INDIVIDUAL DIFFERENCES IN THE L1 AND L2 PROCESSING OF MORPHOLOGICALLY COMPLEX WORDS

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ABSTRACT

INDIVIDUAL DIFFERENCES IN THE L1 AND L2
PROCESSING OF MORPHOLOGICALLY COMPLEX WORDS

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The aim of this study was to examine how native speakers (L1) of Turkish, a morphologically rich language, process a second language (L2) which is morphologically less productive such as English. Critically, the study examined morphological priming effects together with a transposed-letter (TL) methodology using the same target word and compared the processing of derived word forms in L1 English speakers to that of L1 Turkish speakers of L2 English. Two masked primed lexical decision experiments were conducted in which the same target (e.g., BRAVE) was preceded by a morphological prime (*braveness*), a TL-within prime (*bra<u>ev</u>ness*), an SL-within prime (*bra<u>oc</u>ness*), a TL-across prime (*brav<u>ne</u>ess*), an SL-across prime (*brav<u>ru</u>ess*) or an Unrelated prime (*directness*). Furthermore, to clarify the conflicting empirical evidence in L1 and L2 morphological processing, the potential impact of individual differences in the reading networks of individuals was explored. The average group data yielded robust morphological priming in both L1 and L2 speakers, while significant TL priming for within-morpheme transpositions was obtained only in L1 speakers. Nevertheless, the findings of exploratory analyses

into the potential effects of individual variability suggested individual differences might indeed moderate the size and the magnitude of group-level priming in L1 and L2 speakers, leading to the emergence of TL priming effects for particular groups in L2 speakers. These results provided some resolution to the earlier inconsistent empirical evidence, highlighting the importance of considering individual differences while testing L1 and L2 populations.

Keywords: Morphological Processing, TL Priming, Individual Differences, L2 Processing, L1 Processing

ÖZ

ANADİL VE İKİNCİ DİLDE BİÇİMBİLİMSEL AÇIDAN KARMAŞIK SÖZCÜKLERİN BİÇİMBİLİMSEL İŞLEMLENMESİNDE BİREYSEL FARKLILIKLAR

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Bu çalışmanın amacı, biçimbilimsel açıdan zengin bir dil olan Türkçe anadil (D1) konuşucularının İngilizce gibi biçimbilimsel açıdan daha az üretken olan ikinci bir dili (D2) nasıl işlemlediğini araştırmaktır. Çalışma, kritik olarak, aynı hedef sözcüğü kullanarak biçimbilimsel hazırlama etkilerinin yanısıra harflerin yeri değiştirilerek (HYD) hazırlama etkilerini incelemiş ve anadili İngilizce olan konuşuculardaki türemiş sözcük işlemlemesini anadili Türkçe olan D2 İngilizce konuşucularla karşılaştırmıştır. Çalışmada, aynı hedef sözcük ve altı hazırlayıcısı bulunan iki maskelenmiş hazırlama kelime karar deneyi uygulanmıştır. Bu altı koşul, biçimbilimsel hazırlama, biçimbirim sınırında HYD hazırlama, biçimbirim sınırında ikame-harfler ile yerine koyma, biçimbirim sınırı dışında HYD hazırlama, biçimbirim sınırı dışında ikame-harfler ile yerine koyma veya ilişkisiz hazırlamadan oluşmuştur. Ayrıca, D1 ve D2 işlemlemedeki çelişkili bulgulara katkıda bulunmak amacıyla konuşucuların okuma ağlarındaki bireysel farklılıklarının potansiyel etkileri araştırılmıştır. Ortalama grup verileri hem D1 hem de D2 konuşucularında

güçlü biçimbilimsel hazırlama etkilerinin bulunduğunu göstermiş, fakat istatistiksel olarak önemli HYD hazırlama etkileri yalnızca D1 konuşucularında bulunmuştur. Ancak, bireysel farklılıkların olası etkilerine ilişkin açımlayıcı veri analizi sonuçları grup düzeyindeki hazırlayıcı etkilerinin bireysel değişkenlik tarafından modüle edildiğini göstermiştir. Bu modülasyon, D2'nin belirli gruplarında HYD hazırlama etkilerinin ortaya çıkmasını sağlamıştır. Bu sonuçlar, alanyazındaki tutarsız deneysel kanıtlara bazı açıklık getirmiş ve D1 ve D2 konuşucularını test ederken bireysel farklılıkları dikkate almanın önemini vurgulamıştır.

Anahtar Kelimeler: Biçimbilimsel İşlemleme, HYD Hazırlama Etkileri, Bireysel Farklılıklar, İkidilli İşlemlemesi, Anadil İşlemlemesi

To my younger self who did not ever give up

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LIST OF ABBREVIATIONS

AVM	The Activation-Verification Model
DiRT	Diagnostic Reading Test for Nonwords
DRC	Dual Route Cascaded Model
e.g.	Exempli Gratia
ERP	Event-Related Potentials
i.e.	Id Est
IAM	Interactive Activation Model
IELTS	The International English Language Testing System
KPDS	Language Proficiency Test
L1	First Language
L2	Second Language
LDT	Lexical Decision Task
MMN	Mismatch Negativity
MROM	The Multiple Read-Out Model
ms	Millisecond
OB	Open-Bigram
OR	Orthographic
PH	Phonological
RST	The Reading Span Test
RT	Reaction Time
SD	Standard Deviation
SE	Semantic
SE	Standard Error
SERIOL	Sequential Encoding Regulated by Inputs to Oscillations Within Letter Units Model
SL	Substituted-letter
SOA	Stimulus Onset Asynchrony
SOLAR	Self-Organizing Lexical Acquisition and Recognition Model

