation for their targets across all SOAs irrespective of semantic overlap. In fact, the priming effects for these pairs increased over SOAs. In contrast, orthographic similarity alone (condition 1) failed to produce significant priming effects at any SOAs. Likewise, pure semantic overlap at an intermediate level did not yield significant priming at any SOA. In contrast, semantically-transparent pairs produced significant priming at all SOAs. However, these effects were significantly weaker than the priming observed for morphologically decomposable words. When the order of prime-target presentation was reversed (Exp. 2), the same overall pattern of results from Experiment 1 emerged suggesting that decompositionality rather than form overlap was the cause of priming.

Taken together, the above mentioned studies (Rastle et al., 2000; Rastle et al., 2004, Marslen-Wilson et al., 2008) show that whenever the surface string can be segmented into a legal stem and a legal suffix, priming effects emerge. However, priming effects were also attested between other types of morphologically related words, namely orthographically opaque pairs. Orthographically opaque derivations refer to morphologically complex words which cannot be perfectly parsed into a stem and a suffix. Such derivations which exhibit regular orthographic alterations at a morpheme boundary include words with a missing 'e' (e.g., *adorable-ADORE*), words with a shared 'e' (e.g., *writer-WRITE*), and words with a duplicated consonant (e.g., *swimmer-SWIM*). In one study, McCormick, Rastle, and Davis (2008) compared the masked priming effects between these pairs to the priming between orthographically transparent deriva

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derivations (e.g., *darkness-DARK*) and the priming between orthographically-related but morphologically unrelated words (e.g., *shovel-SHOVE*). All types of morphologically related pairs i.e. those with and without orthographic alterations produced robust and statistically comparable priming effects whereas orthographically related but morphologically unrelated pairs produced weaker priming effects. Interestingly, when the orthographically opaque derivational pairs were pitted against pseudo-related pairs with similar orthographic alternations but without any morphological or semantic association (e.g., *badger-BADGE*; *template-TEMPLE*; *committee-COMMIT*), both the derivationally related and the pseudo-derivationally related pairs produced robust and statistically equivalent priming effects that were significantly larger than the priming effects between orthographically-related pairs like *shovel-SHOVE*.

In a subsequent study, the same researchers (McCormick, Rastle & Davis, 2009) obtained robust priming effects for targets such as *ADORE* by the same stem without the final "e" i.e. *ador* and by morphologically structured nonwords comprised of a stem with a missing final "e" and either a vowel-initial suffix (e.g., *adorage*) or a consonant-initial suffix (e.g., *adorly*). The conclusion from these findings is that morphological decomposition applies whenever a potential morphological structure is detected irrespective of semantics and the prime's lexical status and even when the extracted stem is orthographically underspecified (e.g., ador + able; writ + er) or overspecified (e.g., swimm + er).

Morphological priming effects were also obtained for phonologically-opaque pairs. In two studies which employed different experimental techniques, namely cross-modal and auditory priming by Marslen-Wilson and colleagues (Marslen-Wilson et al., 1994; and Marslen-Wilson & Zhou, 1999), the authors reported robust priming effects between allomorphic pairs such as *defensive-DEFENSE* and *sanity-SANE* where the change affects the final consonant of the stem in the first set and the final (pronounced) vowel of the stem in the second set. These priming effects were found to be statistically equivalent to the priming between phonologically transparent pairs such as *friendly-FRIEND*, which in turn were significantly larger than the priming found for phonologically related but morphologically unrelated pairs like *planet-PLAN*.

Evidence for morphological effects also comes from visual long and short lag priming tasks. In long-lag priming experiments, the prime and target are separated by lags of 10 intervening items on average whereas in short-lag tasks, the target is presented almost immediately after the presentation of the prime without intervening items. In one study, Stolz and Feldman (1995) obtained (Exp. 1) statistically strong and comparable long-lag priming effects between two types of morphologically-related words: 1) phonologically and orthographically opaque pairs, e.g. *repetition-REPEAT* i.e. formations whose base morphemes undergo phonological and orthographic modifications under affixation, and 2) phonologically and orthographically transparent pairs, e.g. *marked-MARK* i.e. formations in which the base morphemes retain their phonological and orthographic form under affixation. These effects were not attributed to orthographic similarity because orthographically related but morphologically unrelated words such as *market-MARK* and *repent-REPEAT* failed to yield significant priming effects. Similar findings were obtained at short lags (Exp. 2b). Specifically, both transparent pairs, e.g. *marked-MARK* and opaque pairs e.g., *slung-SLINGS* produced equally robust priming effects whereas orthographically similar but morphologically unrelated pairs e.g., *market-MARK* and *slang-SLINGS* had no priming effect.

In the inflectional domain, several studies found that regularly inflected word pairs (e.g., *vowed-vow*) produced robust priming effects that were constant across several SOAs whereas orthographically related words (e.g., *vowel-vow*) and semantically-related words (*pledge-vow*) did not (Feldman & Soltano, 1999; Feldman & Prostko, 2002; Feldman, 2000). Other studies, taken collectively, generally show robust masked, cross-modal, and long lag priming effects for word pairs involving regular inflections (e.g., *walked-WALK*), semi-regular inflections (e.g., *burnt-BURN*), and irregular inflections (e.g., *spoke-SPEAK* or *fell-FALL*) which in some cases were comparable to ID priming but not for orthographically and phonologically related words with similar orthographic alternations (e.g., *dollar-DOLL*, *feed-FEE*, *coke-CAKE* or *fill-FALL*) or semantically related words (e.g., *jacket-coat*) (Kielar, Joanisse & Hare, 2008; Forster et al., 1987; Pastizzo & Feldman, 2002; Napps & Feldman, 1985; Basnight-Brown, Chen, Hua, Kostić, & Feldman, 2007; Crepaldi, Rastle, Coltheart, & Nickels, 2010; Stockall & Marantz, 2006).

The morphological priming effects obtained for irregularly inflected words suggest morphological decomposition may readily apply to words that cannot be parsed into recognizable stems and affixes. However, evidence for priming with irregular inflections is inconclusive. Several studies have shown that regular but not irregular inflections produced reliable priming. For example, Stanners, Neiser, Hernon and Hall (1979) reported robust priming effects for regular inflections (e.g., *burned-burn*) that was comparable to ID priming but reduced priming for irregular past tense verbs (e.g., *shook-*

shake). Similar results were obtained by Napps (1989). Other researchers like Kempley and Morton (1982) who used long-term (10-40 minutes) priming of spoken words presented in noise and Marslen-Wilson, Hare, and Older (1993) and Sonnenstuhl, Eisenbeiss and Clahsen (1999) who used cross-modal priming reported facilitation for regular forms and absent or reduced facilitation for irregular forms. These results suggest that morphological priming effects in the inflectional domain are not guaranteed unless accompanied by a transparent and regular orthographic and/or phonological relationship.

In a nutshell, there is a substantial body of evidence showing strong priming effects between morphologically (both inflectionally and derivationally) related words in English (and other Indo-European and Slavic languages). These morphological priming effects were shown not to be due to the effects of pure orthographic form similarity, semantic similarity or the added sum of these two factors. However, the evidence is not as unequivocal as it may appear. In the next section, I will provide evidence in favor of orthographic priming whose locus is not at a morphological level of relatedness.

3.2 Orthographic Priming

In the previous section, we have seen that morphological identity was a requirement for priming to occur. Additionally, orthographic overlap that was not at a morphological level of representation failed to yield reliable priming effects. Moreover, it seemed that morphological decomposition applied whenever a potential morphological structure was detected. In the next sections, I will provide evidence for orthographic-based priming that arises due to pure form overlap at an orthographic but not a morphological level of representation. Previous research on orthographic priming distinguished between three types of orthographic priming: substitution priming, transposed-letter priming, and relative-position priming. Discussion in this dissertation, however, will be limited to the first two types of orthographic prime.

3.2.1 Substitution Priming

Several studies showed that there were significant priming effects in English between orthographically-related but morphologically and semantically unrelated prime-target pairs. For example, in a masked priming study, Forster et al. (1987) obtained robust priming effects for target words, e.g. *ANSWER* (Experiment 1) preceded by a single letter substitution prime, e.g. *antwer*. In subsequent experiments (Experiments 2, 5 & 6), Forster et al. (1987) found that low neighborhood prime-target pairs in the substitution condition, e.g. *ench-INCH* produced significant priming effects. Forster and Veres (1998) found that eight and nine letter masked word and nonword primes significantly reduced lexical decision latencies to orthographically-similar targets (e.g., *converse/convenge-CONVERGE*) that were different in one letter (Experiments 3 & 4). In another study, Frost, Kugler, Deutsch, and Forster (2005), found reliable masked form (i.e. orthographic and/ or phonological) priming effects between orthographically-related word pairs in English which differed by one letter only (e.g. *house-horse*) in Hebrew-English (Experiment 3A) and English-Hebrew (Experiment 3B) bilinguals. The authors also found that orthographically-related but morphologically unrelated prime-target pairs in Hebrew did not produce any priming effects by these same bilinguals. In another study, Davis and Lupker (2006) observed facilitatory masked priming effects for targets preceded by a single letter different nonword primes (e.g., *ible-ABLE*) and inhibitory priming effects for targets preceded by a single letter different word primes (e.g., *axle-ABLE*).

Furthermore, Duñabaitia, Carreiras and Perea (2008) found an equal magnitude of masked priming effects at 50 ms SOA between associatively related pairs (e.g. *abeja-MIEL*, the Spanish for *bee-HONEY*) and ortho-phonologically mediated associated pairs (e.g., *oveja-MIEL*, the Spanish for *sheep-HONEY*) where the primes *abeja* and *oveja* are phonologically and orthographically related to each other but only the former is semantically related to its target. Mediated orthographic priming effects were also found in English in a variety of tasks like the semantic categorization task (e.g., is turple an animal? Forster & Hector, 2002) and masked priming (e.g., *stuff-STIFF* which both share one neighbor i.e. *staff* relative to *crown-CLOWN* which do not share an orthographic neighbor) (Davis & Lupker, 2006). There is also evidence for phonologically mediated associative masked priming at brief SOAs in both English and Dutch (e.g., *towed-FROG* or *male-LETTER* relative to *told-FROG* or *mall-LETTER*) (Lukatela & Turvey, 1994; Lesch & Pollatsek, 1993; Drieghe & Brysbaert, 2002). Obviously, the priming effects in these studies cannot be attributed to morphological factors as no morphological relationship, genuine or potential, exists between the critical pairs.

3.2.2 Transposed-Letter (TL) Priming

Previous research has also investigated a type of orthographic relationship in which primes and targets share all their letters but differ with respect to the order of these letters. In one study, Chambers (1979) found that in a single presentation lexical decision task (also known as an interference paradigm), words (e.g. *bale-able*) or nonwords (e.g., *gadren-garden*) differing from a more frequent word in the order of two adjacent letters significantly slowed down lexical decisions (i.e. they were more difficult to reject). However, no significant effects were observed for words (e.g., *collar-dollar*) or nonwords (e.g., *lotor-motor*) that differed from a more frequent word by one letter irrespective of the substituted letter's position within the word i.e. whether it was the first, middle or final letter. Chambers (1979) also observed that nonwords formed by the transposition of a word's two adjacent internal letters produced greater effects (e.g., *gadren-garden*) than nonwords formed by the transposition of two adjacent external letters (i.e. the two initial or two final letters).

A few years later, Forster et al. (1987) obtained robust masked priming effects (facilitation) for high and low frequency target words (Experiment 1) preceded by misspelled primes that were the same as the target words (e.g., *ANSWER*) except for a transposition of two medial letters (e.g. *anwser*). In fact, the priming effects in this condition were found to be as strong as the priming effects in the identity condition (i.e. *answer-ANSWER*). In another masked priming study, Perea and Lupker (2003b) found that TL-internal primes (e.g., *bugdet*) produced larger facilitation to their base words (e.g., *BUDGET*) than did TL-final primes (e.g., *budgte*) as compared to appropriate orthographic control replacement letter (RL) conditions (e.g., *bujfet* and *budgfa* for internal and external TL conditions, respectively). In fact, the orthographic control condition which involved the replacement of the critical word's final letters (e.g., *budgfa*) yielded reliable priming effects relative to an unrelated condition. Similar findings were obtained by Johnson, Perea and Rayner (2007) who employed the sentence parafovial preview paradigm. These researchers found that TL nonword previews resulted in shorter viewing durations for their base target words relative to substituted letter (SL) nonword previews. Additionally, shorter target viewing durations were found for TL-internal nonword previews than TL-external previews (word-initial and word-final transpositions) for seven-letter words.

Perea and Lupker (2003a) found that TL-internal nonword primes (e.g., *jugde*) produced significant facilitatory priming effects for associatively related targets (e.g., *COURT*) relative to TL-final nonword primes (e.g., *judeg*) and to RL-nonword primes (e.g., *judpe*) at SOA 80 ms (40 ms prime duration followed by 40 ms pattern mask). In addition, Perea and Lupker (2004) found that priming effects for TL nonwords created by the transposition of nonadjacent consonants in Spanish words (e.g., *caniso-CASINO*) facilitated lexical decisions in masked priming relative to orthographic controls that involved the substitution of the same letters affected by the transposition (e.g. *caviro-CASINO*). Lupker, Perea, and Davis (2008) replicated these finding in English as well. These findings suggest that in lexical decision, TL nonwords tend to be misperceived as words more than substituted letters nonwords. Perea and Lupker (2004) and Lupker et al. (2008) also observed that nonwords created by the transposition of nonadjacent (internal) consonants produced a higher rate of false positive responses and significantly reduced lexical decision times in a single presentation interference paradigm relative to two-letter replacement nonwords.

TL confusability effects were not only limited to cases of two-letter transpositions but they were also reported for six-letter transpositions (Guerrera & Forster, 2008). In this study, the authors found that nonwords formed by transposition of the six interior letters of eight-letter words (<u>1</u>325476<u>8</u> transpositions e.g., *sdiwelak-SIDEWALK*) as well as words formed by the transposition of all but the first two letters (<u>12</u>436587 transpositions e.g., *chlirdne-CHILDREN*) produced significant facilitation to their base targets. There was also priming, albeit to a lesser extent, by words formed by the transposition of the four exterior letters (first and last two letters of words i.e. 21345687 e.g., *isdewakl-SIDEWALK*) as well as words created by the transposition of all but the final two letters (i.e. 21436578 e.g., *hclirden-CHILDREN*) for their base targets.

To explain the greater priming effects by TL-primes compared to substitution primes, Perea and Lupker (2003a, b) argue that letter identity information and letter position information might become separated in the perceptual system or that position coding lags behind the coding of letter identities. Under position-specific orthographic coding schemes (e.g., Rumelhart & McClelland, 1982), both TL prime (e.g., *jugde*) and a substitution prime (e.g., *jupte*) would be assigned equal weights and hence would be equally effective primes which is not supported by the results from previous transposition priming studies.

One orthographic coding model that successfully accounts for the TL effects in visual word recognition is the Sequential Encoding Regulated by Inputs to Oscillations within Letter units (SERIOL) model (Whitney, 2001; Grainger & Whitney, 2004). This letter coding scheme is an open-bigram model i.e. it is accompanied by ordered pairs of letters. For example, the word *SALT* would be represented by the activation of the following bigram units: SA, SL, ST, AL, AT, and LT[13]. An anagram like *SLAT* would therefore share five bigrams with this word, namely, SL, SA, ST, LT, and AT, which is more bigrams than a single letter substitution prime like *SILT* would share with it (*SILT*

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[13] It is noteworthy that sequentiality as defined by the relative order of letters is strictly observed by SERIOL such that a bigram like AS would not be counted as a bigram of *SALT*. Moreover, although SERIOL tolerates nonadjacent bigrams (e.g., ST), it only allows a maximum of two intervening letters to separate between a given bigram letters. However, activation level is correlated with contiguity in the bigrams with activation or priming being stronger for contiguous letters than noncontiguous letters separated by one intervening letter which in turn is stronger than noncontiguous letters separated by two intervening letters.

shares only three bigrams with *SALT* i.e. SL, ST, and LT). Specifically, using the MatchCalculator (Davis, 2005) to measure SERIOL-based orthographic similarity between the several pairs, one finds the following: the identical pair *SALT-SALT* would get a match score of 1.00 whereas the anagrams *SALT-SLAT* would score .82 in orthographic similarity. However, the orthographic similarity would drop to .49 for single letter substitution primes such as *SILT-SALT* (or to .57 for *SLIT-SALT*) and to .32 for double substitution primes such as *SECT-SALT*.

It is important to note that word confusability effects are not without restrictions. As mentioned above, internal transpositions seem to be more effective than external or word-final transpositions. In one study, Rayner, White, Johnson, and Liversedge (2006) found that compared to the reading rate for normal sentences (255 words per minute, wpm), the reading rate for words with internal transpositions was the least affected (227 wpm) whereas the reading rate for words with external transpositions was severely impeded (163 wpm for beginning letters 189 wpm for ending letters). Also, the transposition of nonadjacent or adjacent vowels did not yield masked priming effects in Spanish or in English (e.g., *anamil-ANIMAL* or *freind-FRIEND*) (Perea and Lupker, 2004; 2003a; Lupker et al., 2008; Perea & Acha, 2009)[14] or resulted in reduced activation of targets relative to transposition that targeted consonants (Carreiras, Vergara, & Perea, 2007). Additionally, Christianson, Johnson, and Rayner (2005) found that transpositions across morpheme boundaries in multimorphemic words (e.g., *susnhine-SUNSHINE*)

[14] Lupker et al. (2008) attribute this finding to frequency effects. Specifically, the results from Experiment 2 of their study suggest that high frequency letters such as vowels may have strict positional coding. However, there is evidence that under other tasks that tap low-level prelexical processing, C-C and V-V transpositions yield comparable effects. For example, Johnson (2007) who used eyetracking procedures found that V-V transpositions (e.g., *flewor-flower*) produced approximately the same magnitude of priming as C-C transpositions (e.g., *fosert-forest*). Likewise, Perea and Acha (2009) found equal priming by C-C transpositions (e.g., *catrel-CARTEL*) and by V-V transpositions (e.g., *craota-CROATA*) in 'cross-case masked priming same-different' task (see Exp. 4 in Kinoshita & Norris, 2009 for similar findings).

significantly reduced naming latencies in masked priming. In fact, naming for across-morpheme transpositions was found to be more similar to naming for orthographic controls (e.g., *sunsbine-SUNSHINE*) whereas naming for within-morpheme transpositions (e.g., *sunhsine-SUNSHINE*) was more similar to identity priming. Interestingly, naming latencies for across-morpheme transpositions in pseudocompounds (e.g., *mahyem-MAYHEM*) was found to be like that of real compounds with significant differences between naming latencies in this condition compared to the identity condition. Moreover, word confusability effects were absent for TL-derived words (e.g., *boastre-BOASTER*). However, pseudo-derived words (e.g. *blustre-BLUSTER*) did exhibit the confusability effects obtained for TL-internal words (e.g., *sacrasm-SARCASM*)[15]. Moreover, Perea and Carreiras (2006) found statistically similar priming for within (noncompounds) and across morpheme boundary (compounds) transposition of nonadjacent letters in Basque, a highly agglutinating language. However, because the letters were nonadjacent and due to the lack of cues that marked the morpheme boundaries in that study, Duñabeitia, Perea, and Carreiras (2007) reexamined this issue but with suffixed words in Basque. The authors found that transpositions of adjacent letters across the morpheme boundary of suffixed words did not yield any effect compared to the strong priming of internal transpositions in non-affixed words. These results were replicated in Spanish for both prefixed and suffixed words. Additionally, the same results were found even when the manipulations occurred within the same affixed Spanish words.