TL	Transposed-letter
TOEFL	Test of English as a Foreign Language,
TOWRE	Test of Word Reading Efficiency
vs.	Versus
WJ III ACH	Woodcock–Johnson III Psycho- Educational Battery—Revised
WMC	Working Memory Capacity
WSE	Word Superiority Effect
YDS	Language Proficiency Test

CHAPTER 1

INTRODUCTION

Accurate and fluent reading requires a fine and systematic orchestration of many cognitive functions that are developed later in life through instruction since humans are not born with an innate ability to acquire a written language. These involve word identification and processing, learning, executive skills, inferencing, syntactic parsing, accessing meaning, which are all processed effortlessly and markedly fast. Therefore, this elaborate synchronization among various cognitive mechanisms has unsurprisingly aroused much interest in investigating the precise order and manner these essential processes take place in skilled readers. As a result, substantial amount of attention has been paid to determine how skilled readers go from a given letter string of printed squiggles and lines on a page to meaning. Hence, shedding light on what mechanisms are involved in the process of gaining access to lexical entries has been the main motive of visual word recognition studies.

Over the last four decades, the cognitive processes involved in the recognition of morphologically complex words such as *government* and *touched* have been extensively examined. Research into psycholinguistic science has shown that letter identity assignment, letter position coding, segmentation of complex words into constituent morphemes and the use of semantic information are important underlying components (e.g., Amenta & Crepaldi, 2012) and that the alignment of these processes occurs in a few hundred milliseconds. However, there is no consensus on how precisely these components work and interact during the early stages of morphologically complex word processing. In spite of the lack of consensus on how multimorphemic words are recognized and processed, the literature suggests three different classes of theory. Full- listing theories claim that all words, irrespective of their internal structure, are stored as whole units and,

therefore, complex words are accessed only through their full-form representations (e.g., Butterworth, 1983; Manelis & Tharp, 1977). However, the recent literature has been dominated by the Morphological Decomposition Hypothesis (e.g., Taft & Forster, 1975), which claims that morphologically complex words are parsed into their morphemic subunits because they are stored as stems and affixes in the mental lexicon. The third account –dual-access theory- acknowledges a process whereby the complex word could be recognized either via representations of the word's constituent morphemes or via its full-form lexical representation (e.g., Baayen et al., 1997; Diependaele et al., 2009, 2011; Grainger & Ziegler, 2011).

Regarding the decomposition of morphemic units, there are three recent accounts that attempt to clarify the time course of morphological decomposition. The first view is the pre-lexical account (e.g., Rastle et al., 2000, 2004; Taft, 2003, 2004), which claims morphologically complex words are exhaustively segmented into their morpho-orthographic subunits, which then triggers the activation of the full-form representation. The post-lexical account, on the other hand, suggests that segmentation occurs only after access to the lexicon with an initial full-form activation has been achieved (e.g., Giraudo & Grainger, 2000, 2001). Finally, the dual-access account (e.g., Beyersmann & Grainger, in press; Diependaele et al., 2009; Grainger & Ziegler, 2011) proposes a co-occurrence of pre-lexical and post-lexical decomposition processes whereby morphologically complex words could be processed via the affix-stripping pathway (i.e., through the pre-lexical route) or via the whole-word pathway (i.e., the post-lexical route). With respect to the influences of semantic properties of words on the morphological decomposition process, two main accounts have been suggested: morpho-orthographic and morpho-semantic accounts. While the former view advocates a pure reliance on orthographic form that is blind to semantics, the latter acknowledges early semantic influences on morphological decomposition during visual word recognition.

Research that aims to clarify the mechanism(s) responsible for the native language (L1) morphological processing of inflectional and derivational phenomena has primarily focused on the dual- versus single- mechanism debate. Though there are quite a few studies that favor single-route models (e.g., Morris & Stockall, 2012;

Taft, 1979, 2004), substantial amount of evidence obtained from research has also supported the dual-route models that basically assume that two mechanisms run in parallel during the initial stages of complex word recognition (e.g., Coltheart et al., 1993; Grainger & Ziegler, 2011; Pinker, 1991; Taft, 2004; Ullman, 2001).

The main experimental paradigms employed in studies investigating these theories and accounts have been the masked and unmasked (overt) morphological priming paradigms. The masked morphological priming procedure (see Figure 1) is widely used in visual word recognition studies and often consists of three stages: Firstly, a forward mask (composed of some hash symbols) is presented for a short time (often 500 milliseconds), followed by the brief presentation of a prime, which typically involves a morphologically complex prime, identity prime or an unrelated prime, followed by the target. Masked priming is a paradigm that taps into early processes in visual word recognition because even though the prime is presented very briefly, and hence there is almost no awareness of the experimental manipulations, it is found to affect the responses of the participants based on its relation to the target word.

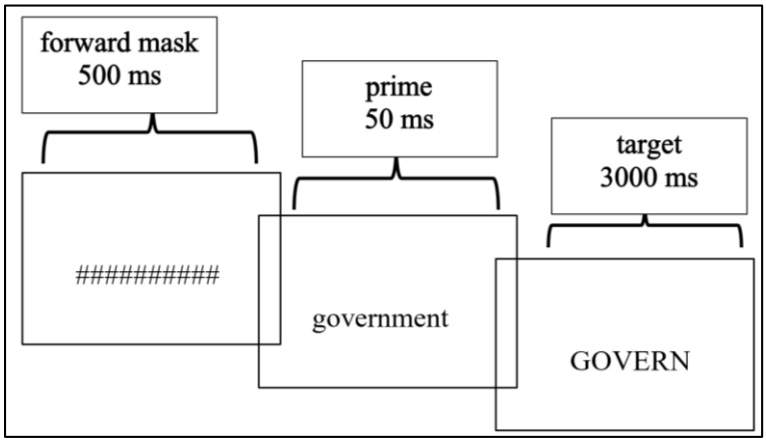


Figure 1. Structure of a Typical Masked Morphological Priming Trial

A paradigm that has recently begun to gain prominence in morphological processing studies is the (masked) transposed-letter (TL) priming. In this paradigm, primes contain a linguistic unit that is the letter-transposed version (e.g., govren) of the target (e.g., GOVERN), and as a result, two perceptually similar neighbors such as

govren and govern are created (e.g., Perea & Carreiras, 2006). This type of priming therefore informs about whether there is any influence on how a word is processed when two letters within the input are reversed. In fact, a significant amount of evidence has revealed that TL words have yielded form-priming effects in relation to the control primes (e.g., govenr-GOVERN vs. govemc-GOVERN; Andrews, 1996; Perea & Lupker, 2004) as well as associative priming effects (e.g., power-GOVERN vs. phoen– GOVERN; Perea & Lupker, 2003b). These effects have also been documented with non-adjacent distant transposed letters (e.g., gorevn-GOVERN vs. gozecn- GOVERN; Perea & Carreiras, 2006).

This paradigm has recently been used with morphologically complex prime words (e.g., govenrment - GOVERN) to reveal whether morphological decomposition co-occurs with the letter position assignment, and if the intertranspositions obstruct the processes readers use during recognition of complex words. Therefore, the transposed letters in primes can be either within the morpheme boundary or can cut across the morpheme boundary. For example, in a TL experiment where the processing of *government* is investigated, for the target word GOVERN, the prime *govenrment* involves transposed letters (TL) within the morpheme boundary whereas the prime *govermnent* involves TL across the morpheme boundary (see also Figures 2 and 3 for illustrations of an experimental design where TL priming is used in the within-morpheme boundary and the across-morpheme boundary conditions, respectively.

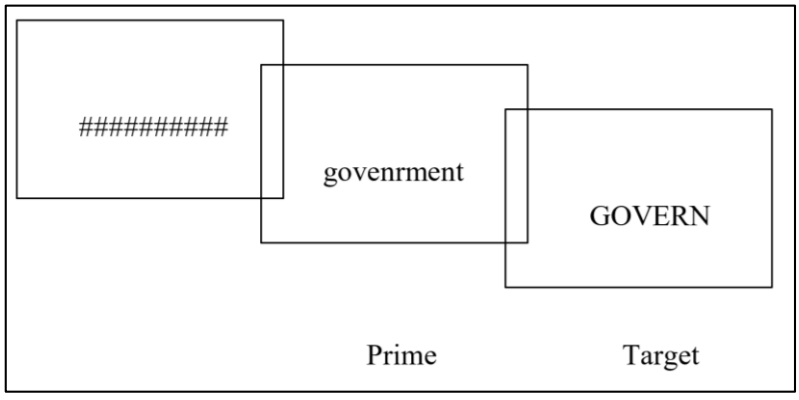


Figure 2. Transposed-Letter Priming, Within-morpheme Boundary Condition

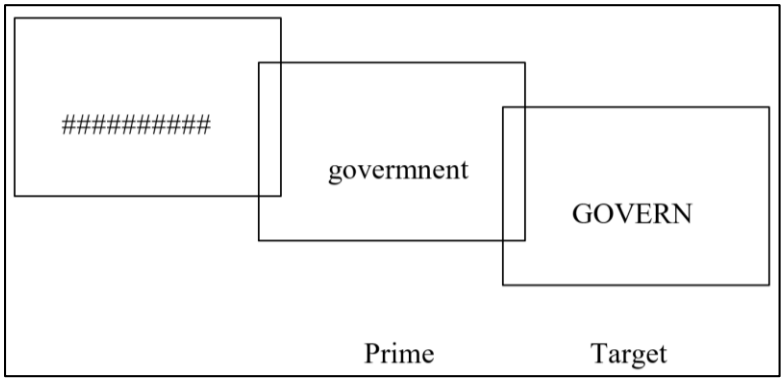


Figure 3. Transposed-Letter Priming, Across-morpheme Boundary Condition

In TL experiments, a substituted-letter (SL) condition is typically included as a baseline condition, which involves the substitution of two new letters (e.g., zc in govezcment) for the transposed-letters (nr in govenrment). An illustration of a substituted-letter condition across morpheme boundary in a TL experiment is provided in Figure 4.