[15] These results are inconsistent with Rastle and colleagues' (Rastle & Davis, 2003; Rastle et al.'s (2004) findings as both types of derived primes were equally effective in facilitating the recognition of their stems.

Another constraint with respect to TL priming effects seems to be the distance between the transposed letters with greater priming for transpositions involving two adjacent (internal) letters (e.g., *chocloate-CHOCOLATE*) and a reduced (but still significant) priming for transposed letters with one and two intervening letters (e.g., *cholocate-CHOCOLATE* and *choaolcte-CHOCOLATE*) (Perea, Duñabeitia, & Carreiras, 2008). Finally, previous research suggests that prime lexicality plays an important role when it comes to TL priming effects. Specifically, prime-target real word anagrams like *casual-CAUSAL* did not have any priming effects (Duñabeitia, Perea, & Carreiras, 2009). However, these results are contrary to previous findings (e.g., Chambers, 1979; Andrews, 2004) which showed significant interference effects by anagrams (e.g., *salt-SLAT*). Remember that in Hebrew and Arabic, TL primes did not facilitate lexical decisions to their non-transposed target words. Thus, Semitic and Indo-European languages diverge with respect to TL confusability effects suggesting that the latter group of languages do not impose strict sequential requirements for morphemic elements.

To recap, past research in English and other Indo-European languages reported priming effects between morphologically-related (at both inflectional and derivational levels) and pseudo-morphologically-related words (e.g. Forster & Azuma, 2000; Rastle et al., 2004). These morphological priming effects were claimed not to be due to the effects of pure orthographic or phonological similarity, semantic similarity or the added sum of these two factors. The reason is that morphological priming effects occur in the absence of a regular orthographic/ phonological relationship (as in *repetition-repeat*; Stolz and Feldman, 1995) or a clear semantic relationship (as in *submit-permit*, *department-depart*, or *number-numb*; Forster & Azuma, 2000; Rastle & Davis, 2003). In addition, priming between semantically-related but morphologically unrelated words was found to be distinct from morphological priming effects in either being relatively weak (Marslen-Wilson et al., 2008) or emerging at longer SOAs (Rastle et al., 2000). Furthermore, orthographically-related words without a morphological relation failed to produce priming effects even though the form overlap between these words resembled the form overlap between the (pseudo)morphologically-related words (e.g., Rastle & Davis, 2003). Nevertheless, not all types of orthographic similarity fail to prime. Past research indicated the existence of substitution priming. However, evidence for substitution priming is scarce and is mostly restricted to nonword-word pairs (e.g., Forster et al., 1987) or mediated priming (e.g., Duñabaitia et al., 2008). A more effective type of orthographic priming in English and other Indo-European languages is the TL-priming. Numerous studies reported TL-priming (or interference) for words (e.g., Chambers, 1979) but mostly for nonwords (e.g., Forster et al., 1987).

Although many studies in English obtained results in favor of the claim that morphological priming effects were irreducible to semantic and form similarity, there are other results which provide evidence to the contrary. For example, Marslen-Wilson, Tyler, Waksler, and Older (1994) reported no priming effects (Experiment 5) between word pairs with bound stems like *submit-PERMIT* in a cross-modal priming task in which both the prime and the target are fully perceptible. Additionally, no significant priming was obtained for morphologically related but semantically-opaque pairs like *department-DEPART* in both cross-modal (Marslen-Wilson et al., 1994; Longtin et al., 2003) and auditory (Marslen-Wilson & Zhou, 1999) priming tasks. Similar findings were obtained by Feldman and Soltano (1999) and Feldman et al. (2004) who found differential priming effects between semantically transparent (e.g., *casually-casualness*) and semantically opaque (e.g., *casualty-casualness*) morphological relatives at 250 ms prime duration (irrespective of prime modality i.e. whether it is auditory or visually unmasked) with facilitation obtained for the former type of pairs and inhibition for the latter type of pairs. Likewise, Rueckl and Aicher (2008) found that under long-term priming (with fully visible primes and targets and 7-13 intervening items) there were significant priming effects for morphologically transparent pairs (e.g., *TEACHER-TEACH*) but not pseudo-derived pairs (e.g., *CORNER-CORN*). In an ERP study, Morris, Grainger, and Holcomb (2008) found evidence that morphologically related (*corner-CORN*) and the orthographically related pairs (*scandal-SCAN*) patterned together during the later phase of the N250 (250-300 ms). Finally, other studies (e.g., Stanners et al., 1979; Kempley and Morton, 1982; Marslen-Wilson et al., 1993) show that morphological priming is obtained only when accompanied by a regular orthographic relationship. These results indicate that morphological priming effects may depend to some degree on semantic similarity and/or transparent orthographic relationship.

Seidenberg and Gonnerman (2000) question the claim that morphological effects in English are irreducible to form and meaning effects. Specifically, they find it unsurprising that morphologically-related words produce strong priming effects in comparison to semantically or orthographically related words. They suggest that morphological priming effects may result from the nonadditive effects of semantic and form overlap. For example, citing Napps (1989), they argue that compared to semantically-related words such as *bread-cake* or orthographically-related pairs like *ribbon-rib*, morphologically-related words like *government-govern* or *ribbed-rib* overlap at both the semantic and form dimensions and accordingly are more likely to prime. They propose instead that "morphology is correlated with other types of lexical information, including spelling, sound and meaning" (p. 355). Other researchers agree with this assessment. For example, Rastle and Davis (2008) argue that morphological processing in English appears to be morpho-orthographic in nature. Specifically, the authors contend that morphological decomposition in English is informed by form-meaning regularities that exist in the language such that the evolving reader begins to detect that certain sequences of letters constitute independent meaning-bearing units; causing the parser to segment written words into their constituent morphemes whenever possible. This explains why morphological decomposition in English applies indiscriminately to unanalyzable words like *corner* and *remain* as well as to genuinely structured words like *teacher* and *regain*.

3.3. The Differences in Lexical Processing Between English and Arabic and the Implications for Arabic-English Bilinguals

In the outset of this chapter, I presented a substantial body of evidence for morphological priming in English which in some cases was shown to be irreducible to pure orthographic or semantic similarity. The conclusion from these studies is that in English, lexical organization and access may be defined primarily in terms of morphological form similarity such that words that are morphologically related are stored in constellations. In this regard, English is similar to Arabic in that lexical organization in both languages depends primarily on the morphological principle of a shared root. However, the languages differ from one another in terms of the decompositional aspect of word processing. Specifically, decomposition in English applies exclusively to derived (and bound stem) words yielding stems and affixes. In Arabic, decomposition applies to all words yielding roots and patterns; two abstract, discontinuous morphemes which alone/separately do not constitute meaningful words. This means that a parser trained to decompose words in English, a language with continuous morphology (unmarked system), may not be necessarily able to decompose words in Arabic, a language with discontinuous morphology (a marked system) despite the fact that the two languages appear to organize their lexicons based on morphological principles. One question this assumption raises: How do Arabic-English bilinguals, whose parsers have tuned in to the system of English, process words in their native language? One goal of this research is to investigate how native speakers of L1 Arabic with high proficiency in L2 English process words in their native language in comparison with monolingual native speakers.

As will be shown in the next chapter, even when investigating processing in L1, it is crucial to consider lexical processing and other areas of linguistic knowledge and use in bilinguals as malleable processes which are subject to influences from the L2. Specifically, with increased experience in the L2, the L1 may start to adopt, by means of transfer, certain properties of the L2 in areas where the two language systems diverge. The prediction here is that if knowledge and proficiency of a second language affects processing in one's native language, then Arabic-English bilingual speakers will differ from monolingual speakers of Arabic. Specifically, the bilinguals may develop insensitivity to the morphological system of their native language such that a shared root or a word pattern will produce reduced or no priming effects. This L1 morphological insensitivity may be the consequence of tuning in to the L2 morphological system in which the concept of a morpheme does not correspond to the notion of a morphemic unit in L1.

Another area in which speakers of Semitic and Indo-European languages clearly differ is Transposed-Letter (TL) words. As shown in chapter 2, Arabic and Hebrew impose a strict positional coding on root morphemes as a requirement for activating these units. Specifically, TL-words or nonwords primes failed to facilitate target recognition, unless the transposition did not affect the order of the root consonants (i.e. in cases where the transposed letters were adjacent root and word pattern letters, e.g., *kaatib-kitaab* (writer-book); a type of transposition that results in another morphologically-related or same-root word). In English, it was shown that TL word and nonword primes produced facilitation (faster RTs) in masked priming and interference (slower RTs) in single presentation tasks, suggesting that English is more flexible with regard to positional coding requirements. Therefore, if transfer of second language processing mechanisms takes place, TL-priming effects may emerge in the L1 of native speakers of Arabic with high proficiency in English. In the next chapter, I will review research which deals specifically with L2 to L1 transfer and the consequences of second language acquisition on the first language of late L2 learners.

CHAPTER 4: THE EFFECTS OF THE SECOND LANGUAGE ON THE FIRST

4.1 Introduction

Central to the current study is the relationship between L1 and L2 and the effects of a speaker's second language proficiency on his/her first language. Research in the field of SLA and bilingualism in late bilinguals (i.e. those who learned a second language in adolescence or early adulthood) has mostly been concerned with the first language influence on the second but not so much with the reverse situation. The main reason for this unbalanced focus is the assumption that once the learners' L1 is established, it somehow becomes immune to any influence from newly introduced languages. Thus, if there is any influence, it has to be unidirectional, from the L1 to the L2. In this chapter, I review research that deals with L2 effects on the L1 in late bilinguals. For early or simultaneous bilinguals, bidirectional or reciprocal influence is more likely as both languages are introduced (possibly sequentially) to the learners before either of them has matured. Accordingly, research that deals with early bilinguals will not be considered in this study.

During early stages of second language learning, late learners of a second language experience interference from their more dominant L1. With higher proficiency in the second language however, the L1 may show some traces of the L2 especially in cases where the L2 becomes increasingly important in everyday life. In fact, there are a number of studies that point to the L1 being restructured, changed and sometimes becoming more like L2 as far as basic processing mechanisms are concerned. L2 effects on L1 or transfer from L2 to L1 has been referred to as 'reverse' or 'backward' transfer

(Cook, 2003). Kecskes and Papp (2003, p. 251) define transfer in multilinguals as "any kind of movement and/ or influence of concepts, knowledge, skills or linguistic elements (structures, forms), in either direction, between the L1 and the subsequent language(s)". The changes that occur in the L1 as a result of the bilingual's L2 influence led Cook (2003, p. 5) to propose that the bilingual's knowledge of his or her L1 is to some extent not the same as that of a monolingual.

According to Cook (2003), effects of the L2 on the L1 may be positive (e.g., enhanced metalinguistic ability), negative (loss or attrition), or neutral. In terms of outcome, Pavlenko (2000; 2003; 2004) classified L2 influence on L1 into the following categories:

1) Borrowing transfer: the addition of L2 elements to L1.
2) Convergence: the formation of a unitary system that is different from both L1 and L2.
3) Shift: moving away from structures or values of the L1 to approximate those of the L2.
4) Restructuring transfer: the incorporation of L2 elements into L1 that results in changes, substitutions or simplifications.
5) L1 attrition: the loss of some L1 elements due to L2 influence.

L1 attrition is likely to occur when the L2 becomes the dominant language and in situations in which contact with L1 is lost due to cultural and linguistic immersion in an L2 environment (e.g., heritage speakers; Montrul, 2008). Although non-pathological L1 attrition is an important field of investigation in SLA research, the aim of this chapter is not to give evidence that L2 causes some deficiency in the native language or leads to L1 loss. There are two reasons why L1 attrition research is not considered here. First, following Kecskes and Papp (2003, p. 254), "[t]he L2 effect will not necessarily result in any errors in L1 use." Acquisition of an L2 may simply lead to changes in the L1. Second, although the vast majority of bilingual participants in this study are immigrants to the US, they are exclusively first-generation settlers who maintain regular use of L1 as a result of their unique linguistic and demographic situation.

In recent years, there has been growing body of research studies reporting L2 to L1 transfer. In these studies, the L2-L1 transfer was not limited to a certain linguistic structure or language phenomenon but was attested in several areas of linguistic knowledge. In the next sections, I am going to present evidence for reverse transfer divided in accordance to the locus of these effects.

4.2 Effects of L2 on L1 in Phonology and Phonetics/ Speech

Several studies have documented the influence of L2 on L1 in the domain of phonology. In these studies, second language learners deviated from the phonetic norm of the monolingual speakers of their first language and moved closer to the phonetic norms of monolingual speakers of their second language. Several of these studies have shown that these L2 learners have been perceived as less native-like in their first language. For example, in one study, Flege (1987) compared the voice onset time (VOT) values or the amount of aspiration of voiceless stops by four groups of participants: English and French monolinguals and highly experienced French-English and English-French late bilinguals. Both groups of bilinguals had lived in an L2-speaking country (the former in the US and the latter in France) for 12 years on average and some were married to a native speaker of their L2. VOT is argued to serve as an adequate acoustic cue for distinguishing between initial stop consonants cross-linguistically and is argued to be closely tied to the degree of "nativeness" or "accentedness" of one's speech (Flege & Eefting, 1987; Major, 1992).

Flege found that the French-English bilinguals produced French /t/ with longer (i.e. English-like) VOT values than French monolingual speakers and that the English-French bilinguals produced English /t/ with shorter (i.e. French-like) VOT values than English monolingual speakers. Flege argued that L2 learning is what influenced this production of /t/ in the L1 in these bilinguals. Specifically, L2 learning triggered a restructuring of the L1 phonetic space making it more similar to the L2. Major (1992) reported similar results in a group of five English-Portuguese bilinguals who were American post-puberty immigrants to Brazil. Like Flege, Major observed that the bilinguals' VOT became shorter and more Portuguese-like in their speech in English as compared to English and Portuguese monolingual control groups (Also see Williams, 1979 for similar findings in Spanish-English bilingual children and teenagers and for a review of related literature see Watson, 1991; Zampini & Green, 2001).

In another study, Sancier and Fowler (1997) showed that native Brazilian Portuguese listeners reported more foreign-accented speech in the L1 of a native Brazilian Portuguese speaker after a few months of exposure to English in the US. In addition, an examination of the subject's VOT revealed that her Portuguese voiceless consonants' [p, t] VOT values gravitated toward those of American English (i.e. they became generally longer) during the time she was in the US and as such may have triggered the reports of a foreign accent.

Bullock and Gerfen (2004) present evidence for the influence of L2 English on L1 French in two late French-English bilinguals. The researchers report that under the influence of L2 English, their two French subjects experienced a loss of a standard French allophonic distinction between mid front rounded vowels which mapped onto the American English rhoticized schwa both acoustically (formant structure) and articulatorily (lip rounding). More recently, De Leeuw, Schmid, and Mennen (2010) had native monolingual listeners assess global foreign accent of German speaking immigrants to Anglophone Canada or to the Dutch Netherlands. The bilinguals had moved to their country of choice at an average age of 27 years and had resided there for an average of 37 years. The monolingual German raters were more likely to perceive the German speech of the bilingual immigrants as less native-like than the speech of German monolingual controls living in Germany matched on age and educational background.

Finally, some studies provide evidence for the influence of L2 on L1 in the domain of suprasegmental phonology. In one study, Andrews (1999) elicited spoken interview data from ten Russian-English bilinguals who immigrated from the former Soviet Union to the US either in late childhood or early adolescence. Andrews reported L2 influence on the participants' L1 intonation patterns. Specifically, the author observed that in contrast to what would be expected in Russian, the bilinguals' speech was marked by English-like high falls and rise-falls, the predominance of falling tones in declarative utterances and the use of the English rising tone in yes / no questions (Also see Mennen, 2004).

4.3 Effects on L2 on L1 in Semantics

Most instances of semantic backward transfer involve lexical borrowing into L1, the semantic extension of L1 words in analogy with L2 words, and the literal translation of L2 expressions into L1. In fact, semantic backward transfer accounts for the majority of instances in which L2 effects on L1 have been observed (Pavlenko & Jarvis, 2002). One example of semantic extension under the influence of L2 is the use of the Spanish verb, *correr* 'to run' by Cuban immigrants in the US to refer to the metaphorical meaning of running for office, a meaning that is not available in standard Spanish (Otheguy & Garcia, 1988). Another example is the Russian-Hebrew speakers' association of the verb 'close' (*zakryl*) with 'TV' (*televizor*) or 'telephone' in L1 Russian instead of the appropriate verb 'turn off' (*vykluchil televizor*); an extension based on L2 Hebrew where one "closes the TV/ telephone' (Laufer, 2003). Similar findings were obtained by Schmitt (2010) who investigated the influence of L2 English on the L1 production of early Russian-English bilinguals living in New York. Schmitt identified L2 influence at different levels of abstract lexical structure including lexical conceptual structure (e.g., using the Russian verb *sprashivat* "to ask a question" instead of *prosit* "to make a request" under the influence of the English verb *ask* which expresses both meanings).

Using a script similarity sorting task, Stepanova Cachs and Coley (2006) also report that sequential Russian-English bilinguals grouped envy and jealousy situations together deviating from Russian monolinguals. In Russian, the word *revnost* (jealousy) is limited to cases of romantic jealousy or sibling rivalry while *zavist* (envy) refers to the resentment or the unhappy feeling of wanting other people's possessions, success or good fortune. Judging these situations as similar was interpreted as a blurring of the categorical boundary between these words presumably under the influence of English in which the semantic scope of the word *jealousy* extends to envy situations. This interpretation is corroborated by the fact that these bilinguals' judgments were similar to English monolingual participants who grouped envy and jealousy situations together and different from Russian monolinguals who treated these situations as different.

Crucially, some studies have provided evidence for what appears to be the restructuring of semantic networks in late bilinguals. In one study, Yoshida (1990) reported that Japanese-English bilingual college students who had lived in the US and attended American schools (and accordingly were bicultural as well) behaved differently from Japanese monolingual speakers in a word association task in Japanese particularly in the category of culture. In another word association study, Grabois (1999) observed that late English-Spanish bilinguals, who had lived in Spain for about a decade, showed a shift from L1-like processing behavior to an L2-like processing pattern (as compared to monolingual speakers of both of their languages) in their L1 with respect to abstract concepts like *happiness*.

4.4 Effects of the L2 on L1 in Syntax, the Syntax-Semantics Interface and Morphosyntax

In the syntactic domain, reverse transfer has been documented in several studies. In one sentence processing study, Su (2001) investigated cue preferences when interpreting sentences both in Chinese and English by Chinese-English and English-Chinese bilinguals. In English, native speakers rely more on word order (syntax-based) cues for determining form-function mappings (i.e. determining the agent-patient relation in a sentence) while in Chinese, speakers reply on animacy (semantics-based) cues. Su's

Chinese and English monolinguals' results were consistent with these language-specific cue preferences. However, when processing sentences in their L1, intermediate and advanced Chinese-English bilinguals and advanced English-Chinese bilinguals (albeit to a small extent) showed a decrease in dependence on L1 processing strategies and an increase in reliance on L2 cue preferences.

In two studies, Dussias (2003, 2004) compared the parsing strategies used by monolingual speakers of English and Spanish as well as bilingual Spanish-English speakers in resolving temporarily ambiguous sentences containing a complex noun phrase (NP) followed by a relative clause (RC) e.g., *Peter fell in love with the daughter of the psychologist who studied in California*. Monolingual speakers of Spanish show a tendency to interpret the relative clause non-locally (i.e. they attach the RC to the first NP) while English monolingual speakers favor a reading in which the RC is attached to the NP immediately preceding it (local attachment). Dussias reported that Spanish-English bilinguals showed a bias to interpret the RC locally in Spanish. Given that the Spanish-English bilinguals were in an immersion environment, their results were taken as evidence of the L2 influence on the L1.

In another study, Gürel (2004) investigated the binding conditions of overt and null pronouns in L1 Turkish; a language that allows null subjects (i.e. a pro-drop language). In English, the subject pronoun in an embedded clause (e.g., *he* in *Brian said he would come*) can refer to the sentential subject (i.e. *Brian*). In the Turkish equivalent of this sentence (i.e. *Brian o-nun gel-eceğ-i-ni söyle-di*), the subject pronoun *o* is disjoint from the antecedent and as such cannot refer to the sentential subject. Gürel tested Turkish-English immigrants to North America who had been residing in the L2 environment for at least 10 years. The task required of the participants in interpreting such L1 sentences is to determine if the pronoun refers to the sentence subject, to another person, or both. The researcher found that under the influence of L2, the Turkish overt pronoun *o* was taken to refer to the sentence subject. In other words, the Turkish pronoun *o* was assigned the binding properties of the English pronouns *he/she* in clear violation of the Turkish binding constraints.

The influence of the second language on the first has not only been observed in sentence comprehension tasks but has also been attested in grammaticality judgments tasks. For example, Balcom (2003) examined grammaticality judgments of middle constructions in French by Canadian Francophone French-English bilinguals as well as French monolinguals. As illustrated below, in French but not in English, middle constructions with impersonal (dummy) subjects (1), par (by)-phrases (2), or unaffected grammatical subjects (i.e. without change of state; 3) are considered grammatical.

(1) L'année prochaine, il se traduira beaucoup de textes acadiens à l'Université de Moncton.
*Next year, there will translate many Acadian texts at à l'Université de Moncton.

(2) Ce costume traditionnel se porte surtout par les femmes.
*This traditional costume wears mostly by women.

(3) La musique de Mozart s'entend merveilleusement bien au theater Capitol.
*Mozart's music hears marvelously well at the Capitol Theatre.

Participants were asked to determine whether or not the sentences were grammatical and to provide their corrections of sentences they judged as ungrammatical. The results show that under the influence of L2 English, French-English bilinguals judged these sentences as ungrammatical significantly more than French monolinguals did. As for the proposed corrections, bilingual participants used more passive constructions and fewer middle constructions than did the monolinguals in line with the higher frequency of passive voice use in English than in French.

In another study, Ribbert and Kuiken (2010) administered a grammaticality judgment task to German-Dutch bilinguals living in the Netherlands who immigrated after puberty and had ample opportunity to use their native language. Of interest was the participants' performance in infinitive clauses in German which contained the complementizer *um*. In German, the cases in which this complementizer is used form a subset of the cases in which the corresponding Dutch complementizer *om* is used. The results show that participants made significantly more mistakes (overgeneralization) in German than a German control group who had no contact with Dutch in sentences where the use of the complementizer was ungrammatical in German but optional in Dutch. The bilinguals' results were therefore taken as evidence for the influence of the L2 (Dutch) on L1 (German).

As for sentence production tasks, Tsimpli, Sorace, Heycock, and Filiaci (2004) found that L1 Greek near-native speakers of L2 English preferred both definite and indefinite preverbal subjects more than monolingual Greek subjects did. This difference reached significance for the production of preverbal definite subjects. It is worth noting that in Greek, the syntactic distribution of preverbal and postverbal subjects is not determined by definiteness. Thus, the Greek-English bilinguals' increased use of preverbal definite subjects was arguably caused by the influence of the L2 English in which subjecthood is closely associated with definiteness/ topichood.

Several studies have reported changes in L1 in the direction of the L2 in the syntagmatic dimension, particularly morphosyntax. In one study, for example, Seliger and Vago (1991) found that the rules for agreement, tag questions, word order, and preposition preposing were projected in the production of L1 by Hungarian and German speaking learners of English. Likewise, Boyd and Andersson (1991) reported that L2 Swedish resulted in more variability in the placement of adverbials in the L1 of American-Swedish bilinguals and loss of possessive clitics in the L1 of Finnish-Swedish bilinguals. In another study, Pavlenko and Jarvis (2002) found that late Russian-English bilinguals' narratives in Russian involved instances of L2-induced subcategorization transfer when referring to emotion. For example, one participant stated 'vygliadela kak-budto ona byla zla na kogo-to' (looked as if she were angry at someone). According to the authors, the verb *vygliadet* (look/appear) subcategorizes for a limited number of adverbs and the construction "look as if…" is common in English but not Russian particularly with this verb. There were other instances of L2 → L1 subcategorization transfer. For example, one participant stated "kakoi-to orkestr igral muzyku" (some orchestra played music).

According to Pavelenko and Jarvis (2002), in Russian SVO constructions, the verb *igral* 'to play' when used for an orchestra can only be used as a double transitive verb to talk about a particular type of music or music by a particular composer (e.g., *kakoi-to orkestr igral muzyku Shostakovicha 'some orchestra play music [by] Shostakovich*). Thus, these subcategorization mistakes were modeled on sentences from L1 English in which such constructions are acceptable. Other L2-induced errors in L1 by late Russian-English bilinguals include incorrect choice of tense or aspect (i.e. imperfective instead of the perfective), incorrect case marking, and preposition misselection (Pavelnko, 2003).

4.5 Effects of L2 on L1 in Cognitive Semantics

One of the loci in which L1 has been shown to be influenced by the L2 is the area of cognitive semantics especially the domain of event construal and encoding. In one study, Hohenstein, Eisenberg, and Naigles (2006) had early and late immersed Spanish-English bilingual adults use their first and second language to orally describe video clips depicting motion events (e.g., a man walking or crawling up hill). In an earlier study, Naigles, Eisenberg, Kako, Highter and McGraw (1998) found that monolingual English speakers used more manner verbs (e.g., run, walk, skip, leap) while Spanish monolingual speakers used more path verbs (e.g., go, come, enter, exit, cross) as well as more manner modifiers (e.g., He is exiting the house *running*) and bare verbs. In contrast to, these results, Hohenstein et al.'s (2006) Spanish-English bilinguals used significantly more manner than path verbs and less manner modifiers in L1 Spanish; thus, clearly deviating from the Spanish monolinguals and becoming more like the English monolinguals in Naigles et al. (1998). These results which were explained in terms of L2 effects on L1 were obtained for both early and late bilinguals and if anything, they were more pronounced in the late bilinguals. In fact, Hohenstein et al. reported effects in the forward direction (i.e. L1 → L2) for manner verbs but they acknowledged that the effects in the backward direction (i.e. L2 → L1) were larger.

In another study, Wolff and Ventura (2009) investigated the effects of L2 English on the use of causation expressions in L1 Russian. The focus was on two types of causation expressions: CAUSE-type and ENABLE-type verbs. These two types of verbs differ with respect to the patient's/causee's (or entity acted upon) tendency towards the goal/result. In their study, Wolff and Ventura (2009) had English and Russian speakers choose a sentence that best described animations in which the causee's tendency was varied (i.e. once being in agreement with the affector's action, hence ENABLE-type verbs were appropriate in both languages; once opposing it, hence CAUSE-type verbs were appropriate in both languages; and once being ambiguous or unknown). When the causee's tendency was unknown, monolingual speakers of both languages chose descriptions that conformed to the semantics of their respective languages. In Russian, the tendency in this case is seen as internal to the causee (hence ENABLE-type verbs are appropriate) while in English, the tendency may be either internal or external to the causee (hence CAUSE-type verbs are appropriate). In line with this, English monolingual speakers were more likely to choose CAUSE-type verbs while Russian speakers tended to choose ENABLE-type verbs. On the other hand, responses by Russian-English and English-Russian bilinguals tested in their first language differed from monolingual speakers of their first language but were similar to or in the direction of monolingual speakers of their second language.

Other studies have shown that L2 also affects the way bilingual speakers encode path of motion in their L1. For example, Brown and Gullberg (2010; in press) showed that Japanese-English bilingual speakers at an intermediate level of proficiency lexicalized path information in their L1 using both verbs, like monolingual speakers of Japanese, and adverbials like monolingual English speakers. There was also an increased mention of the goal of motion in the L1 discourse of these bilinguals. Brown and Gullberg (in press) argue that the difference in bilinguals' encoding of path information results from the fact that these bilinguals construe motion events differently from monolingual speakers of their L1 which suggests a possible restructuring of linguistic conceptualization. In other words, knowledge of an L2 caused a shift in the bilinguals' attention to different information in expressing motion events as evidenced by the increased mention of Goal in their L1.

4.6 Effects of L2 on L1 on Cognition and Conceptualization

The studies reviewed in this section are based on the weak version of the linguistic relativity hypothesis. This version of the linguistic relativity theory claims that language affects thought. The basic assumption behind these studies is that under the influence of their mother tongues, monolingual speakers of different languages may have different views or perceptions of realities or they may differ in how they process and construe events and situations. When the monolingual acquires a second language that differs from or conflicts with his/her own mother tongue in the way it encodes information about the world, the bilingual's cognitive or conceptual system is changed.

For example, previous studies show that the way speakers of different languages perceive the number or amount of different types of entities hinges on how their languages mark number on different types of noun phrases. For example, Lucy (1992) found that monolingual speakers of English, a language that marks number on both animate and inanimate, discrete nouns but not inanimate, indiscrete nouns, judged that alternate pictures depicting countable objects and non-countable substances with changes in the number of animals and implements as significantly different from an original picture. On the other hand, speakers of Yucatec, a language in which only animate nouns are marked for number, regarded pictures with changes in the number of animate objects but not inanimate objects (whether discrete i.e. implements or indiscrete i.e. substances) were considered significantly different from originals. Athanasopoulos (2006) who used

Lucy's materials noted that both monolingual speakers of English and Japanese, a language which is more or less similar to Yucatec with respect to grammatical number marking, behaved similarly to Lucy's monolingual participants. Crucially, another group of advanced Japanese-English bilingual speakers showed a pattern of responses similar to that of the monolingual English speakers i.e. treating alternate pictures with changes in the number of both animate and inanimate discrete objects as different from the original pictures. Athanasopoulos attributed these findings to the influence of L2 English on the Japanese speakers' cognitive disposition towards implements causing it to change from the L1 norm to the L2 norm.

Monolingual speakers of English and Japanese are also different with regard to object classification preferences. For example, Imai and Gentner (1997) reported that monolingual speakers of English tended to group simple objects (i.e. objects with simple shape and no clear function) based on their shape (e.g., categorizing a cork pyramid with a plastic pyramid rather than a piece of cork) while Japanese monolingual speakers tended to classify objects based on their material (e.g., grouping a cork pyramid with a piece of wood rather than with a plastic pyramid)[16]. In comparison to the object classification preferences by the two monolinguals groups in Imai and Gentner (1997) Cook, Bassetti, Kasai, Sasaki, and Takahashi (2006) observed that Japanese-English bilinguals with 3-8 years Length of Residence (LOR) in an English-speaking country had object classification preferences similar to the monolingual English speakers i.e. they showed shaped-based categorization preferences. Cook et al. argued that these findings were suggestive of a restructuring process that occurs for second language users as a result of a acquiring a second language.

[16] Imai and Gentner (1997) and Imai (2000) argued that these are linguistically-driven differences.

The results of Cook et al. were replicated by two studies (Athanasopoulos, 2007; Athanasopoulos & Kasai, 2008). In both studies, English-like object categorization preferences were observed for high proficiency Japanese-English bilinguals. However, in the second study, the researchers used drawings of novel, artificial objects as standards with two alternates: a same-color but differently shaped object or a same-shape but different color object. The use of novel stimuli which could not be labeled with a count or mass noun arguably reduced possible verbal coding. Accordingly, Athanasopoulos and Kasai (2008) took these findings as clear-cut support for the claim that advanced proficiency in the L2 causes cognitive behavior in second language learners to shift towards an L2 pattern leading to "genuine cognitive reorganization or restructuring". Other studies also show that bilingual speakers of different languages differ from monolingual speakers of their native languages in prototypicality judgments. For example, Shimron and Chernitsky (1995) reported that in comparison to both native speakers of Spanish in Argentina and native speakers of Hebrew in Israel, Argentinean immigrants to Israel experienced a shift from L1 to L2 in typicality judgment for items in several categories (e.g., fruit, beverage, sport).

In the color categorization domain, Caskey-Sirmons and Hickerson (1977) noted that color categorization by monolingual speakers of Korean, Japanese, Hindi, Cantonese, and Mandarin was different from bilingual speakers of these languages with English as a second language. Specifically, there was a shift of category boundaries in L1 toward L2 boundaries in many cases. This finding led the authors to conclude that "the world view of bilinguals, whatever their first language, comes to resemble, to some degree, that of monolingual speakers of their second" (p. 365). In another study, Athanasopoulos (2009) reported that Greek-English bilinguals with 24 months or longer LOR in the UK judged two shades of blue across a color boundary that is demarcated in their native language as more perceptually similar. This L2-like pattern of color categorization was taken as support for cognitive/conceptual reorganization caused by L2 influence since in Greek a distinction is made between *ble* (darker shade) and *ghalazio* (lighter shade) whereas in English there is no such distinction.

Although the results of the studies in this section have been presented as evidence of the effects of the L2 on the L1, a word of caution is in order. It is generally the case that the acquisition of a second language in these studies took place in the target language country. This means that bilinguals are not only immersed in the target language environment but also the in L2 culture. Accordingly, the results of these studies may be interpreted as cultural (i.e. the result of cultural transition) rather than linguistic effects. In the next section, I present evidence for what appears to be the effects of the second language on the first in another area of linguistic competence, namely lexical processing.

4.7 Effects of L2 on L1 in Lexical Processing

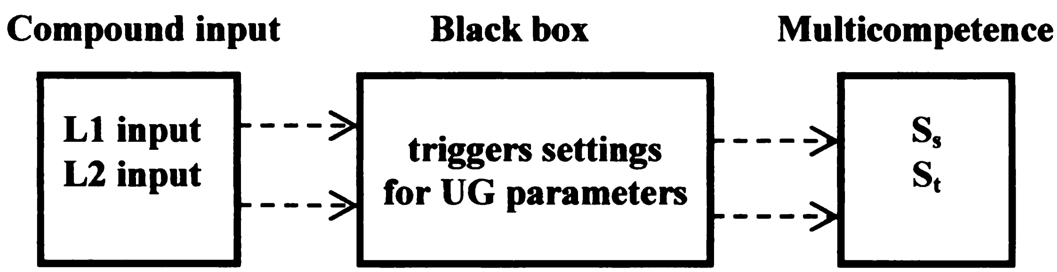
The above studies described in this chapter have enriched the field of crosslinguistic influence particularly in the area of reverse transfer. A close examination of the methodologies employed to elicit data in these studies reveals that apart from very few exceptions (e.g., Dussias, 2004) all measures used were off-line tasks (e.g., grammaticality judgment and sentence elicitations tasks). To get the big picture, however, research in this field needs to employ online tasks (e.g., time constrained behavioral measures, eye-tracking techniques and electrophysiological measures). The advantage of these RT-based measures is that they tap into more automatic, unconscious processes. In addition, past research has examined a variety of areas of linguistic knowledge, however only one study conducted by Qasem and Foote (2010), to my knowledge, has found what appears to be effects of the second language on the first with regard to lexical processing.

In this study, the researchers tested Arabic-English bilinguals using a translation recognition task (De Groot, 1992) to examine the predictions of the Revised Hierarchical Model (Kroll & Stewart, 1994), a developmental model of bilingual lexical activation. In the translation recognition task, bilingual participants are visually presented with two words, one corresponding to each of their languages, and their task is to determine whether they are translations of each other. In addition to correct translation pairs, e.g. *shoulder-katif,* in Qasem and Foote (2010), participants were presented with foils in which the second word was either morphologically-related (e.g. *takaatuf [unity]*) or orthographically-related (e.g. *kahf [cave]*) to the correct translation (e.g. *katif*). The authors found that words that were morphologically-related to the Arabic translation equivalent were indeed activated, e.g. *katif (shoulder)-takaatuf (unity)* providing further support for the idea that the Arabic lexicon is organized according to the morphological principle of a shared root. More importantly, the researchers observed that bilinguals with relatively high proficiency level in English (L2) experienced increased interference from orthographically-related distracters, e.g. *katif (shoulder)-kahf* (cave); a finding they attributed to the influence of the bilingual's second language on the first.