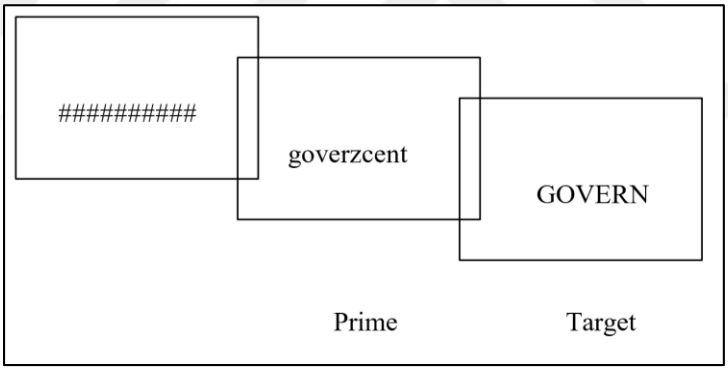


Figure 4. The Substituted-letter (SL) Condition across Morpheme Boundary in a TL Experiment

One methodological point that has been discussed in relation to whether the target word should be stems (govenrment - GOVERN) or whole words (govenrment - GOVERNMENT) in TL experiments that investigate priming effects using within and across TL conditions. While some studies have used whole words as target words (Christianson et al., 2005; Duñabeitia et al., 2007, 2014; Perea & Carreiras, 2006; Rueckl & Rimzhim, 2011; Sánchez-Gutiérrez & Rastle, 2013), others have presented stems as the target words (Beyersmann et al., 2013; Diependaele et al.,

2013; Rueckl & Rimzhim, 2011). Importantly, Rueckl and Rimzhim (2011) reported that the magnitudes of intra-morphemic transpositions and cross-morphemic transpositions were similar when targets were stems or whole words.

The transposed letter-effect is obtained when it is easier to respond to target words preceded by letter-transposed nonword primes than those preceded by letter-substituted nonword primes. The difference between the reaction times in these conditions is taken as evidence for the measure of transposed-letter priming. The transposed letter-effect is obtained when reaction times (RTs) to the TL prime are faster than RTs in the SL prime condition. Obtaining a TL effect makes it generally possible to draw two conclusions: Firstly, decomposition is an automatic process and is independent of the lexical activation in the lexicon; for a TL prime is a nonword and non-existent in the mental lexicon. And secondly, there is a very early decomposition process that operates along with letter position coding processes because recognizing a morphologically complex word in isolation firstly requires the encoding of letter position. This is significant evidence that can be highlighted particularly in TL experiments; for a study that examines letter transpositions could find morphological priming despite the reversed letters, which proffers evidence that decomposition processes are tolerant to inexact coding of letter positions.

Other studies have also examined TL effects by eliciting response times to morphologically complex words which involve both cross-morphemic and intra-morphemic transpositions (Christianson et al., 2005; Duñabeitia et al., 2007; Rueckl & Rimzhim, 2011). In these studies, the evidence in favor of the obligatory decomposition theory was provided when cross-morphemic transpositions were more disruptive than intra-morphemic transpositions. For example, if government is recognized after the stripping off of the affix -ment from the stem *govern*, then the disturbance of the affix should obscure the processing by making it easier to reject the target; this is because *govermnent* may not prime GOVERN as much as the prime *govenrment* as the affix in the first condition is disrupted and cannot be isolated from the stem.

However, in spite of the robust findings and combined investigation of imprecise letter coding and morphological processing that TL priming could provide, there is not much work using this paradigm to investigate the visual recognition of morphologically complex words, and the findings obtained from available studies are not clear-cut. Some studies have shown that TL priming effects were obtained only in the intra-morphemic transposition condition (Christianson et al., 2005; Duñabeitia et al., 2007), whereas other studies have revealed similar sizes of priming across the two conditions (Beyersmann et al., 2013; Rueckl & Rimzhim, 2011; Sánchez-Gutiérrez & Rastle, 2013). Rueckl and Rimzhim (2011) also point out the need for more research to discover the underlying factor(s) for these incongruent findings.

Another line of complex word recognition research has broadened the scope to L2 inflectional and derivational processes to question if and how L2 morphological processing is different from L1 morphological processing. The findings obtained in this line of research are largely contradictory, ranging from studies that posit similar mechanism(s) in L1 and L2 processing (e.g., Chen et al., 2007; Diependaele et al., 2011) to studies that point to distinct mechanisms (e.g., Babcock et al., 2012; Jacob et al., 2018; Neubauer & Clahsen, 2009).

Studies which argue for the presence of distinct mechanisms state that even though L2 speakers could obtain very high scores in proficiency tests, L2 processing will still differ from L1 processing because of the differences in processing specific domains of grammar (e.g., Clahsen & Felser, 2006; Ullman, 2001). Regarding the differences in sentence processing, it has been proposed that L2 speakers utilize surface cues to understand sentences such as lexico-semantic and associative patterns of sentences unlike L1 speakers, who use deeper level cues such as the abstract syntactic structure of a sentence (Clahsen & Felser, 2006). Similarly, Ullman (2001) argues that there are two distinct brain memory subsystems: a declarative subsystem that promotes the storage function of words and a procedural subsystem that processes rules of language. It is also posited that these two memory systems are vulnerable to maturational changes that lead to the reduction in effect after puberty. This leads to L2 processing to be more reliant upon the memorized

system unlike L1 processing which is more dependent upon the procedural memory system.

Other studies that favor the similar approach posit that processing takes place along similar principles even though there might be significant differences in speakers with lower proficiency levels (e.g., Clahsen et al., 2010; Clahsen & Felser, 2006) and words with lower frequency levels (e.g., Dal Maso & Giraudo, 2014; Lehtonen et al., 2006; Lehtonen & Laine, 2003). Also, it is reported that despite the presence of general mechanisms underlying the visual word recognition system, L2 performance could be slightly slower and require more mental exertion than that of L1.

CHAPTER 2

LITERATURE REVIEW

2.1. Morphological Processing Models

The fundamental issue for word recognition and processing theories is to elucidate how the linguistic system tackles the storage and retrieval of lexical entries and how skilled readers gain access to those lexical units. Therefore, most theories have been particularly developed based on whether morphologically complex words have their own mental representational units and how and when morphological information is available in visual word recognition. To elucidate the very early processes involved in the representation and processing of these complex words and to explain whether these systems run independently or in parallel, several influential accounts of morphological processing have been proposed, and as a result, these opposite theoretical accounts have yielded considerable evidence in favor of the morphological models of lexical processing. Fundamentally, two theoretical models have gained influence in the literature: single-mechanism models and dual-mechanism models. In the following chapter, these two accounts are reviewed along with the studies that have provided significant evidence with regards to each theoretical model.

2.1.1. Single-Route Models

Two main influential single-mechanism accounts prevail in the morphological processing literature. While they all posit only one processing route that has control over the processing of morphologically complex words, they vary in a particular mechanism that they select to account for the processing. These two main accounts involve full-decomposition models and full-listing models and are discussed below.

2.1.1.1. Full-Decomposition Models

These purely morphological-access models (e.g., Rastle et al., 2000; Stockall & Marantz, 2006; Taft & Forster, 1975) predict that the mental lexicon holds separate entries for their stems and affixes. They adhere to the notion of compulsory segmentation of the surface form of any stimulus (be it a word or a nonword) that possesses a letter sequence that could potentially be a morpheme. Therefore, the only way to get access to the lexical representations of a complex word involving more than one morpheme is through an initial access to its morphemic subunits. The implications of this model with regards to how the input is processed, beginning with the earliest registration of visual stimuli, are that complex words with detectable affixes are represented componentially, and hence, are first segmented into their units of stem and affix prior to the access to their whole-word representations in the second recombination step when morphemic constituents are concatenated. Such a word recognition system implies that identification of the word (e.g., impatiently) requires an early morphological analysis of the complex word. In other words, the prefix -im and the suffix -ly must be stripped off before the lexical representation of *impatiently* can be accessed.

According to this account, to gain access to the mental representations of a morphologically structured word, the language processing system obligatorily goes through an affix-stripping process whereby affixes are initially decomposed into stem and affix units in the initial stages of visual word recognition. This obligatory decomposition model assumes that complex words are exhaustively segmented into their morphemic subunits in which certain parts of the complex forms are identified as the stem morpheme or as the affix morpheme. One of the earliest findings for the affix-stripping model came from Taft and Forster (1975) who, in their lexical decision study, investigated bound stems (e.g., cursion in excursion) and real stems (e.g., juvenate in rejuvenate), and last parts of non-prefixed words (e.g., nace in menace). They conducted three experiments to determine whether morphological decomposition takes place even when the stem of a word is not a real word. In the first experiment, they constructed stimuli with real stems that were formed by the removal of their prefixes (e.g., rejuvenate – juvenate) as well as pseudo-stems that

were also constructed by stripping off their pseudo-prefixes (e.g., repertoire – pertoire). The results of their study demonstrated that prefixed nonwords with real stems (dejuvenate) were harder to respond to compared to prefixed pseudo-stems (depertoire). In line with this finding, the authors suggested that the increase in reaction times was due to uncertainty regarding whether the real stems could be used on their own, which interrupted the lexical search since an inappropriate lexical entry was found. Their results also showed that participants made more errors with real stems because the process where the lexical entry is checked to decide if the stem could stand alone is not always performed successfully. In the second experiment, Taft and Forster investigated whether, in the mental lexicon, bound morphemes are represented as separate entries and argued that if the stems of derived words existed, real words (free morphemes) as well as bound morphemes could also be represented. A word like *vent* is a free morpheme (i.e., an outlet for air), but it also functions as a bound morpheme as in *prevent*. Because *vent* carries out two different functions, it could employ two separate listings as *vent1* (as a free morpheme) and *vent2* (as a bound morpheme). The results revealed that words that have more frequent bound morphemes than free morphemes (e.g., vent) were responded to slower than free morphemes. This finding was taken to demonstrate that word stems are listed as lexical items. The stimuli used in the third experiment were comprised of the same items as used in the first experiment to validate the findings. In this experiment, real stems (e.g., juvenate) and pseudo-stems (e.g., pertoire) were attached incorrect prefixes (e.g., dejuvenate, depertoire). The results corroborated the initial findings, showing that prefixed nonwords took longer to respond to when they involved a real stem, in contrast to items which did not. Taft and Forster took the evidence from these three experiments to claim for the assumption that an analysis of morphological structure words is made before lexical lookup and proposed the model shown in Figure 5.