In short, the study above suggests that it is possible that higher proficiency (as measured by immersion experience) in the L2 may cause the lexical processing of the L1 by highly proficient bilinguals to be different from that of monolinguals or language learners with a low level of proficiency in the L2. In other words, with increasing proficiency in the L2, bilinguals seem to function in their L1 less like monolingual native speakers of their L1 and more like monolingual native speakers of their L2. It is important to note that the results of Qasem and Foote's study are only suggestive and not conclusive. The reason is that they used a translation recognition task i.e. a between language rather than a within language task. To address this issue, the present study employs a within language masked priming paradigm. As mentioned in chapter 2, this task is likely to tap very early automatic, unconscious processes that do not result from the conscious appreciation of the prime-target relationship. In the next section, which concludes this chapter, I am going to present a model that deals with reverse linguistic transfer.

4.8 Theoretical Framework for the Effects of L2 on L1

Crosslinguistic influence from the L2 to the L1 can be explained in reference to Cook's (1991; 1992) model of multicompetence (see Figure 4.1 below) defined as the compound state of a mind with two grammars. Specifically, first language acquisition leads to specific parameter-setting values of the Universal Grammar (UG). The introduction of a second language whose UG parameters differ from that of the first language causes these parameters settings to relax. However, during early stages of SLA, L1 parameter values are applied to L2 grammar by means of forward transfer. At an advanced stage of SLA, namely, when the L2 learner achieves high proficiency in the L2 and when the L2 becomes the primary language of communication for the bilingual speaker, the UG parameters may be reconfigured to reflect the L2 values even in L1.



(Ss = stable state; St = terminal state)

Figure 4.1: The multicompetence model
Adapted from Cook (1991, p. 112)

Although the multicompetence approach to second language acquisition provides useful insight into the field of SLA, this model is more related to core grammar (e.g., phonology and syntax) than it is to language processing. An alternative model that deals with bilingual syntactic processing is MacWhinney's Competition Model (1997; 2005). This model differs from the multicompetence approach in its reliance on universals of cognitive structure rather than the parameters of Universal Grammar. The Competition Model views second language learning as an input-driven process (in terms of cue validity and cue strength) in which transfer plays a primary role. Specifically, the Competition Model is a connectionist model which assumes that "all mental processing uses a common, interconnected set of cognitive structures" (MacWhinney, 1997; p. 119). According to this model, the processing system selects among various cues for form-function mappings based on cue weight and strength. For example, agent identification involves several cues like word order, agreement morphology, animacy, and case marking. Each of these cues is assigned a certain weight or strength; a value which differs crosslinguistically. The model predicts that in cases where the L1 and L2 cues differ, transfer will occur. This transfer will most likely be from the L1 to the L2 during early stages of SLA. In other words, L2 will be to a large extent "parasitic" on L1. With increasing L2 proficiency, there will be transfer in the opposite direction i.e. from the L2 to L1. For example, Su's (2001) study shows that in Chinese, animacy cues are given more weight when it comes to determining the sentence's argument structure while in English word order cues outrank animacy cues. In line with the predictions of the Competition Model, there were clear signs of change in L1 cue preferences for native speakers of Chinese with relatively high proficiency in English. Specifically, the L1 cue preferences for the Chinese-English bilinguals were becoming more like the L2 cue preferences showing more reliance on word order and less reliance on animacy for sentence interpretation in Chinese.

Even though MacWhinney's competition model applies to syntactic processing, it is a working model that has the potential of extending to other areas of grammatical knowledge and language processing. For monolingual speakers of Arabic and Arabic-dominant speakers, the strongest cue for morphological relatedness is the root which is a discontinuous consonantal morpheme. In other words, the sharing of the root morpheme is the cue that determines whether or not two words are lexically related. For monolingual speakers of English, morphological family membership is indicated by cues of transitional probability of linearly ordered continuous units which is often aided by semantics (Seidenberg, 1987). However, for a native speaker of Arabic with high proficiency in English, the linearity + semantics cue for morphological relatedness may outweigh the nonlinearity cue, leading to a decrease or absence of morphological priming effects between same-root L1 words which do not reflect the linearity + semantics property of the morphological systems in concatenative languages. Note here that the linearity + semantics cue can be used for English and to a lesser degree for Arabic too (in which case many morphologically related words will not be grouped together). In contrast, the non-linearity cue will fail for English. This means that the linearity + semantics will be a better candidate if the parser relies on a single system for processing.

As seen above, in both the multicompetence approach and the Competition Model, proficiency in a second language is an important factor that triggers the resetting of the UG parameters or leads to cue reranking, which causes L2 effects on L1 to emerge. However, proficiency is only one of several factors that contribute to the influence of the L2 on the L1. According to Pavlenko (2000), these factors which range from sociolinguistic, psycholinguistic, and linguistic variables include: the learner's age and onset of L2 acquisition (early vs. late), the learner's language-related goals and attitudes (positive vs. negative), proficiency level (low vs. high), individual differences (e.g., working memory, input sensitivity, phonetic mimicry ability), learning environment (immersion vs. foreign language classes), length and amount of language exposure, prestige level associated with the known languages (high vs. low), areas of linguistic competence and use (e.g., phonology, semantics, syntax), and the languages' typological similarity. The interaction of these variables causes the effects of L2 on L1 to be stronger in some situations than others. For example, it is more often than not that L2 effects on L1 in adults emerge with earlier age of L2 acquisition, higher L2 proficiency, extended periods of L2 exposure, a positive attitude towards the L2, or when the L2 is high language code, or when the L2 learner is in an immersion environment with relatively less contact with L1. Moreover, L1 phonology and semantics seem to be the most vulnerable to these effects in comparison to other areas of linguistic competence.

CHAPTER 5: THE EXPERIMENT

5.1 Overview and Research Questions

The review of previous research in Semitic languages reveals several research gaps. First, in past research in both Hebrew and Arabic, several studies obtained morphological priming effects for words that were either dissociated in semantics or in orthography. These results were taken as evidence for the decompositional view and the morpheme-based theories of Semitic morphology. However, no study ever investigated morphological priming effects when the morphologically-related words were dissociated in terms of both semantics and orthography. Second, past research in Semitic has not adequately addressed TL effects. Investigating TL-root similarity is important because it provides an answer to the question of whether or not such similarity is morphological or orthographic in nature and reveals how flexible Semitic languages may be with respect to positional coding requirements. Finally, previous lexical processing research in Semitic has never looked at an important variable which was shown to affect one's native language, namely knowledge of and proficiency in a second language.

In addressing the above research gaps, the present study investigates three research questions: (1) Is morphological priming in Arabic caused by form and semantic overlap or is it independent of these two factors? (2) Does the Arabic lexicon impose linearity constraints on the root consonants? (3) Does higher proficiency in a second language (English) have any consequences for lexical organization and processing in the first language (Arabic) of bilingual speakers?

With regard to the first research question, the goal of the current study is to investigate the effects of morphological similarity between same-root word pairs that are dissociated semantically and orthographically and to compare these effects to the effects of orthographic similarity between orthographic minimal pairs in L1 Arabic. In previous research (e.g., Boudelaa and Marslen-Wilson, 2005) the form overlap between morphologically related (i.e. same-root) primes and their corresponding targets was larger than that between the orthographically-related primes and their corresponding targets; hence, the morphological priming effects might have been attributed to orthographic form similarity. On the other hand, studies that manipulated the orthographic distance between the target and the related primes in the desired direction did that at the expense of the semantic relationship between the target and the morphologically-related prime such that the relation was semantically-transparent (e.g., Frost, Kugler, Deutsch, & Forster, 2005).

The orthographic distance between the target and the related primes in the present experiment was manipulated such that the form overlap between the target and the same-root prime was less than that between the target and the orthographically-related prime. Accordingly, the same-root primes were orthographically distanced from the target as much as possible. This way, orthographic form overlap between the target and the prime with which it shared the root morpheme was minimized in order to see if root similarity alone was responsible for the priming effects observed in the previous studies. In addition, to minimize any advantage caused by meaning similarity between target words and same-root primes in the present experiment, the prime-target pairs in this condition were semantically opaque. With these manipulations, morphological priming effects will provide clear-cut support for the root-and-pattern approach while orthographic priming effects will constitute strong evidence for the word-based approach to Semitic morphology.

As for the second research question, findings of previous research in Semitic languages show that a strict sequentiality requirement is imposed for the triliteral root (Velan & Frost, 2009; Perea, Abu Mallouh, & Carreiras, 2010). However, these studies either used nonword primes (i.e. Velan & Frost, 2009) or failed to control their stimuli, introducing many confounds like multimorphemic[17] primes and targets (i.e. Perea et al., 2010). In the present experiment, TL-priming effects are investigated using monomorphemic singular nouns; thus, avoiding all confounds in previous research.

As stated in Chapter 3, results from Qasem and Foote (2010) showed that there was a difference in L1 lexical processing between two groups at two proficiency levels in L2: one with low and one with high L2 proficiency. Accordingly, to answer the third research question, it is important to investigate masked priming in Arabic (L1) as it applies to bilingual speakers of Arabic and English with different proficiency levels in English (L2). If the answer to the third research question is affirmative then the priming pattern observed for highly proficient L2 speakers will be different from those who know little or no L2.

Unlike previous priming studies in Semitic, this study compares several types of relatedness using a within-target design. In other words, priming effects are investigated using the same (or constant) list of target words with different types of related primes. According to Rastle and Davis (2003) a within-target design has a greater power to detect differences between different experimental conditions.

[17] It should be noted that since lexemes in Arabic consist of two abstract morphemes (the root and the word pattern) they may be considered bimorphemic. However, since it is assumed that all words in Arabic consist of these two morphemic units, "multimorphemic words" refer to words that contain additional morphemes like clitics (e.g., subject or object affixes).

5.2 Method

5.2.1 Participants

Participants were 90 native speakers of Arabic L1 and learners or speakers of English L2 who were residing in the US at the time of testing. Discounting all past EFL experience, the participants' major contact with the English language began after their arrival to the US, which took place post-puberty. Accordingly, all participants were late learners of English. The participants were divided into two groups with regard to their proficiency in the second language (English): 45 low proficiency learners and 45 high proficiency bilinguals. The vast majority of participants came from the Detroit metropolitan area in Michigan, particularly, Dearborn; a city with the largest population of Arab-Americans in the US. Generally, the low proficiency learners in this study had very little knowledge of English (and hence were the closest thing one can find to monolinguals in the Arabic-speaking community from which subjects were recruited) whereas the high proficiency bilinguals had near-native speaker fluency in their second language. Several measures were used to determine proficiency level in the L2. First, low proficiency participants in this study were drawn from lower level ESL classes from several educational institutions in Michigan. Usually, ESL classes are aimed at enhancing the English language skills of international students whose TOEFL scores are less than 550 or anything equivalent to that score on other English proficiency tests. On the other hand, all of the high proficiency participants were members of professional organizations (e.g., school teachers, graduate students, university professors, and so on) where advanced knowledge of English that goes beyond ESL experience is required.

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Second, participants were assigned to high and low proficiency groups according to classroom experience. Only those participants who had learned English as a foreign language were assigned to the low proficiency group unless their total length of residence in the US was found to be equal or greater than 12 months. Bilinguals who learned English for an extended period of time in schools where English was the main language of instruction, whether in the US or elsewhere, were assigned to the higher proficiency group.

Third, proficiency level was also assessed by administering a language history and self-rating questionnaire in which participants described their language learning experience and rated their L2 reading, writing, speaking, and comprehension skills (see Appendix A). Given the variability of the nature and quality of classroom experience and since self-rating is a subjective measure for proficiency, no single measure mentioned above was used alone. In other words, the three measures mentioned above were used in combination with each other to determine L2 proficiency. It is noteworthy that low proficiency participants were fairly recent arrivals to the US (Length of Residence ≤ 7 months). This way, any immersion benefit was arguably minimized. Accordingly, length of residence (L of R) was used in combination with the above measures as an indication/ a criterion of proficiency level. Finally, whenever in doubt proficiency in English was verified by a reading aloud task where participants were asked to read a text of intermediate difficulty before the researcher. Table 5.1 below lists mean participant self-ratings in the L1 and L2, mean length of residence in the US, and mean age by group.

Table 5.1: Participant characteristics

Measure	Less proficient (n = 45)	More proficient (n = 45)
Self-ratings in L1 (Arabic)[a]		
Reading	6.3	6.2
Writing	6.3	5.9
Speaking	6.5	6.3
Comprehension	6.4	6.3
Self-ratings in L2 (English)		
Reading	3.6	6.1
Writing	3.2	5.8
Speaking	2.8	5.8
Comprehension	3.4	6.0
L of R in the US	3 months	18.8 yrs
Age	25.3	40.76

[a]Self-ratings were based on a 7-point scale ranging from 1 (very poor) to 7 (native or native-like)[18].

On average, the high proficiency participants reported they used more English than did the low proficiency participants in reading, watching TV and movies[19], internet browsing, text messaging, and listening to the radio. In fact, the high proficiency participants reported that they used more English than Arabic in all these activities. In addition to that, the high proficiency group reported that they used more English than did the low proficiency group with their family members and friends and in school or work.

5.2.2 Materials

A total of 63 target words were generated for this experiment. Each target, e.g. *safar* (traveling), was paired with a prime that fell in one of the following conditions (see Appendices B & C): (1) An identity prime i.e. a prime identical to the target, e.g. *safar*

[18] As can be noted, none of the participants' mean self-ratings in Arabic approached 7 (native or native-like). This may be due to the diaglossic situation in Arabic-speaking countries, which may cause speakers of Arabic to perceive themselves as less literate in Modern Standard Arabic than their dialects.

[19] Low proficiency participants reported that the L2 movies they watched were subtitled.

(traveling), (2) a prime that shares the same word pattern (and accordingly the number of letters) as the target and matches it in frequency, e.g. *baṭal* (hero), (3) a prime that shares the same root with the target but which is semantically opaque[20], e.g. *safaarah* (embassy), (4) An orthographically-related prime i.e. a prime that is similar in orthography to the target, e.g. *siḥr* (magic), (5) Transposed-letter (TL) prime i.e. a prime that has the same root letters as the target but in different order, e.g. *faras* (horse), (6) A control condition for both the identity and the word pattern conditions in which words match the identity primes on frequency and number of letters but are morphologically unrelated, (7) A control for the same-root prime that matches it in frequency and number of letters, (8) A control for the orthographically-related prime that matches it in frequency and number of letters, and (9) A control for the TL prime that matches it in frequency and number of letters. All control conditions included words that were orthographically, morphologically, and semantically unrelated to their corresponding target words. In addition, primes in all conditions were matched on length with their targets except in the morphological root condition and its control conditions in which most primes mismatched with their targets on number of letters. For convenience, the first condition will be referred to as the ID condition, the second as the WP condition, the third as the root condition, the fourth as the orthographic condition, and the fifth as the TL condition.

Orthographic similarity in the orthographic form condition was operationalized as sharing the same number of letters with the target word with an overlap of all but one root letter thus the prime words in this condition were never morphologically-related at the root level to their corresponding target words. The position of the different root letter

[20] Morphologically related and semantically less related primes were chosen in order to tease apart morphological and semantic effects. Semantic effects, however, are argued not to be existent at SOAs shorter than 50 ms (e.g., Frost, Deutsch & Frost, 1997; Rastle, Davis, & New 2004).

could be anywhere. It was not only the orthographic overlap between the primes and their corresponding targets in the orthographic form condition that distinguished these pairs but also the great amount of phonological similarity the corresponding pairs bore (rhymes, alliteration and assonance, etc).

The prime words in the root condition contained the same root as their corresponding target words. As a result, these morphologically-related primes-target pairs shared the same root letters. For two words to be derived from the same root, there will necessarily be a certain degree of orthographic overlap or form similarity in addition to a shared meaning component. In the present study, however, the primes and their corresponding targets in the root condition were semantically opaque and accordingly they were unrelated in meaning. The transparency of the prime-target semantic relationship in the morphological condition was determined in a pilot test in which a panel of 7 native speakers of Arabic with a relatively high literacy level in that language rated the meaning relatedness of a set of potential stimuli including the pairs used in this experiment on a 9-point scale that ranged from *unrelated* (a rating of 1) to *strongly related* (a rating of 9). The mean rating for the pairs in the root condition in this experiment was 2.99. In addition, the primes in the root condition were orthographically distanced from their corresponding targets to the maximum possible degree. In fact, the stimuli were generated such that the orthographic overlap between the primes and their corresponding targets in the root condition was smaller than that between the primes and these targets in the orthographic condition (see Appendix B).

All the primes in the root condition differed from the corresponding targets by a minimum of two non-root letters. Using the Levenshtein Edit Distance calculator[21], the orthographic distance between the prime-target pairs in the root condition was found to be as follows: twenty-five primes differed by 2 letters from their corresponding targets, twenty-nine words differed by 3 letters, seven words differed by 4 letters and two words differed by 5 letters.

The words in the TL condition contained the exact same letters as the corresponding target words but in a different linear order. Using the same terminology as in Prunet, Béland, & Idrissi (2000), there are two kinds of transpositions: bipartite and tripartite. Bipartite transposition occurs when two consonants swap positions while a third remains in situ (i.e. 213, 132 and 321). Tripartite transposition refers to orderings in which all three consonants are displaced (i.e. 231 and 312). Bipartite transposed letters may be adjacent (i.e. 213 and 132) or nonadjacent (i.e. 321). In this experiment, there were 28 tripartite transpositions and 35 bipartite transpositions. Sixteen bipartite transpositions involved nonadjacent root consonants and 19 involved adjacent letters in the orthographic written form. Of 19 bipartite adjacent transpositions, 9 transpositions occurred at the word initial position, 5 transpositions occurred word-medially, and 5 occurred word-finally. Overall, 12 bipartite adjacent transpositions crossed a word pattern vowel and 7 transpositions did not. It is noteworthy that the Arabic spelling system/orthography is characterized by numerous instances of allographic variation. The surface realization of many consonants is dependent on the position in which these consonants occur within a word. For example, the consonant /k/ is realized as ك word-

[21] The Levenshtein Edit Distance calculator can be found at: http://www.miislita.com/searchito/levenshtein-edit-distance.html

initially and as ك word-finally. Another example would be the consonant /ʤ/ which is realized as جـ word-initially and as ج word-finally. Allographic variation stems from the cursive nature of the Arabic writing system in which most letters are joined to adjacent letters (apart from very rare exceptions like دور or ذرة). This feature of the Arabic writing system made it impossible to find a sufficient number of real word anagrams that did not include allographic variation.

As for the WP condition, the primes were related to the target words by virtue of a shared word pattern. The WP condition was included in order to see if there are is any WP priming at an SOA of 32 ms and to compare the effects of pairs with shared WP to the effects of another type of morphologically-related pairs, namely same-root words. It is noteworthy that 27 primes in the orthographic condition and 37 primes in the transposition condition shared a word pattern with their corresponding target words. It was next to impossible to avoid shared WP in these cases due to the lack of other words that were orthographically-related (i.e. minimal pairs) or were anagrams but which did not share a word pattern with the target words.