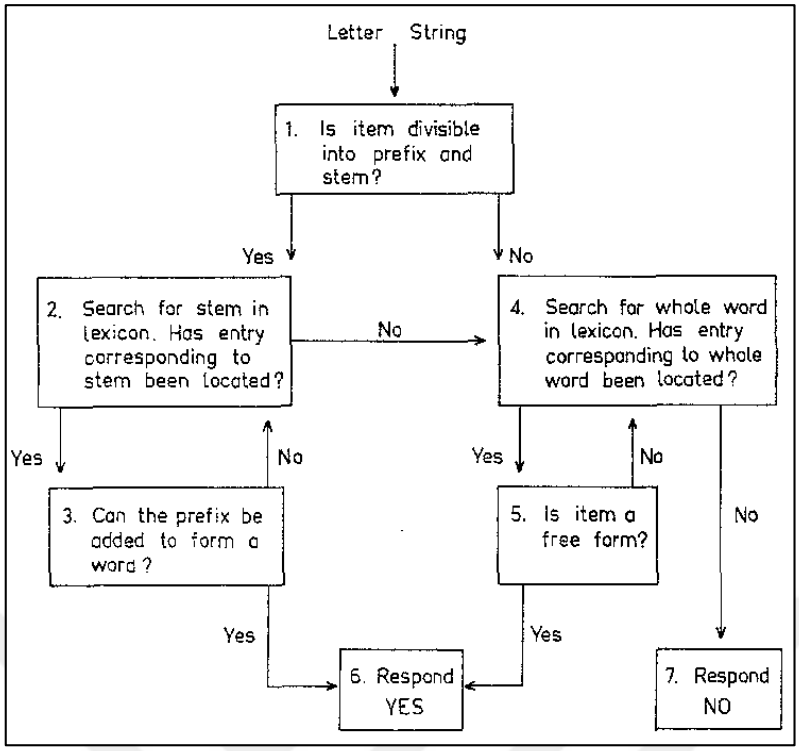


Figure 5. Taft and Forster's (1975) Word Recognition Model

The model accounts for the findings obtained from the first experiment where participants took longer to respond to real stems (e.g., juvenate) than to pseudo stems (e.g., pertoire). Because responses to the stimuli in the former condition necessitated the use of steps of 1, 4, 5, 4 and 7 and increased the amount time necessary to respond to the real stems in comparison to the following sequence of operations necessary for pseudo-stems: 1, 4, 7.

An alternative account where morphemic constituents have a significant function is the sequential search model which was called the file drawer model (Forster, 1976). In this model, a whole-word representation for every multimorphemic word is listed in the mental lexicon, which was likened to the "file drawer" but only accessed after the stem of the word is extracted and activated. According to this model, a word is searched in a prelisted location in the lexicon in two phases: The first phase is to acquire access to the file drawer through the stem of a complex word that provides important information in locating the remaining word. The whole-word representation is then searched through the drawer where full-forms are stored and ordered according to their frequency.

The decomposition model and the search model converge on their assumption that the first morphemic constituent with a higher frequency will expedite the initial processing phase, yet they differ in their prediction about the following processing. The decomposition model proposes the facilitation of the morphological processing as the second morphemic constituent gets a higher frequency, while the file drawer account does not suggest a potential effect on the morphological processing. The only influence that would impact the processing is whether the complex word is filed in an ascending or descending order of frequency in relation to the other complex word units in the file drawer. The two accounts also diverge on their assumptions of the influence of full-form frequency. While the obligatory decomposition account suggests words that have a higher frequency will be processed faster in the third phase, file drawer account only makes predictions regarding the location of the word unit in the file drawer.

The decomposition model that was previously developed as a search theory was modified (Taft, 1994) to integrate the framework of a prominent interactive-activation model to better understand the morphological processing. Primary interest in the prior model had focused on the pre-lexical morphological segmentation of prefixed words with bound stems that happened before a search for the stem morpheme within the mental lexicon. In this reformulation of the model (see Figure 6), a lemma level of representation proposed by Schreuder and Baayen (1995) was added to the model (Taft, 1994; Taft & Nguyen-Hoan, 2010), making affix-stripping an integral process instead of a distinct phase of processing that occurs before the lexical access.

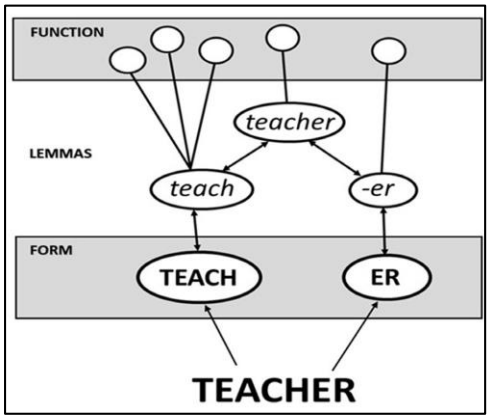


Figure 6. Reformulated Obligatory Morphological Decomposition Model (Taft & Nguyen-Hoan, 2010)

The full segmentation of complex words is assumed to be the main access route in the processing of complex words (e.g., Taft, 2004). Therefore, completely transparent words (e.g., teacher) do not possess their own representations at the lemma level, and instead computes all information in line with their constituents (i.e.,{teach}{er}), whereas complex words that are not transparent (e.g., feathery), are represented at the lemma level that provides from access to the meaning. As a result, at this lemma level, a difference between the activation of transparent and opaque affixed words arises. In addition, in line with the obligatory decomposition of complex transparent stimuli, obtaining significant base frequency effects is vital to the model. However, Taft (2004) reported that the absence of base frequency effects would be indicative of the compensation for high base frequency words where the later stage of reassembling the stem and affix has been more difficult than for lower base frequency words when they have an equal surface frequency. Support for a single-route full segmentation route was provided by Stockall and Marantz (2006) where all complex words were shown to be fully segmented into their individual constituents independently of whether they were regularly or irregularly inflected. In their unmasked primed MEG study, the stimuli consisted of identical, orthographically related and morphologically related prime-target pairs. Results indicated similar effects for the identity and morphologically related primes, and these findings were taken to indicate that the language processing system indiscriminately segments all complex words into their morphemic subunits. They further argued that this segmentation process occurs even for irregular word forms like *drank*, providing evidence for an account that considers regular and irregular past tenses as the same units and that uses the same decompositional process.

In line with single-mechanism hypotheses, several other studies (e.g., Devlin et al., 2004; Marslen-Wilson, 2007; McCormick et al., 2008; Rastle et al., 2000, 2004) have demonstrated the presence of an initial morpheme identification process before access to the lexicon is achieved. They acknowledge that morphological segmentation performs automatically and subconsciously before the whole-word representation is activated, and this serves both on the morphological and pseudo-morphological complex word constructions. While morphological word constructions share lexical and semantic representations with their constituent morphemes (e.g., teacher - {teach}+{er}), pseudo-morphological word constructions are actually simplex words

that cannot be further segmented into stems and affixes, and there is no semantic relationship between the full-form and the stem (e.g., corner could not be further segmented into {corn}+{er} due to the absence of semantic relationship between the meaning of corner and corn).

Rastle et al. (2000), for example, examined the pattern of morphological priming using prime-target pairs that had a real morphological relationship (e.g., teacher - TEACH) and a pseudo-morphological relationship (e.g., corner - CORN) that had an orthographic overlap in the context of masked priming with different SOAs (43 ms, 72 ms and 230 ms) in English. Their results revealed that "teacher" and "corner" were analyzed regarding their apparent morphemic constituents and thus showed that morpho-orthographic decomposition process applies to all words irrespective of whether they are truly-affixed or only appear to be morphologically complex. These results were replicated in other studies using less stimulus onset asynchronies (SOAs) including 42 ms (e.g., Rastle et al., 2004), 36 ms (e.g., Marslen-Wilson et al., 2008), 33 ms (e.g., Devlin et al., 2004), and using other languages including Dutch (e.g., Diependaele et al., 2005), French (e.g., Longtin et al., 2003) and Russian (e.g., Kazanina et al., 2008). Duñabeitia et al. (2013) investigated the influences of orthographic form relationships in L1 and L2 morphological processing using cognate words (i.e., words that have a common etymological origin). Unbalanced Spanish-English bilinguals and Basque-Spanish balanced bilinguals participated in two lexical decision experiments. In line with their findings, they argued for a processing mechanism that relies upon early morpho-orthographic decomposition.

Strong evidence for fast-acting automatic morphological decomposition was obtained in numerous studies using morphologically structured nonwords as primes. They showed that decomposition process takes place for all morphologically complex words including suffixed nonwords (e.g., adorage - ADORE; sportation - SPORT). For example, Longtin and Meunier (2005), in addition to prime-target pairs that had a true morphological relationship, used semantically interpretable, non-interpretable prime words relative to non-morphological pseudowords. The findings revealed that nonword primes significantly facilitated the identification of stems, showing that they were rapidly decomposed into their morpho-orthographic constituents. These results pointed

to an early and fast morpho-orthographic decomposition that applies to both truly derived and pseudo-derived complex words. Beyersmann et al. (2016) offered further evidence of masked priming effects with complex nonword primes employing a more robust methodology by using the same targets across all conditions. They obtained significant priming effects in all experimental conditions, showing that affix-stripping functions in all complex words, irrespectively of the legality of the morpheme morphological construction.

2.1.1.2. Full-Listing Models

The predictions of full-listing models are in stark contrast to those made by the compulsory decomposition models and differ markedly in how morphological information is used during the complex word processing. Full-listing models essentially postulate that morphologically complex words are always listed as whole-word representations in the mental lexicon. The earliest model that hypothesized complex words are listed as full forms was introduced by Butterworth (1983). According to the model, since lexical access to multimorphemic words requires their own full-form lemma, they are accessed exclusively through their whole-word representations.

Full-listing theories view the mental lexicon as a reserve of whole-word units, forming a dictionary-like structure where each word (be it monomorphemic such water) or multimorphemic such as government, snowman) has its individual, whole-word listing so there is only one corresponding word form. Even though morphological information does not have an early fast automatic influence on the word recognition in this non-compositional theory, morphological information might still be available post-lexically. According to Libben (1998), due to the lack of the computation of the meaning of the morphologically constructed word from its morphemes, the computational efficacy of the mental lexicon is increased. However, in the case of *snowman*, for instance, an extensive number of different entries where both complex words (i.e., snowman) and its constituents (i.e., {snow} and {man}) are separately stored would lead to a higher loaded memory system, diminishing the storage efficacy.