The stimulus set for one target word *safar* (traveling) is given in Table 5.2. The word *baṭal* (hero) and its target *safar* are morphologically related by virtue of sharing the same word pattern, namely CaCaC. The word *safaarah* (embassy) is also morphologically related to the word *safar*. Both words are derived from the same tri-consonantal root i.e. *s-f-r*, which denotes the notion of travel. In one realization of the root, namely the word *safar* (traveling), the meaning is central such that the word carries the same meaning of the root. In another realization of the root, however, namely the word *safaarah*, the meaning of the word is further distanced from the common core meaning of the root such that it can only be associated to it indirectly through logical reasoning. The word *safaarah* (embassy) denotes a place abroad located away from one's homeland. The prime *siħr* (magic) is orthographically similar to the target word *safar*. Both of these written Arabic word forms share all but one root letter. Finally, the word *faras* (horse) contains the same root letters as the target *safar* but in a different linear order; thus, it is an anagram of its target. It is important to note that changing one root letter or the linear order of the root letters results in a completely different root.

Table 5.2: Example stimulus set for the target-سفر (*safar*) [travel]

Condition	Prime	Transcription	Meaning
WP	بطل	baṭal	hero
Root	سفارة	safaarah	embassy
Orthographic	سحر	siħr	magic
TL	فرس	faras	horse

For each word in the root, orthographic, and TL conditions, a control unrelated to its target which matches the prime on word length and frequency was generated. Since primes in the ID and WP conditions were matched on frequency and length, one list of unrelated primes matched with the ID and WP primes on word length and frequency served as a control for both of these conditions. Frequency and word length matching was done word-for-word rather than listwise. Word length was determined by the number of letters the word contains. As for word frequency, the Aralex database (Boudelaa & Marslen-Wilson, 2010) was consulted to obtain the orthographic frequency for the words used in this experiment. Since the lexical properties of words including length and frequency varied within and across conditions, it was necessary to generate a control for each prime in order to cancel out any effects attributable to these factors on the masked priming task. Table 5.3 provides the mean word length in number of letters, the mean orthographic frequency for the primes in each condition and their matched controls. Word length in terms of number of letters was deliberately made identical for each prime-control pair. A two-tailed, independent-samples t test to compare the orthographic frequency values of the primes with their corresponding controls in each condition showed that there were no statistically significant differences: ID condition, $t(124) = 0.052, p = .959$; WP condition, $t(124) = 0.008, p = .994$; root condition, $t(124) = 0.135, p = .893$; orthographic condition, $t(124) = 0.019, p = .985$; TL condition, $t(124) = 0.074, p = .941$.

Table 5.3: Lexical properties of the primes and their controls in each condition

	Prime		Control	
Condition	Length	Frequency	Length	Frequency
ID	3.762	40.650	3.762	40.017
WP	3.762	40.116	3.762	40.017
Root	5.524	29.142	5.524	27.532
Orthographic	3.762	29.740	3.762	29.539
TL	3.762	27.569	3.762	26.434

Thirty-five unrelated word-word pairs were generated to serve as fillers. This way, the proportion of related prime-target words was diluted to 36%. Finally, a list of 98 target nonwords was created and these were paired with 91 word primes and 7 nonword primes. Of these, thirty-five pairs were constructed so as to mimic the form overlap between the word-word pairs in the five experimental test conditions: ID (hence the 7 nonword-nonword pairs), WP, root, orthographic, and TL conditions. The remaining 63 word-nonword pairs were unrelated in form just like the word-word pairs in the experimental control and filler conditions. The nonwords in the experiment were created from real words by changing one letter only. All nonwords were orthographically and phonologically legal sequences and accordingly were permissible but non-existent words in the language.

It is worth mentioning that in Modern Standard Arabic, short vowels and gemination of consonants are both expressed by the use of various diacritic marks on the word. Nevertheless, diacritic marks are not generally used in print except infrequently in poetry and religious texts. Given this, there exist some words that are ambiguous between two or more readings depending on the type of vowels the word contains. For example, the same orthographic form, if diacritically unmarked, can be ambiguous between a verb and a noun reading and/ or have different unrelated meanings. In this case, diacritic marks are used to disambiguate the orthographic word form such that the other unintended readings are eliminated. Alternatively and usually, the context is used to restrict the ambiguous, diacritically unmarked orthographic word form to the intended reading. For this reason and in order to avoid the use of diacritic marks, the stimuli were selected very carefully such that each orthographic word form had one and only one frequent reading. In addition, all words included in the experiment were either singular or mass nouns only. In fact, in a separate test, participants reading isolated words that were ambiguous between a noun and a verb reading and which were judged as having equal frequency preferred the noun reading.

5.2.3 Design

A total of 196 targets (98 target words and 98 target nonwords) were included in the experiment. Nine counterbalanced experimental lists were generated using a Latin square design. Each list included 98 prime-target word pairs and 98 prime-target nonword pairs. The primes in the experimental word-word pairs belonged to one of the following conditions: ID condition, WP condition, root condition, orthographic form condition, TL condition, ID/WP control condition, root condition, orthographic control condition, and TL-control condition. In each list, every condition had a share of 7 primes. The target part of the experimental word-word pairs along with the filler word-word and prime-target nonword pairs was one and the same for all participants; however, it was the word prime part in the word-word pairs that was different for the participants across lists. The lists were constructed such that every participant saw only one type of prime for a given target word.

5.2.4 Procedure

Participants were tested individually. The experiment consisted of three visual events: A forward pattern mask consisting of a series of eight pilcrow signs (¶¶¶¶¶¶¶¶) displayed for 500 milliseconds, a prime that appeared for 32 milliseconds immediately followed by the target that appeared and remained on the screen until the participant made a response. It is noteworthy that at an SOA of 32 ms, the prime is never available for report. An SOA of 32 ms was chosen since at this time window no semantic (generally speaking) and/or word pattern effects have been previously reported (Boudelaa & Marslen-Wilson, 2005). Due to the lack of lowercase vs. uppercase distinction in Arabic, the prime was written in 24 font size and the target in 34 font size to avoid prime-target visual overlap. Both primes and targets were written using traditional Arabic font. Participants were instructed to determine whether what appeared on the screen was a word or a nonword. They were asked to press a "yes" button for a word and a "no" button for a nonword. Participants were instructed in advance to respond as quickly and accurately as possible. Response Times (RTs) and Response Accuracy were recorded. Response Times (RTs) were recorded from the onset of the presentation of the target item. Target items were randomized for each participant in the test part of the experiment by the experimentation software. The vast majority of testing was conducted using two Intel(R) Core 2 Duo PCs. The presentation of items and the recording of RTs and accuracy were carried out using the DMDX display software system (Forster & Forster, 2003)[22]. A total of 10 practice trials were administered before the experimental trials for each participant.

Priming effects were measured by comparing the reaction times (RTs) to the target word in the critical conditions (WP, root, orthographic, and TL) to the RTs in both the ID, in which full priming or maximum facilitation is typical and expected, and the RTs in the control conditions, in which little or no priming or facilitation is expected. If the RTs for the target words in the critical conditions are found to be in the near vicinity of the RTs in the ID condition, then full priming is said to have occurred. If, on the other hand, the RTs in the critical condition are close to the RTs in the corresponding control conditions, then no priming would have resulted.

[22] DMDX display system software package can be obtained for free from http://www.u.arizona.edu/~kforster/dmdx/dmdx.htm

5.3 Results

The RT analyses included correct responses only, whereas the accuracy analyses included both correct and incorrect responses. No participant had an error rate on the experimental task equal to or greater than 25% which was set as the threshold point for exclusion from the analysis (with only two participants whose error rate were over 15%). High (1750 ms) and low (200 ms) cutoff points were set to remove outliers. RTs two standard deviations above or below each participant's mean RT were also excluded from the analyses. Finally, all display errors were discarded and removed from the analyses; altogether, these data trimming procedures affected 8.1% of the data.

Mean RTs and percentage accuracy for the five test conditions are provided in Table 5.4. The differences in the mean RTs and accuracy between the related test trials and their unrelated, matched controls were calculated and are also presented in Table 5.4 as the amount of priming. These priming values serve as a measurement of the influence, if any, of each type of relatedness on the speed and accuracy of word recognition by each group of participants. Separate mixed ANOVAs were performed on RTs and accuracy both by-participant and by-item for each condition to see whether the amount of priming for each condition was statistically significant and to find out if there was any significant difference between the performance of the two groups in each of the five conditions. In the by-participant analyses, a 2×2 design was used, with proficiency (high or low) as the between-participants factor and relatedness (related/test vs. unrelated/control) as the within-participants factor, whereas, in the by-item analyses, relatedness was the between-items factor and proficiency was the within items factor. The results will now be considered for each condition separately.

Table 5.4: Mean RTs (ms) and percentage accuracy of translation recognition by condition and group

Condition	Low proficiency		High proficiency	
	RT	Accuracy	RT	Accuracy
ID				
Test	790.4 (143.4)	93.9% (12.3)	768.6 (145.5)	96% (7.3)
Control	852.7 (164.0)	95.9% (6.9)	796.2 (164.6)	96% (7.3)
Priming	62.3	2%	27.5	0.0%
WP				
Test	818.8 (145.3)	95.8% (10.3)	801.6 (168.1)	97.2% (7.5)
Control	852.7 (164.0)	95.9% (6.9)	796.2 (164.6)	96% (7.3)
Priming	33.9	1%	-5.4	-1.2%
Root				
Test	785.5 (128.4)	93.8% (10.4)	792.9 (149.6)	95.6% (9.7)
Control	843.6 (152.4)	95.6% (8.4)	786.6 (142.0)	96.0% (8.2)
Priming	58.1	1.8%	-6.3	0.5%
Orthographic				
Test	821.3 (164.3)	94.4% (9.1)	795.2 (157.1)	97.7% (5.5)
Control	828.7 (134.3)	95.3% (8.8)	798.5 (173.7)	97.4% (7.3)
Priming	7.4	0.9%	3.3	-0.3%
TL				
Test	831.9 (148.0)	97.0 (6.7)	785.8 (188.5)	95.6% (7.6)
Control	837.9 (176.5)	96.1 (8.6)	805.6 (144.0)	96.7% (7.0)
Priming	6	-1.0%	19.7	1.1%

Note. Standard deviations are in parentheses. Priming is the difference between the test and the control conditions.

5.3.1. ID Condition (safar-safar "travel")

RTs. As Table 5.4 illustrates, there is ID priming for both the high- and the low-proficiency participants, with the latter group showing numerically greater magnitude of priming than the former. By-participant and by-item analyses revealed that there was a main effect of relatedness (test vs. control) such that all participants, regardless of their proficiency in the L2 were faster in target recognition when the target word was preceded by an identical prime than when it was preceded by an unrelated matched control, F_1 (1,

88) = 11.28, $p < .05$ and F_2 (1, 124) = 4.59, $p < .05$. An interaction between relatedness and group did not reach significance in either the participant or the item analysis, F_1 (1, 88) = 1.687, $p = .197$ and F_2 (1, 124) = 2.66, $p = .105$, suggesting that the two groups of participants did not significantly differ in the amount of priming, although, numerically, the low proficiency participants showed more priming. There was no effect of proficiency in the by-participant analysis, F_1 (1, 88) = 1.733, $p = .191$. This lack of statistical significance suggests that the time it took participants to recognize a target word preceded by an identical or a control prime was not moderated by proficiency. The by-item analysis yielded results that did not entirely match the results obtained from the by-participant analysis; specifically, there was a main effect of proficiency such that the high-proficiency participants were significantly faster than low-proficiency participants in lexical decisions in this condition F_2 (1, 124) = 6.05, $p < .05$.

Accuracy. The results obtained from by-participant and by-item accuracy analyses show that there is no effect of relatedness, F_1 (1, 88) = .75, $p = .388$ and F_2 (1, 124) = .16, $p = .692$. This means that all participants, regardless of the proficiency in the L2, were equally accurate in target recognition whether it is preceded by an ID prime or an unrelated matched control. There was no interaction between relatedness and proficiency in ether the participant or item analyses, F_1 (1, 88) = .83, $p = .366$ and F_2 (1, 124) = .73, $p = .394$. Furthermore, the main effect of proficiency did not reach significance in the by-participant analysis F_1 (1, 88) = .56, $p = .457$ but it was significant in the by-item analysis, F_2 (1, 124) = 7.44, $p < .05$, meaning that the high proficiency participants were more accurate overall than the low proficiency participants.

5.3.2 WP Condition (baṭal "hero"- safar "travel")

RTs. Both by-participant and by-item statistical analyses of RTs in the WP condition revealed that there was no effect of relatedness, F_1 (1, 88) = 1.23, p = .270 and F_2 (1, 124) = .62, p = .43. This lack of effect was not qualified by an interaction between relatedness and proficiency in either by-participant or by-item analyses, F_1 (1, 88) = 2.35, p = .129 and F_2 (1, 124) = 3.86, p = .052. In statistical terms, neither low proficiency nor high proficiency groups showed priming effects for in the WP condition, although, as Table 5.4 shows, there was numerical facilitation for the low proficiency group and small amount of inhibition for the high proficiency group. The by-participant analysis indicates that there was no effect of proficiency F_1 (1, 88) = 1.38, p = .243. In contrast, the by-item analysis shows a main effect of proficiency F_2 (1, 124) = 5.23, p < .05, with the high proficiency participants exhibiting faster RTs than the low proficiency participants.

Accuracy. In terms of accuracy, by-participant and by-item analyses show that the effect of relatedness is not significant, F_1 (1, 88) = .22, p = .638 and F_2 (1, 124) = .36, p = .550. Similarly, the interaction of relatedness and proficiency was not significant in either by-participant and by-item analyses, F_1 (1, 88) = .284, p = .595 and F_2 (1, 124) = .27, p = .604. Finally, by-participant and by-item analyses show that there was no main effect of proficiency, F_1 (1, 88) = .37, p = .546 and F_2 (1, 124) = .45, p = .505. The lack of significant effects in the accuracy data in this condition means target recognition was equally accurate whether preceded by related or unrelated primes and both by low and high proficiency participants.

5.3.3 Root Condition (safaarah "embassy"- safar "travel")

RTs. Data from the root condition show that there was facilitation for the low proficiency but not the high proficiency participants. By-participant and by-item analyses show that there was no effect of relatedness, F_1 (1, 88) = 3.62, p = .06 and F_2 (1, 124) = .892, p = .347. However, the interaction between relatedness and proficiency was significant in the by-participant analysis, F_1 (1, 88) = 5.61, p < .05, and missed significance by a small margin in the by-item analysis, F_2 (1, 124) = 3.73, p = .056. This indicates that the two proficiency groups were affected differently by relatedness. Specifically, there was priming in the low proficiency but not the high proficiency group. Finally, there was no effect of proficiency in either the by-participant or the by-item analyses, F_1 (1, 88) = .84, p = .361 and F_2 (1, 124) = 3.25, p = .074, meaning that the time to recognize the target word was similar across both groups of participants.

Accuracy. Participant and item ANOVAs on accuracy data in this condition did not yield any significant effects. By-participant and by-item analyses reveal that the effect of relatedness was not significant, F_1 (1, 88) = .77, p = .383 and F_2 (1, 124) = .606, p = .438. There was no interaction between relatedness and proficiency in either by-participant or by-item analyses, F_1 (1, 88) = .25, p = .615 and F_2 (1, 124) = .63, p = .430. Likewise, the effect of proficiency was not significant in either by-participant or by-item analyses, F_1 (1, 88) = .535, p = .467 and F_2 (1, 124) = 1.195, p = .277. The lack of significance in this condition suggests that there was no difference between the two proficiency groups in terms of their accuracy of target recognition irrespective of the prime type.

5.3.4 Orthographic Condition (siħr "magic"- safar "travel")

RTs. As can be seen from Table 5.4, there were small facilitation effects in this condition for both low and high proficiency groups. However, by-participant and by-item analyses show that the effect of relatedness is not significant, F_1 (1, 88) = .13, p = .717 and F_2 (1, 124) = .07, p = .791. The interaction between relatedness and proficiency was not significant in either the by-participant or the by item analysis, F_1 (1, 88) = .02, p = .889 and F_2 (1, 124) = .02, p = .892. This suggests that the pattern of responses in this condition was very similar across the two proficiency groups. As for the speed, by-participant analysis reveals that there was no effect of proficiency F_1 (1, 88) = .89, p = .348 whereas by-item analysis shows a barely significant effect of proficiency F_2 (1, 124) = 4.20, p < .05, indicating that the high proficiency participants were generally faster than the low proficiency participants.

Accuracy. By-participant and by-item analyses show there was no effect of relatedness, F_1 (1, 88) = .11, p = .740 and F_2 (1, 124) = .16, p = .692, meaning that target recognition was equally accurate whether it was preceded by related or unrelated prime. The effect of relatedness was not moderated by an interaction with proficiency, F_1 (1, 88) = .41, p = .522 and F_2 (1, 124) = .73, p = .394. Finally, there was a main effect of proficiency: The high proficiency participants were more accurate in general than the low proficiency participants. This effect was marginal in the by-participant analysis but not the by-item analysis, F_1 (1, 88) = 3.98, p < .05 (p = .049) and F_2 (1, 124) = 7.44, p < .05.

5.3.5 TL Condition (faras "horse"- safar "travel")

RTs. Although the high proficiency participants show more numerical facilitation effects in this condition, the effect of relatedness in both by-participant and by-item analyses was not significant, F_1 (1, 88) = .74, p = .391 and F_2 (1, 124) = .53, p = .469. The effect of relatedness was not qualified by an interaction with proficiency F_1 (1, 88) = .21, p = .645 and F_2 (1, 124) = .19, p = .661, meaning that both groups did not differ significantly in this condition. Finally, there was no effect of proficiency in the by-participant analysis, F_1 (1, 88) = 1.55, p = .217. In contrast, the by-item analysis shows a main effect of proficiency, F_2 (1, 124) = 8.24, $p < .05$, which indicates that the low proficiency participants had slower RTs than the high proficiency participants.

Accuracy. The results obtained from by-participant and by-item accuracy analyses show that there was no effect of relatedness, F_1 (1, 88) = .006, p = .941 and F_2 (1, 124) = .001, p = .978. This indicates that accuracy was a near match for the test and the control pairs. Additionally, the interaction between relatedness and proficiency was not significant, F_1 (1, 88) = .98, p = .326 and F_2 (1, 124) = .36, p = .547. In other words, the performance of the two proficiency groups did not significantly differ in terms of their accuracy in the related versus unrelated pairs. Finally, the main effect of proficiency did not reach significance, F_1 (1, 88) = .14, p = .709 and F_2 (1, 124) = .196, p = .659, which indicates that the low and the high proficiency participants did not significantly differ in their overall accuracy in this condition.

5.4 Summary of Results

The pattern of priming (defined as the difference between the test and control conditions) obtained for the two groups of participants reveal many important findings. The results of the low proficiency group show there were robust priming effects in the root condition (58.1 ms); the effect was numerically close to the priming in the ID condition (62.3 ms), indicating full priming. The other type of morphological relatedness, namely the WP condition yielded 33.9 ms facilitation which, although it did not reach significance, was equivalent to almost half of the full priming effects (i.e. ID priming) in magnitude, a result characteristic of partial priming. As for the other form conditions, namely the orthographic and TL conditions, there were negligible facilitation effects (7.4 and 6 ms for the orthographic and the TL conditions, respectively). Turning to the results of the high proficiency participants, only the ID condition yielded significant priming effects (27.5 ms). Neither of the two morphological conditions (WP and root conditions) nor the orthographic condition yielded any noteworthy facilitatory priming effects. In contrast, the TL-condition produced numerical facilitation (19.7 ms) which was closer to the priming in the ID condition than any other condition for that group.

A comparison between the two groups of participants shows that priming in the ID condition yielded significant priming for both groups alike. The two groups significantly differed in the amount of priming obtained in the root condition with the low proficiency participants showing a prominently large magnitude of facilitation while the high proficiency group exhibiting a tendency towards inhibition (-6.3 ms). In the WP condition, there was a large numerical difference between the priming effects for the two proficiency groups (39.3 ms). The two proficiency groups did not differ in the amount of priming in the orthographic condition. Interestingly, the high proficiency participants had an edge, numerically speaking, over the low proficiency group in the TL condition with a difference of 13.7 ms. In terms of overall speed, the high proficiency group was numerically faster than low proficiency participants. This difference reached statistical significance in the by-item analyses in the ID, WP, orthographic and TL conditions but not the root condition. With regard to accuracy, the high proficiency participants were more accurate than the low proficiency participants in all but one condition, namely the TL condition. However, the only difference that reached significance occurred in the orthographic condition. The next chapter provides a discussion and the theoretical implications of these results as well as suggestions for future research.

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CHAPTER 6: DISCUSION AND CONCLUSION

6.1 Introduction

Previous research in Arabic and Hebrew has established that morphological priming effects cannot be reduced to orthographic or semantic overlap (e.g., Boudelaa and Marslen Wilson, 2005; Frost, Kugler, Deutsch, & Forster, 2005). In these studies, strong priming effects were obtained for words that shared the same root and even when the prime-target pairs were semantically-opaque. On the other hand, orthographically-related but morphologically unrelated words did not yield significant priming effects even for word pairs that differed in one root letter. As regards the word pattern, the evidence was mixed. In Hebrew, previous research (e.g., Frost, Deutsch & Frost, 1997; Deutsch, Frost & Forster, 1998; Frost, Deutsch, Giboa, Tennebaum & Marslen-Wilson, 2000) shows priming for verbal but not nominal patterns while in Arabic, some studies (e.g., Boudelaa & Marslen-Wilson, 2005) obtained priming for both verbal and nominal patterns at 48 ms but not at 32 ms SOAs while other studies (e.g., Mahfoudhi, 2007) reported no priming effects for the verbal pattern. The conclusion from these studies is that morphological identity as defined by a shared root rather than orthographic similarity is the basis of lexical organization in Semitic languages. These findings were taken as strong support for the decompositional view of Semitic morphology (e.g., Taft, 1981; Taft & Forster, 1975) on which the root-and-pattern framework rests leaving the word-based stance hard to sustain as no evidence has been obtained for the full-listing hypothesis (e.g., Butterworth, 1983).

Although the findings from the above mentioned studies were used as evidence that lexical neighborhood is governed by morphological rather than orthographic principles, the results could be disputed on the grounds that form similarity was greater for the same-root pairs than the orthographically-related pairs in all but one study (viz. Frost et al., 2005). However, in this study, morphological priming effects could have been attributed to the great semantic overlap which the same-root but not the orthographically related pairs enjoyed.

One type of form-based priming in Semitic languages that has received little attention in psycholinguistic research is transposed-letter (TL) priming. TL pairs provide a special case of form similarity in which two words share all of their root consonants but which appear in different order. Investigating this type of form similarity is important for knowing whether Semitic languages impose any positional requirements with regard to root consonants. Previous research on TL-effects in Semitic languages (e.g., Velan and Frost, 2009; Perea, Abu Mallouh, & Carreiras, 2010) shows no TL priming effects, which suggests Semitic languages impose a strict position coding requirement on the root consonants. However, in these studies either nonword primes were used (Velan and Frost, 2009) or the stimuli were severely confounded (Perea et al., 2010).

In previous research, lexical processing in L1 has been investigated without taking into account a seemingly important variable, namely knowledge of and proficiency in a second language (e.g., Frost et al., 2005). For late L2 learners who are at the beginning stages of L2 acquisition, transfer and interference effects are more likely to be in the L1→L2 direction. However, with increased proficiency in the L2, transfer in the reverse direction may start to emerge particularly in areas where the L2 and the L1 clearly diverge. In most cases, transfer will be in areas of core grammar like syntax, phonology, and semantics. In other cases, transfer will also leak into online processing.

One of the consequences of reverse transfer is to observe L2-like L1 categories and processing patterns.

In addressing the shortcomings of previous research, the goal of the present study was threefold. First, the current study aimed to investigate the validity of two competing theories of Semitic morphology: the root-based/decompositional view and the word-based/full listing view. The second goal of this study was to investigate whether or not Semitic languages (Arabic in this case) impose any positional requirements with respect to the consonants of the root morpheme. Finally, the present study examined if proficiency in L2 English would have any consequences for lexical processing in L1 Arabic.

6.2 The Experiment: Summary and Findings

An experiment was designed to address the above mentioned goals which were translated into the following three research questions: (1) Is root priming in Arabic caused by form and semantic overlap or is it independent of these two factors? (2) Does the Arabic lexicon impose linearity constraints on the root consonants? (3) Does higher proficiency in a second language (English) have any consequences for lexical organization and processing in the first language (Arabic) of bilingual speakers?

The experiment presented above included five test conditions and four control conditions. Unique to this study is the comparison of several types of relatedness using a within-target design This means that different types of related primes are paired with the same list of targets. The reason for this manipulation was to avoid variability within the data that results from the use of different prime-target pairs for each condition and to be able to directly compare different types of relatedness. Finally, the present experiment used a 32 ms SOA in which no WP effects have been reported (see Boudelaa & Marslen-Wilson, 2005).

6.2.1 Decompositional vs. Full Listing View of Semitic Morphology

With regard to the first research question, the aim of the experiment presented above was to investigate the effects of morphological similarity between same-root word pairs that were dissociated semantically and orthographically and to compare these effects to the effects of orthographic similarity between orthographic minimal pairs in L1 Arabic. In contrast to previous research, the form overlap between the target words and the same-root primes was less than that between the targets and the orthographically-related primes. Additionally, the primes in the root condition were screened for semantic transparency such that only semantically-opaque pairs were included. All in all, the manipulations in this study ensured a fair comparison between the two types of primes (i.e. the morphologically related and the orthographically-related).

The results of the experiment showed strong root priming effects in low proficiency participants (58.1 ms). These priming effects were numerically very close to identity priming (62.3 ms). On the other hand, orthographic priming effects were weak and non-significant (7.4 ms). These results confirm and lend stronger support to previous findings which suggested that root priming in Semitic languages is not the combined outcome of the form plus meaning overlap that same-root words have.

Turning to the other type of morphological relatedness, namely shared WP, we find numerical facilitation in the low proficiency participants which did not reach significance (33.9 ms). The fact that there were numerical priming effects for the low proficiency group in this condition may be taken as evidence for the independent morphemic status of WP morphemes. However, note that in both the orthographic and TL conditions many primes shared WP with their corresponding targets; nevertheless, the priming obtained in these conditions was negligible. As mentioned above, Boudelaa and Marslen-Wilson (2005) did not find WP priming at 32 ms SOA. Since WPs consist primarily of vowels which provide the phonological structure of the surface form and which in most cases are not specified in the writing system, their processing may require access of phonological information. Therefore, the brief exposure of the prime may not have allowed sufficient time for phonological activation to take place. Accordingly, it is possible that with larger SOAs, WP effects will be larger in magnitude. However, it is also expected that root priming effects will be stronger than WP priming effects irrespective of the SOA due to the primacy of the root morpheme over the WP morpheme in determining the meaning and the orthographic shape of the word. Additionally, following Boudelaa and Marslen-Wilson (2005), words sharing a root morpheme constitute a more uniform morphological family compared to words with shared word patterns and as such root-based priming will always be larger than WP-based priming.

Together, the results of the root, WP, and orthographic form conditions provide strong support for the decompositional account of Semitic morphology. Since the morphemic status of the root and word pattern was firmly established, the root-based theory of Semitic morphology is validated beyond any doubt. If Semitic morphology were word-based rather than root-based, we would have seen no priming for the morphologically-related words and significant priming for the orthographically related words but this was not the case. This means that in speakers of Semitic languages, words are grouped together via a shared representation of the root morpheme irrespective of the semantic and form overlap that exists amongst these words. If, however, lexical organization is not based on form and semantic overlap, what is it based on? It stands to reason that same-root words with similar form and meaning are stored together in lexical space, but it is less clear why same-root words that are semantically and orthographically dissociated are grouped together.

In most cases, Semitic words derived from the same root have transparent orthographic and semantic relationships with each other. It is the recognition of these relationships that causes these words to be associated together. It is possible that with time, morphologically-based lexical organization becomes established in the child acquiring a Semitic language, and expands to include words which despite sharing the same root have impoverished semantic and form relationships with the prototypical members of their the morphological family.

6.2.2 Positional Coding in Semitic Roots

To investigate the second research question, the experiment in this study included a Transposed-Letter (TL) condition. The TL condition was investigated in the context of real words. All the words in the TL-priming (and other conditions) were singular nouns; thus, all confounds in previous research were avoided. The results of the low proficiency participants showed a small and non-significant 6 ms priming in this condition. It is noteworthy that Velan and Frost (2009) reported significant inhibitory effects by primes consisting of TL- existing roots. Likewise, Perea et al. (2010) found inhibition effects by TL-word primes; however, these effects were small and did not reach significance. In fact, Velan and Frost (2009) attributed the inhibitory effects for TL-existing roots to lexical competition. In the present study, the magnitude of priming obtained in the TL condition and the single-letter substitution condition (orthographic condition) were very similar for the low proficiency participants. This suggests that anagrams simply represent another type of orthographic similarity in which all root consonants are shared across the prime and target. Thus, root family membership is not only defined in terms of the identity of the root consonants but also in terms of the relative position of these letters.

The absence of TL-effects in Semitic languages indicates that contrary to Perea and Lupker's (2003a, b) proposal for Indo-European languages, letter identity and letter position information in Semitic languages are either inseparable or that their activation occurs concurrently. Additionally, the finding that TL-effects are no stronger than orthographic priming effects suggests that only position-specific letter coding schemes (e.g., Rumelhart & McClelland, 1982), in which TL primes and substitution primes are assigned equal weights, can account for the lack of priming by these two types of primes in the present study whereas open-bigram letter coding schemes such as the SERIOL model (Whitney, 2001; Grainger & Whitney, 2004) are not able to offer adequate explanations.

The results of the TL condition in the present study have to be taken with caution, however. First of all, 57 out of 63 pairs involved letter transpositions at a word boundary (word-initial and/or word-final positions). Several studies in English and Spanish mentioned in Chapter 3 found that internal transpositions were more effective than external (i.e. word-initial or word-final) transpositions (e.g., Chambers, 1979, Perea & Lupker, 2003 a, b; Rayner, White, Johnson & Liversedge, 2006; Johnson, Perea & Rayner, 2007). Thus, although there are cross-linguistic differences between Indo-European and Semitic languages, the relative effectiveness of the internal and external transpositions may apply to Semitic languages including Arabic. Second, in previous research (Perea, Duñabeitia & Carreiras, 2008), transposition of adjacent (and internal) letters was found to be more effective than transposition of nonadjacent letters. Given that 44 out of 63 pairs in the TL condition involved transpositions of nonadjacent letters, potential priming effects may have been suppressed. Third, even though all transpositions in the present study were within words, 56 words included transposed letters that crossed a word pattern vowel and/or consonant. If a morpheme boundary in a nonconcatenative language like Arabic is marked by the letters of the root and word pattern, then apart from 7 pairs, all the prime-target pairs in the TL condition involved transpositions that crossed a morpheme boundary. Remember that earlier studies (e.g., Christianson, Johnson & Rayner, 2005; Duñabeitia, Perea, & Carreiras, 2007) found reduced or no TL priming effects for transpositions across morpheme boundaries in multimorphemic words (i.e. compound, pseudo-compound, or suffixed words) in English, Spanish, and Basque. Accordingly, the priming effects in the TL condition in this study may have been diminished as a result of the root consonants crossing a WP vowel. Finally, as mentioned above, the TL-condition was characterized by numerous cases of allographic variation. If the perception and processing of two variants of a single consonant is different, then it is possible that this allographic variation may have led to the negligible priming effects in the TL condition for the low proficiency participants.

6.2.3 The Effect of the Second Language on the First

In order to answer the third research question, native speakers of Arabic with high proficiency in L2 English were tested and compared with near monolingual speakers of Arabic. The results of the high proficiency L2 speakers show that significant priming was limited to the ID condition. Crucially, there was a small amount of inhibition rather than facilitation in the two morphological conditions, the WP and the root conditions. Also, there were priming effects in the TL condition for this group (19.7 ms) which despite being non-significant are worth noting. The TL priming effects were numerically closer to the priming in the ID condition than any other condition.

The statistical analyses in chapter 5 reveal that the high and the low L2 proficiency participants differed significantly in the root condition. Specifically, the root priming effects were numerically similar to ID priming for the low proficiency group but were nonexistent for the high proficiency group. Furthermore, despite being a non-significant difference, there were WP priming effects for low proficiency participants but not the high proficiency participants. Together, these results suggest that there indeed is a processing difference between native speakers with little or no knowledge of a second language and native speakers with advanced (or near-native) competence in a second language. In this case, a prime failed to facilitate recognition of target with which it shared the root or the WP morpheme in the high proficiency L2 speakers.

But, what might cause a processing difference between the two groups of participants? Could L1 attrition or loss in the high proficiency L2 speakers be behind this difference? Although the high proficiency L2 speakers in this study were at the upper end of the L2 proficiency scale and they reported using more English than Arabic, there is little reason to believe that their L1 was undergoing any form of attrition or language loss. This is because participants in this group come almost exclusively from a large Arabic American community in Dearborn, Michigan, where both English and Arabic are used with equal frequency (as opposed to predominantly L1 or L2 monolingual communities). The continuous waves of immigrations from the Arab world to this part of this US have kept this situation of language equilibrium in a steady state at least at the societal level. Additionally, many of the high proficiency L2 speakers reported that they travelled on a regular basis back and forth between the US and their homelands. Furthermore, although the high L2 proficiency participants had relatively long lengths of residence in the US (and/ or the UK), their age of arrival in these English-speaking countries indicates that their substantial contact with English started post-puberty i.e. after their L1 became fully established.

If it is not L1 attrition, then could the pattern of priming observed for the high proficiency bilinguals have been the result of those speakers' L1 processing becoming less automatized or even losing automaticity altogether? This interpretation seems highly unlikely as high proficiency L2 speakers were generally faster in their responses and more accurate than the low proficiency bilinguals. Additionally, this group of participants had significant ID priming, which would not be expected had they lost automaticity in processing their L1. In the next section, I will discuss the implications of the results obtained for the two proficiency groups and propose an explanation for why the results of the high L2 proficiency participants differ from the established monolingual norm.

6.3 Theoretical Implications

The present study has established that lexical access and organization in Semitic languages is determined primarily by their morphological systems as viewed by the root-based theories. The presence of significant priming in the root condition and its lack in the orthographic and TL conditions for the low proficiency L2 participants strongly suggest that word recognition in Semitic languages involves obligatory morphological decomposition à la Frost et al.'s (1997) model whereby words are decomposed into their constituent morphemes. In turn, these morphemic constituents activate all words which they are part of. For example, when the word *ʔiʕtiraaf* (recognition/ confession) is accessed, the parser separates the tri-consonantal root *ʕ-r-f* (know) out of the word pattern *ʔi-ti-aa-*. These two units activate other morphologically-related words. However, since the root defines a more uniform morphological family, the root effects will supersede the WP effects. Here, the root *ʕ-r-f* will activate other words which contain it like *maʕrifah* (knowledge) and *ʕirfaan* (acknowledgment). If a word that shares all but one root letter with the word *ʔiʕtiraaf* like *ʔiʕtiraaḍ* (objection) is presented, root priming effects will not show up as a different root entry is accessed in each case. Additionally, the root letters are accessed and processed as a unitary set of ordered elements since a word like *ʔirtifaaʕ* (altitude) fails to open up the entry for the *ʔiʕtiraaf* which contains the same root letters but which show a different permutation. Put differently, an orthographically related word like *ʔiʕtiraaḍ* and an anagram like *ʔirtifaaʕ* are no closer in lexical space to the word *ʔiʕtiraaf* than a word with all-different root letters like *ʔiktimaal* (completion) whereas a word like ma*ʕrifah*, which despite being more distant in form to *ʔiʕtiraaf* than the orthographically related word *ʔiʕtiraaḍ*, is stored in close vicinity to its same-root relative.

It is noteworthy that the existence of a decomposition process which is able to extract the root from the word pattern suggests that the parser is able to distinguish between these two discontinuous morphemes even though they are interposed within a word. Recall that in print word pattern vowels are indicated by the use of diacritical marks rather than letters (with the exception of long vowels) but their use is mostly limited to certain types of texts/genres. Accordingly, when a word like ***ribħ*** (profit; orthographically appearing as ***rbħ***) is visually presented, the parser is less likely to experience any difficulty since only the root consonants appear as letters. However, not all words are triliteral. Although rare, there are words with quadriliteral roots e.g., ***daħradʒa*** (rolled; written as ***dħrdʒ***) or ***tardʒama*** (translated; written as ***trdʒm***). Most importantly, word patterns are not exclusively made up of vowels. Many word patterns consist of consonants in addition to vowels. For example, in the words ***taʕaamul*** (dealing), ***ʔistiʕmaal*** (usage), ***muʕaamalah*** (treatment), and ***ʔiʕtidaal*** (moderation), all the underlined letters are consonants that belong to the word pattern. The question is: How does the parser distinguish between the root and the word pattern letters in such cases especially since the root consonants do not occupy fixed positions across words (e.g., could the parser dissect the word ***taʕaamul*** in the wrong spot getting the incorrect root ***t-ʕ-m*** instead of the correct ***ʕ-m-l***?). According to Frost et al. (2005), the parser uses a distribution-based algorithm to identify and separate these two morphemic units from each other. Since word pattern letters are limited to certain consonants that appear in certain positions within the word, the computations are likely to take into account the position, the identity, and the number of the letters the word contains. So, for example, word-initial *ʔ*, *m*, or *t* which appears in words consisting of four or more letters, will most likely be identified as WP consonants.

Turning to the results of the high L2 proficiency speakers, the pattern of priming obtained for this group of participants differs from native speakers who have little or no knowledge of L2. They diverged from the low proficiency L2 learners in the two morphological conditions (i.e. the WP and the root conditions) as well as the TL condition. It was argued above that this change in the pattern of priming was caused by higher proficiency in the L2 for there is no other linguistic variable that distinguishes the two proficiency groups from each other[23]. The assumption here is that for processing to deviate from the monolingual norm, lexical space in the high proficiency L2 learners should have undergone a restructuring process.

In one study, Frost et al. (2005) reported that Hebrew-English and English-Hebrew bilinguals processed words in their two languages in accordance with the monolingual norms of these two languages. In other words, a bilingual was more of two monolinguals in one person. Many authors reject this kind of schizophrenia-like split personality diagnostic for bilinguals. For example, Cook has stressed time and again (e.g., Cook, 1992; 2002; 2003) that a bilingual is not the added sum of two monolinguals (see also Grosjean, 1989). Instead, Cook views "L2 users" as a different population who diverge from the monolingual norms of both their L1 and L2. Cook's argument was not unfounded but was rather based on solid evidence including the research presented in Chapter 4. According to this, language processing models should not view L1 processing in a vacuum or as an activity which is impervious to influence from a second language. The term influence here is not reserved to interference effects but includes cases of crosslinguistic transfer which result in a restructuring of some areas of L1 competence due to contact with L2 within the same individual. In some cases changes in the L1 may clearly show up in the production of the L2 speaker in his/her L1. In other cases, these differences may not be obvious to the "naked eye" and therefore require the use of

[23] Though sociolinguistically speaking, the two proficiency groups differed in their level of education and age. Specifically, the low proficiency participants were mostly recent high school graduates whereas most of the high proficiency participants had a college or a university degree as well as several years of work experience in the US.

experimental techniques such as priming paradigms, neuroimaging, eye-tracking, and speech analysis; measurements with which it is possible to catch these subtle differences.

At this point, one question remains unanswered: If lexical organization in high proficiency L2 speakers is not based on morphological identity or orthographic similarity (as indicated by the lack of priming in these conditions), then what is it based on? In English, which is the second language of these participants, morphological identity seems to be the basis for lexical organization. However, morphological relatedness in this concatenative language is defined differently from morphological relatedness in a nonconcatenative system like that of Arabic. Specifically, in English morphological relatedness is established based on the appreciation of form + meaning regularities. Remember that the primes in the root condition of the present study were dissociated from their corresponding targets both semantically and orthographically. Accordingly, when a parser that is tuned in to the English system does not detect form-meaning regularities in a given prime-target pair, priming falls apart. This means that for native speakers of Arabic with high proficiency in L2 English, only morphological relatives with transparent orthographic and semantic relationships may be grouped together in the lexical space and hence these speakers start to develop insensitivity to morphological relatives with opaque relationships. The prediction here is that morphologically related words that mirror a concatenative relationship, e.g. ***miθaal-timθaal*** (example-statue; written as ***mθAl-tmθAl***) may show strong priming effects.

Using the Competition Model mentioned in Chapter 4, the above line of reasoning for the high L2 proficiency group may be modeled as follows. In both Arabic and English, organization of the lexicon seems to be based on morphological identity. In

Arabic, an ordered set of consonants (i.e. the root) is used as the sole cue for morphological family membership. In English, form-meaning regularities constitute the strongest cue for morphological-relatedness. The model predicts that in native speakers of Arabic with high proficiency in English, the form-meaning cue for morphological relatedness will gain more weight and will accordingly be carried over to processing in the L1 (Arabic) while the discontinuous root-based cue will lose ground. In this research, we have part of the story, namely that the discontinuous root has lost its effectiveness as a cue for morphological relatedness. What remains to be seen is if form-meaning regularity (as exemplified by orthographically and semantically transparent words) is actually used as a cue for morphological identity by the native speakers of Arabic with high proficiency in English.

6.4 Future Research

During the course of the present discussion, one can clearly notice that Arabic and other Semitic languages offer a fertile ground for research due to their unique morphological systems. One of the research venues in Arabic lies in the TL-effects. In the present study, the TL-pairs involved transpositions of root consonants that crossed a word pattern vowel or consonant. In addition, the TL-pairs were characterized by allographic variation, an unavoidable issue with real word anagrams. Furthermore, in most cases the transpositions involved at least one external letter i.e. word-final or word-initial letter, which again is inevitable for words consisting of three letters only. This calls for more research that controls for these issues. What is specifically needed is to use nonword primes formed by the transposition of targets' two adjacent root letters that do not cross a WP vowel (even if it is an orthographically unrepresented vowel). This necessitates the use of words with more than three consonants. Although very difficult, the interested researcher should also control for orthographic variation or even use it as a research variable. In this future research, it would be very informative to compare internal letter transposition with the two external letter transpositions, namely word-initial and word-final transpositions. The baseline for these TL-conditions should include an ID condition in addition to a single or double letter substitution condition. It is less clear if an unrelated control condition would be felicitous in this context as the comparison would then be between nonwords which do not have mental representations and real words.

To further the part of this research that investigates effects of the L2 on the L1 part of this research, there are at least two future research possibilities. The first is to investigate how native speakers of Arabic with high proficiency in English process orthographically and semantically transparent same-root words that are modeled on concatenative morphological systems i.e. using same-root derivatives that contain one WP consonant at one end of the word as in ***miθaal-timθaal*** (written as ***mθAl-tmθAl***). It is important in this case to include both a semantic condition in which the test pairs are only semantically related and an orthographic condition in which the test pairs are related in form but are morphologically and semantically unrelated.

The second research possibility with respect to bilinguals is to investigate if markedness has an effect in determining the direction of transfer. This research requires testing high L2 proficiency English-Arabic bilinguals in Arabic. It would be interesting to see the pattern of responses by this population of participants to the two types of morphological relatives in Arabic mentioned above (viz. the transparent and the opaque pairs). If markedness is crucial in cue selection, then it is expected that English-Arabic bilinguals with high L2 proficiency will behave similarly to the high proficiency Arabic-English bilinguals in this study as their L1 less marked morphological system will impede the learning of the more marked L2 morphological system. If, however, markedness is not important in cue selection, then English-Arabic bilinguals should be able to tune in to the morphological system of Arabic. Whether or not these bilinguals will show morphological insensitivity in their L1 English as a result of high L2 (Arabic) proficiency is also another area of future research

6.5 Concluding Remarks

Assuming that priming serves as a reliable measure for the psychological reality of a given linguistic unit, the present paper has strongly validated the morphemic status of the root and the word pattern in accordance with root-based theories of Semitic morphology. When priming for same-root words which were dissociated on both form and semantic levels was contrasted with priming for orthographically related words, a clear advantage was observed for the same-root words. Here, word-based theories, which deny the existence of the root, cannot adequately account for the results obtained in the root condition. The results in this study are also in favor of an obligatory morphological decomposition process in which Arabic words are parsed into roots and word patterns; two morphemic units which regulate lexical access and organization, albeit to different to extents. Together, the results from the root and TL conditions suggest that in Semitic languages, morphological membership strictly requires that words share an ordered set of consonants irrespective of the degree of form and meaning overlap.

While the above was true for native speakers of Arabic with little or no knowledge of a second language, Arabic native speakers with extensive knowledge of a structurally different language, namely English, did not conform to the monolingual norm. It was hypothesized that due to the influence of the L2, L1 processing changed in the direction of the L2 pattern in the high proficiency L2 speakers. Whether researchers readily accept or reject this claim, higher proficiency in the L2 has to be taken as an important variation-inducing factor in any language processing study.

APPENDIX A: LANGUAGE HISTORY, ENGLISH CLASSROOM/LEARNING EXPERIENCE AND SELF-RATING QUESTIONNAIRE

Subject # _____________	Date _________________

A. Language History

1. Age: _________ years

2. Sex: ☐ Male ☐ Female

3. What is your native language?

☐ Arabic

☐ Other _________________ (If your native language is not Arabic, you need not continue this form)

4. Please list all the languages you know? _________________________________

5. What level of education have you completed? (High school, college or university degree) Specify_____________________

6. If you are student, please state what year are you in now.

☐ Freshman ☐ Sophomore ☐ Junior ☐ Senior ☐ graduate

7. Have you visited for tourism any English speaking country (If yes, state the country and duration of your visit and your age at the time of visit)?

____

8. What is the total amount of your stay in the US?

____

9. What is the native language of your parents?

____

10. For the languages you speak, which do you use for the following activities (If you use more than one language for a particular activity, specify the percentage of your first language use)?

Activity	Arabic	English	Other
Reading (books, magazines & newspapers)			
Watching TV and movies			
Email and on-line chatting			
Internet browsing			
Text messaging			
Listening to the radio			

11. State the language(s) you use in the following contexts/ situations (If you use more than one language for in a particular situation, specify how much you use each one).

Home

a. Father___________
b. Mother___________
c. Siblings__________
d. Spouse__________
e. Children___________

School_______________
Work________________
Friends_______________

12. Which of the languages you know is your preferred language of communication?

____

B. Self-rating

13. Please rate your skills in the languages you speak according to the scale you see below.

1= very poor 2 = poor 3 = fair 4 = good 5 = very good
6 = excellent 7 = native or native-like

Language	Speaking	Listening & comprehension	Writing	Reading
Arabic				
English				

C. English Language Learning and Classroom Experience

14. At what age did you first start learning English (in school and/or home)?

____

15. What was the **main** language of instruction in which you received your education in the following levels and what was the type of education you had in these levels (private or governmental)?

Primary/ Elementary School____________
Secondary/ Middle School____________
High School___________
College/University______________________________________

16. Have you studied or lived in an English speaking country other than the US?

☐ Yes ☐ No

If yes, please specify below the place, time and duration of your study/ stay

Country	Approximate dates	Duration of study/ length of stay

17. Have you had any intensive English courses (e.g. TOEFL preparation courses) or any training in English?
______. If yes, please specify____

18. In my English classes, I mostly get:

☐ A's ☐ B's ☐ C's

End of Questionnaire

Thank you for your participation!

APPENDIX B: TEST ITEMS USED IN THE EXPERIMENT

WP	Morphological	Orthographic	Transposition	Target
بطل /baṭal/ hero	سفارة /sifaara/ embassy	سحر /siħr/ magic	فرس /faras/ mare, horse	سفر /safar/ travel
عقيدة /ʕaqiidah/ doctrine	مصداقية /miṣdaaqijjah/ credibility	حديقة /ħadiiqah/	قصيدة /qaṣiidah/ poem	صديقة /ṣadiiqah/ friend
حقد /ħiqd/ malice	إشتراك /ʔiʃtiraak/ subscription	شبك /ʃabak/ net	شكر /ʃukr/ thanks	شرك /ʃirk/ polytheism
وجهة /widʒhah/ destination	إستخدام /ʔistixdaam/ usage	خدعة /xudʕah/ trick	مخدة /mixaddah/ pillow	خدمة /xidmah/ service
وضع /wadʕ/ situation	دوران /dawaraan/ rotation, revolution	دهر /dahr/ eon, age, epoch	ورد /ward/ flowers	دور /dawr/ role
طلقة /ṭalqah/ shot	مفتاح /miftaaħ/ key	فترة /fatrah/ period	تحفة /tuħfah/	فتحة /fatħah/ opening
شتاء /ʃitaaʔ/ winter	إقتناع /ʔiqtinaaʕ/ conviction	قناة /qanaah/ channel	عناق /ʕinaaq/ hug	قناع /qinaaʕ/ mask
شأن /ʃaʔn/ matter	محراب /miħraab/ mihrab, prayer niche	حزب /ħizb/ party	بحر /baħr/ sea	حرب /ħarb/ war
سبيل /sabiil/ path	إفتراق /ʔiftiraaq/ separation	حريق /ħariiq/	رفيق /rafiiq/ companion	فريق /fariiq/ team
غريزة /ɣariizah/ instinct	معاشرة /muʕaaʃarah/ cohabitation, concomitance	عشيقة /ʕaʃiiqah/ mistress	شريعة /ʃariiʕah/ religious law	عشيرة /ʕaʃiirah/ clan
ناطق /naaṭiq/ spokesman	مشروع /maʃruuʕ/ project	شارب /ʃaarib/	شاعر /ʃaaʕir/ poet	شارع /ʃaariʕ/ street
قسمة /qismah/ destiny, division	إنحراف /ʔinħiraaf/ aberration	غرفة /ɣurfa/ room	حفرة /ħufrah/ hole, pit	حرفة /ħirfah/ craft
وقود	إعتماد	جمود	موعد	عمود

/waquud/ fuel	/ʔiʕtimaad/ dependence	/ʤumuud/ rigidity	/mawʕid/ appointment	/ʕamuud/ pole
سمكة /samakah/ fish	مراقبة /muraaqabah/ surveillance	رقصة /raqṣah/ dance	بقرة /baqarah/ cow	رقبة /raqabah/ neck
نسل /nasl/ offspring	برقية /barqijjah/ telegram, cable	برص /baraṣ/ Leprosy	قبر /qabr/ grave, tomb	برق /barq/ lightening
إسم /ʔism/ name	إنصاف /ʔinṣaaf/ equity	نصر /naṣr/ victory	صنف /ṣinf/ class, kind	نصف /niṣf/ half
خطف /xaṭf/ abduction	مبادرة /mubaadarah/ initiative	بئر /biʔr/ well	درب /darb/ path	بدر /badr/ full moon
كفر /kufr/ blasphemy	بارجة /baariʤah/ battleship	برد /bard/ coldness, chill	جرب /ʤarab/ scabies, mange	برج /burʤ/ tower
تخت /taxt/ wardrobe, chest bed	إختصار /ʔixtiṣaar/ abridgement, curtailment	خصم /xaṣm/ discount, antagonist	صخر /ṣaxr/ rock	خصر /xaṣr/ waist
صمت /ṣamt/ silence	إقتصاد /ʔiqtiṣaad/ economy	قصر /qaṣr/-/qiṣar/ palace-shortness	صدق /ṣidq/ truthfulness, sincerity	قصد /qaṣd/ intent
حلف /ħilf/ alliance	إنفعال /ʔinfiʕaal/ emotion	فصل /faṣl/ separation, season	علف /ʕalaf/ fodder, mash	فعل /fiʕl/ act
سياسة /sijaasah/ policy	مدار /madaar/ orbit	إنارة /ʔinaarah/ lighting	إرادة /ʔiraadah/ will	إدارة /ʔidaarah/ administration, management
مناخ /munaax/ climate	إرتياد /ʔirtijaad/ frequentation	مزاد /mazaad/ auction	دمار /damaar/ destruction	مراد /muraad/ desideratum
إنجاب /ʔinʤaab/ procreation	عجوز /ʕaduuz/ elderly	إعجاب /ʔiʕʤaab/ admiration	إزعاج /ʔizʕaaʤ/ nuisance	إعجاز /ʔiʕʤaaz/ miraculousness
ثغر /θaɣr/ gap	إقتراح /ʔiqtiraaħ/ proposal	قرد /qird/ monkey	حرق ħarq burning	قرح /qarħ/ ulcer
عكس /ʕaks/ opposite	حافلة /ħaafila/ bus	حبل /ħabl/ rope	فحل /faħl/ stallion	حفل /ħafl/ ceremony

جيش /ʤajʃ/ army	مستوصف /mustawṣaf/ medical center	قصف /qaṣf/ bombardment	صوف /ṣuuf/ wool	وصف /waṣf/ description
شعار /ʃiʕaar/ slogan, logo	إنسياق /ʔinsijaaq/ drift	سباق /sibaaq/ race	قياس /qijaas/ measurement	سياق /sijaaq/ context
تثبيت /taθbiit/ stabilization	موافقة /muwaafaqah/ approval	توفير /tawfiir/ saving, provision	توقيف /tawqiif/ arrest	توفيق /tawfiiq/ success
رخام /ruxaam/ marble	إستغراب /ʔistiɣraab/ wondering	غرام /ɣaraam/ adoration	غبار /ɣubaar/ dust	غراب /ɣuraab/ crow
مكتب /maktab/ office	صدارة /ṣadaarah/ lead	مصير /maṣiir/ destiny, fate	مرصد /marṣad/ observatory	مصدر /maṣdar/ source
بدعة /bidʕah/ heresy	تعبير /taʕbiir/ expression	عشرة /ʕaʃrah/-/ʕiʃrah/ ten-companionship	عربة /ʕarabah/ cart	عبرة /ʕibrah/ example
رحيل /raħiil/ parting	أربعة /ʔarbaʕah/ four	رضيع /raḍiiʕ/	بعير /baʕiir/ camel	ربيع /rabiiʕ/ spring
خيمة /xajmah/ tent	صاروخ /ṣaaruux/ rocket, missile	صرعة /ṣarʕah/ fad	صخرة /ṣaxrah/ rock	صرخة /ṣarxah/ scream
شعاع /ʃuʕaaʕ/ ray	إستدعاء /ʔistidʕaaʔ/ summoning, (re)call	دواء /dawaaʔ/ medicine	عداء /ʕidaaʔ/ hostility	دعاء /duʕaaʔ/ supplication
ولاية /wilaajah/ state, reign	تمساح /timsaaħ/ crocodile	مسافة /masaafah/ distance	حماسة /ħamaasah/ enthusiasm	مساحة /misaaħah/ area
سرب /sirb/ flock	ملاحة /milaaħah/ navigation	ملك /malik/-/mulk/ king-ownership	حلم /ħul(u)m/- /ħilm/ dream-patience	ملح /milħ/ salt
شعر /ʃiʕr/-/ʃaʕr/ poetry-hair	إحتمال /ʔiħtimaal/ possibility, endurance	حقل /ħaql/ field	محل /maħal/ store, site	حمل /ħaml/ lifting
كره /kurh/ hatred	منطقة /minṭaqah/ region	نفق /nafaq/ tunnel	قطن /quṭ(u)n/ cotton	نطق /nuṭq/ articulation
صدأ	بداءة	بدل	بند	بدن

/ṣadaʔ/ rust	/badaana/ obesity	/badal/ substitute, indemnity	/band/ item, item, clause	/badan/ body
غفلة /ɣaflah/ negligence, inadvertence	إبتكار /ʔibtikaar/ invention, innovation	بشرة /baʃrah/ skin	كربة /kurbah/ distress	بكرة /bakrah/ bobbin, pulley
تسريب /tasriib/ leak(age)	إخلاص /ʔixlaaṣ/ loyality	تخليد /taxliid/ immortalization	تلخيص /talxiiṣ/ summary	تخليص /taxliiṣ/ rescue
توديع /tawdiiʕ/ farewell	مصطلح /muṣṭalaħ/ term	تسليح /tasliiħ/ arming	تحصيل /taħṣiil/ collection	تصليح /taṣliiħ/ repair
فأر /faʔr/ mouse	مهارة /mahaarah/ skill	ممر /mamar/ passage	هرم /haram/ pyramid	مهر /mahr/ dowry bride price
أحد /ʔaħad/ prime, sole, one	إستعمال /ʔistiʕmaal/ usage	عقل /ʕaql/ mind	علم /ʕilm/-/ʕalam/ knowledge-science, flag	عمل /ʕamal/ work
رأفة /raʔfah/ clemency, mercy, leniency	إستبدال /ʔistibdaal/ replacement	بصلة /baṣalah/ onion	بلدة /baldah/ town	بدلة /badlah/ suit
إختراق /ʔixtiraaq/ penetration	معرفة /maʕrifah/ knowledge	إحتراف /ʔiħtiraaf/ professionalism	إرتفاع /ʔirtifaaʕ/ height, rise altitude	إعتراف /ʔiʕtiraaf/ recognition, confession
منع /manʕ/ ban	صراحة /ṣaraaħah/ frankness	صلح /ṣulħ/ peace, pact	حرص /ħirṣ/ care, keenness	صرح /ṣarħ/ edifice
هتك /hatk/ assault	مغادرة /muɣaadarah/ departure	غدة /ɣuddah/ gland	رغد /raɣad/ wealth, welfare	غدر /ɣadr/ treachery
هلع /halaʕ/ panic	إقتراع /ʔiqtiraaʕ/ vote	قرب /qurb/ closeness	عرق /ʕaraq/-/ʕirq/ sweat, race	قرع /qaraʕ/ pumpkin
حظر /ħaðr/ ban, embargo	مقارنة /muqaaranah/ comparison	قرص /qurṣ/ tablet, disc	نقر /naqr/ peck, click	قرن /qarn/ horn, century
كبد /kabid/ liver	تكاتف /takaatuf/ collaboration	كهف /kahf/ cave	فتك /fatk/ lethality	كتف /katif/ shoulder
بحث	إعصار	عصب	صرع	عصر

/baħθ/ (re)search	/ʔiʕṣaar/ hurricane	/ʕaṣab/ nerve, root	/ṣaraʕ/-/ṣarʕ/ epilepsy, knocking down	/ʕaṣr/ era, evening
تكييف /takjiif/ air conditioning	حلقة /ħalqah/ loop	تحليل /taħliil/ analysis	تلقيح /talqiiħ/ vaccination, fertilization	تحليق /taħliiq/ flight
قلم /qalam/ pen	إستكانة /ʔistikaanah/ subservience	سجن /siʤn/ prison, jail	نسك /nus(u)k/ ritual	سكن /sakan/ housing
نبأ /nabaʔ/ piece of news	حرامي /ħaraami/ thief	حرف /ħarf/ letter, character	مرح /maraħ/ run	حرم /ħaram/ sanctuary
فرع /farʕ/ branch	مناقصة /munaaqaṣah/ bid, tender	نقد /naqd/ criticism, cash	قنص /qanaṣ/ hunting	نقص /naqṣ/ shortage
عزف /ʕazf/ playing, performance	شطارة /ʃaṭaarah/ savvy, shrewdness	مطر /maṭar/ rain	شرط /ʃarṭ/ condition, term provision	شطر /ʃaṭr/ fragment
عمد /ʕamd/ deliberateness	إنطباع /ʔinṭibaaʕ/ impression	طمع /ṭamaʕ/ greed	عطب /ʕaṭab/ defect, fault	طبع /ṭabʕ/ print, nature
إنتخاب /ʔintixaab/ election	عقل /ʕaql/ mind	إعتدال /ʔiʕtidaal/ moderation	إقتلاع /ʔiqtilaaʕ/ extraction, uprooting	إعتقال /ʔiʕtiqaal/ arrest
سرعة /surʕah/ speed	مجاملة /muʤaamalah/ compliment, courtesy	جولة /ʤawlah/ round	مجلة /maʤallah/ magazine	جملة /ʤumlah/ sentence
إعتداء /ʔiʕtidaaʔ/ aggression, assault	مركبة /markabah/ vehicle	إرتياب /ʔirtijaab/ suspicion	إرتباك /ʔirtibaak/ confusion, awkwardness	إرتكاب /ʔirtikaab/ commission
ترميم /tarmiim/ renovation, restoration	إدبار /ʔidbaar/ turning tail	تدمير /tadmiir/ destruction	تدريب /tadriib/ training	تدبير /tadbiir/ management, providence

APPENDIX C: CONTROL ITEMS USED IN THE EXPERIMENT

ID WP control	Morph control	Ortho control	Trans control	Target
ثقة /θiqah/ trust	تسديد /tasdiid/ settlement, aiming, sight	ريب /rajb/ doubt	كبت /kabt/ inhibition, suppression	سفر /safar/ travel
مملكة /mamlakah/ kingdom	إستضافة /ʔistiḍaafah/ hosting	تطبيع /taṭbiiʕ/ normalization	تصدير /taṣdiir/ export	صديقة /ṣadiiqah/ friend
قمح /qamħ/ wheat	إنقسام /ʔinqis:am/ division, split	شمع /ʃamʕ/ wax	جثة /ʤuθθah/ corpse, body	شرك /ʃirk/ polytheism
سلطة /sulṭah/- /salaṭah/ authority-salad	إنسانية /ʔinsaanijjah/ humanity	مدفع /midfaʕ/ cannon	تسوس /tasawwus/ rot, decay	خدمة /xidmah/ service
مرة /marrah/ once	تجنيد /taʤniid/ recruitment, levy	خبث /xubθ/ wickedness	زمن /zaman/ time	دور /dawr/ role
بريق /bariiq/ glitter	فضيلة /faḍiila/ virtue	نظام /niðaam/ order, system	صيام /ṣijaam/ fasting	فتحة /fatħa/ opening
نهوض /nuhuuḍ/ awakening	مكافأة /mukaafaʔah/ reward	فندق /funduq/ hotel	حانة /ħaanah/ bar	قناع /qinaaʕ/ mask
جهة /ʤihah/ side, direction	عفريت /ʕifriit/ goblin, jinni	سنة /sanah/- /sunnah/ year-mores, rubric	فئة /fiʔah/ category	حرب /ħarb/ war
فكرة /fikrah/ idea	إنحدار /ʔindiħaar/ rout, debacle	مثلث /muθallaθ/ triangle	صيغة /ṣiiɣah/ formula	فريق /fariiq/ team
فيضان /fajaḍaan/ flood	إحتكام /ʔiħtikaam/ invocation, petition	معجون /maʕʤuun/ paste	تلميذ /tilmiið/ pupil	عشيرة /ʕaʃiirah/ clan
جوهر /ʤawhar/ essence	نهاية /nihaajah/ end	وقار /waqaar/ gravity, dignity	ذكرى /ðikraa/ memory, anniversary	شارع /ʃaariʕ/ street
حذاء	مساومة	ثورة	رماد	حرفة

/ħiðaaʔ/ shoe	/musaawamah/ bargaining	/θawrah/ revolution	/ramaad/ ash	/ħirfah/ craft
يقظة /jaqaðah/ vigilance	مكافحة /mukaafaħah/ control	موكب /mawkib/ procession	سؤال /suʔaal/ question	عمود /ʕamuud/ pole
زورق /zawraq/ speed boat	مسرحية /masraħijjah/ play	قالب /qaalib/ mould, cast	نقاء /naqaaʔ/ purity	رقبة /raqabah/ neck
عطش /ʕaṭaʃ/ thirst	تأخير /taʔx:ir/ delay, tardiness	ذلة /ðillah/ ignominy	ضرر /ḍarar/ harm	برق /barq/ lightening
ظهر /ðuhr/-/ðahr/ afternoon- back	نصيحة /naṣiiħah/ advice	ملف /milaf/ file	شلل /ʃalal/ paralysis	نصف /niṣf/ half
ثلث /θul(u)θ/ third	إنعقاد /ʔinʕiqaad/ convening	عدو /ʕaduw/-/ʕadw/ foe-scamper	رحم /raħim/ womb	بدر /badr/ full moon
رمز /ramz/ code, symbol	خنزير /xinziir/ pig	كفة /kaffah/ balance pan	يأس /jaʔs/ despair	برج /burʤ/ tower
كفؤ /kuf(u)ʔ/ counterpart, equivalent	معلومة /maʕluumah/ information	جنة /ʤannah/- /ʤinnah/ paradise- insanity	وجع /waʤaʕ/ pain	خصر /xaṣr/ waist
ضيق /ḍiiq/ malaise, tightness	مقاطعة /muqaaṭaʕah/ boycott, province	كرة /kurah/ ball	نار /naar/ fire	قصد /qaṣd/ intent
مقر /maqar/ headquarters	إصطدام /ʔiṣṭidaam/ collision	أمل /ʔamal/ hope	حرث /ħarθ/ tillage	فعل /fiʕl/ act
نتيجة /natiiʤah/ result, consequences	سرور /suruur/ pleasure	تحريف /taħriif/ distortion	تمثيل /tamθiil/ acting, representation	إدارة /ʔidaarah/ administration, management
كتلة /qutlah/ mass	جرثومة /ʤurθuumah/ germ	معدة /maʕidah/ stomach	هاتف /haatif/ telephone	مراد /muraad/ desideratum
بركان /burkaan/ volcano	حزام /ħizaam belt	سياحة /sijaaħah/ tourism	ينبوع /janbuuʕ/ fountain	إعجاز /ʔiʕʤaaz/ miraculousness
كرز /karaz/ cherry	مراجعة /muraaʤaʕah/ review	تين /tiin/ fig	ضجة /ḍaʤʤah/ noise, tin	قرح /qarħ/

				ulcer
كرم /karam/ generosity	تعميم /taʕmiim/ generalization	ذرة /ðurah/-/ðarrah/ corn-atom	رقة /riqqah/ tenderness	حفل /ħafl/ ceremony
نمو /numuw/ growth	إكتئاب /ʔiktiʔaab depression	فكر /fikr/ thought	وبر /wabar/ fur	وصف /waṣf/ description
نظرة /naðrah/ look, view	محاماة /muħaama(t/h)/ law	موسم /muwsim/ season	سماء /samaaʔ/ heaven, sky	سياق /sijaaq/ context
زراعة /ziraaʕah/ agriculture, farming	إلتزام /ʔiltizaam/ obligation, engagement	حماية /ħimaajah/ protection	رائحة /raaʔiħah/ smell	توفيق /tawfiiq/ success
كذبة /kiðbah/ lie	إستعارة /ʔistiʕaarah/ loan, borrowing	نكسة /naksah/ setback, relapse	أديب /ʔadiib/ author, scholar	غراب /ɣuraab/ crow
نقطة /nuqṭah/ point	تقييد /taqjiid/ restriction, limitation	رحلة /riħlah/ trip, journey	نكبة /nakbah/ calamity	مصدر /maṣdar/ source
رصاص /rasṣaaṣ/- /riṣaaṣ/ lead	شهادة /ʃahaadah/ certificate, testimony	هيئة /hajʔah/ organization, body	باطل /baaṭil/ voidance, voidness	عبرة /ʕibrah/ example
تراث /turaaθ/ heritage	مصلحة /maṣlaħah/ interest	لكمة /lakmah/ punch	مفرش /mifraʃ/ tablecloth, sheet	ربيع /rabiiʕ/ spring
منظر /manðar/ landscape, view	صحراء /ṣaħraaʔ/ desert	عثور /ʕuθuur/ find, discovery	عزاء /ʕazaaʔ/ consolation	صرخة /ṣarxah/ scream
حليب /ħaliib/ milk	سيناريو /siinaarju/ scenario	منصة /minaṣṣah/ platform	فجوة /faʤwah/ gap	دعاء /duʕaaʔ/ supplication
تعزيز /taʕziiz/ reinforcement	طاووس /ṭaawuus/ peacock	بلدية /baladijjah/ municipality	تمرير /tamriir/ passing	مساحة /misaaħah/ area
تلف /talaf/ damage	تساهل /tasaahul/ leniency	صلة /ṣila/ relation	وعي /waʕj/ consciousness	ملح /milħ/ salt
لعب /laʕib/ play	معاهدة /muʕaahadah/ convention, treaty	جهد /ʤuhd/-/ʤahd/ effort	قصة /qiṣṣah/ story	حمل /ħaml/ lifting

دفء /difʔ/ warmth	إتفاق /ʔittifaaq/ agreement, concord	فرز /farz/ sorting	وحش /waħʃ/ monster	نطق /nuṭq/ articulation
صدع /ṣadʕ/ crack, fracture	سروال /sirwaal/ pants	سير /sajr/ walk, course	صقر /ṣaqr/ falcon	بدن /badan/ body
مسدس /musaddas/ pistol, revolver	إنقضاء /ʔinqiḍaaʔ/ expiry	قضيب /qaḍiib/ pole, bar	عجين /ʕadʒiin/ dough	بكرة /bakrah/ bobbin, pulley
ميراث /miiraθ/ inheritance	حصانة /ħaṣaanah/ immunity	تلاحم /talaaħum/ cohesion, unity	تلاعب /talaaʕub/ manipulation, jugglery	تخليص /taxliiṣ/ rescue
تفاخر /tafaaxur/ boastfulness	حراسة /ħiraasah/ guard	قاموس /qaamuus/ dictionary	زلزال /zilzaal/ earthquake	تصليح /taṣliiħ/ repair
عشب /ʕuʃb/ grass	طمأنة /ṭamʔanah/ reassurance	قاع /qaaʕ/ bottom	عدد /ʕadad/ number	مهر /mahr/ dowry bride price
عدة /ʕuddah/- /ʕiddah/ equipment- numeration	إفريقية /ʔifriiqijja/ Africa	دين /diin/-/dajn/ religion- debt	رقم /raqm/ number	عمل /ʕamal/ work
نفاق /nifaaq/ hypocrisy	إنطلاقة /ʔinṭilaaqah/ launch	مرشد /murʃid/ advisor, leader	مادة /maaddah/ subject, matter	بدلة /badlah/ suit
معاملة /muʕaamalah/ treatment	تأمين /taʔmiin/ insurance	ثمانين /θamaaniin/ eighty	مباراة /mubaaraa(t)/ match	إعتراف /ʔiʕtiraaf/ recognition, confession
هدف /hadaf/ goal, objective	قنبلة /qunbulah/ bomb	خشب /xaʃab/ wood	طول /ṭuul/ length	صرح /ṣarħ/ edifice
أرق /ʔaraq/ insomnia	إنقلاب /ʔinqilaab/ coup	نكد /nakad/ grouchiness	شاي /ʃaaj/ tea	غدر /ɣadr/ treachery
رئة /riʔah/ lung	مزاولة /muzaawalah/ practicing	دار /daar/ house, home	عطر /ʕiṭr/ perfume	قرع /qaraʕ/ pumpkin
خطأ /xaṭaʔ/ mistake, error	إنخفاض /ʔinxifaaḍ/ decrease, drop	عار /ʕaar/ disgrace	بؤس /buʔs/ misery	قرن /qarn/ horn, century

ثأر /θaʔr/ feud, vendetta	تبرئة /tabriʔah/ exoneration, acquittal	ندم /nadam/ remorse, regret	مشط /muʃt/, /miʃt/ comb	كتف /katif/ shoulder
بلد /balad/ country	حضانة /ħaḍaanah/ incubation, nursery	حزن /ħuzn/-/ħazan/ sorrow, sadness	زهد /zuhd/ asceticism	عصر /ʕaṣr/ era, evening
باخرة /baaxirah/ ship	لوحة /lawħah/ portrait, picture	ضريبة /ḍariibah/ tax	تناسق /tanaasuq/ consistency, coordination	تحليق /taħliiq/ flight
عفو /ʕafw/ forgiveness	إستهزاء /ʔistihzaaʔ/ mockery	صفة /ṣifah/ adjective, character	زجر /zaʤr/ reprimand, rebuke	سكن /sakan/ housing
ميل /majl/ inclination	تناحر /tanaaħur/ clash	عنق /ʕunuq/ neck	ليث /lajθ/ lion	حرم /ħaram/ sanctuary
نية /nijjah/ intension	إستياء /ʔistijaaʔ/ resentment	مرض /maraḍ/ disease	حرز /ħirz/ periapt, juju	نقص /naqṣ/ shortage
غرق /ɣaraq/ drowning	أنوثة /ʔunuuθah/ femininity	درع /dirʕ/ shield	ثمن /θaman/ price, cost	شطر /ʃaṭr/ fragment
فرح /faraħ/ joy	إمتصاص /ʔimtiṣaaṣ/ absorption	جبن /ʤubn/ cowardice	بوق /buuq/ horn, trumpet	طبع /ṭabʕ/ print, nature
مواصلة /muwaaṣalah/ continuance	حجر /ħaʤar/-/ħiʤr/ stone-lap	معايشة /muʕaajaʃah/ co-existence	مجازفة /muʤaazafah/ risk, venture	إعتقال /ʔiʕtiqaal/ arrest
صراع /ṣiraaʕ/ conflict	إبتزاز /ʔibtizaaz/ blackmail, extortion	نشاط /naʃaaṭ/ activity, energy	لحظة /laħðah/ moment	جملة /dʒumlah/ sentence
محاربة /muħaarabah/ fighting	تعظيم /taʕðiim/ glorification	إنشطار /ʔinʃiṭaar/ splitting, schism	علانية /ʕalaanijah/ overtness, publicity	إرتكاب /ʔirtikaab/ commission
كرامة /karaamah/ dignity	نعناع /niʕnaaʕ/ mint	جزيرة /ʤaziirah/ island	ترجمة /tarʤamah/ translation	تدبير /tadbiir/ management, providence

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