Though studies have yielded only limited evidence in favor of this first form of full-listing account, a new model has been put forward that extensively depends upon full-form representations. The supra-lexical model, which was proposed by Giraudo and Grainger (2001), envisages the mental lexicon as being composed of full-form representations that are always initially accessed so that constituent morphemic units could receive activation from their full-form representations. The model, therefore, predicts that complex words are segmented into constituents only when they are associated in meaning to their stems and that an initial whole-word activation will be followed by a morpheme representation activation. In line with this prediction, complex words without semantic relationship with their stems are purported to be stored as whole words. This account relies substantially on lexeme-based models of morphological processing (e.g., Aronoff, 1994), the structure of which is visualized in Figure 7. According to these models, morphological information is not designated as separate and independent morphemes, but rather lexeme units are located at the interface of word and semantic representations.

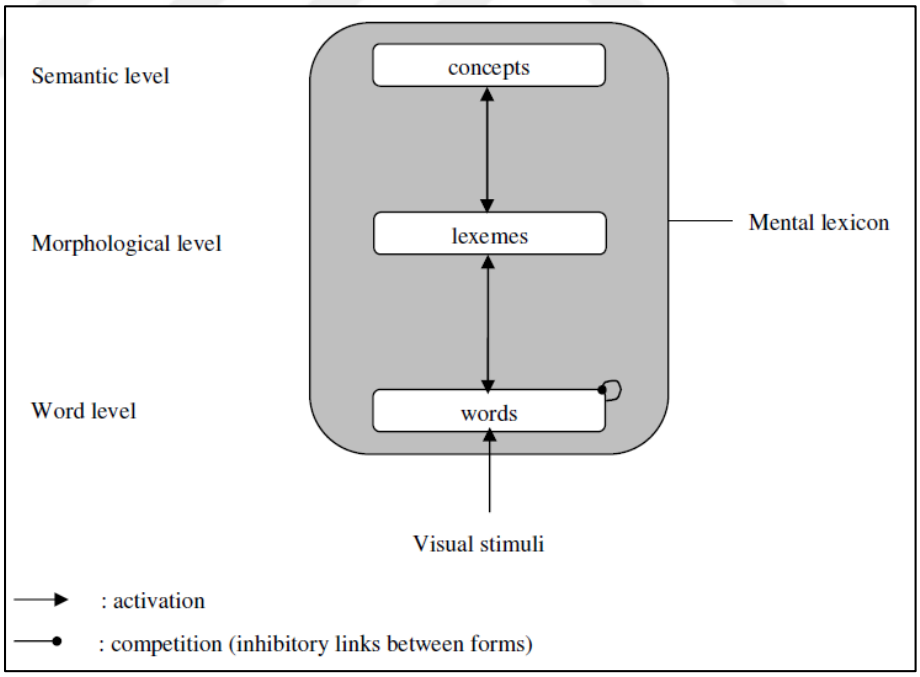


Figure 7. A Lexeme-based Model of Morphological Processing

In line with the assumptions of lexeme-based approaches, the figure shows that morphology acts only for a network of conventional link between words and

therefore is more abstract in nature in contrast to the affix-stripping models that identify morphemes as concrete units of words. Due to this abstractness, morphologically complex words are tolerant of form variations such as allomorphs that are brought about in derivational and inflectional morphology, and hence, the word is viewed as central to the lexicon and to the morphological operations. When the recognition of a morphologically complex visual stimulus activates corresponding word forms, competition arises among the triggered word forms until the correct word form is identified. Those competing word forms excite their corresponding base morpheme which then forwards the excitation back to the competitors. Thanks to this facilitatory bidirectional links with their stems, the two complex words that bare similar morphological structure are activated. Overall, the mechanisms to gain access to the morphologically complex word and a monomorphemic word are similar since morphological components are proposed to be activated only after the first access.

2.1.2. Dual-Route Models

More recent theoretical models permit influences of both full-form representations and morphological information that run simultaneously during word recognition. The dual-route models suggest that the access to the lexical representations of morphologically complex words is achieved through thier full-form representation or through the representations of their morphemic subunits (e.g., Baayen, Dijkstra, et al., 1997; Diependaele et al., 2009; Grainger & Ziegler, 2011). Therefore, dual-access theories incorporate both processes of decomposition and whole-word access (e.g., Clahsen, 1999; Pinker, 1999; Schreuder & Baayen, 1995).

One of the very early developments of two operating route models of word recognition came from a cognitive neuropsychology study. Caramazza et al. (1985) proposed the Augmented Addressed Morphology Model of lexical processing for inflectional morphology where access to lexical entries is made through whole-word activation for familiar words and through decomposition for novel words since lexical look-up would be more efficient for unfamiliar words. In this model, entries consist of stems positively connected to the inflectional affixes with which they

could join and (for irregular verbs) of stems negatively connected to suffixes with which they could not join. However, this model disregards the morphological characteristics of the affixes and the word stems. In the early dual-system theory of Schreuder and Baayen (1995), the use of full-form representations route and morphological segmentation route is dependent upon several factors. Complex words would be stored only in the presence of demanding morphological rules; for, retrieval on the basis of whole-word access presentations is a function of the computational cost during morphological processing together with the frequency of the word. Since complex words that have higher frequency will require considerable amount of morphological computation, they will be listed in the lexicon. For example, locally unmarked plurals such as *eyes* are ideal for storage (Baayen, Burani, et al., 1997) as well as suffixes that are phonologically neutral and that share the same form with freestanding words. In their model, they also propose inflections rather than derivations to be more likely to activate morphological segmentation route.

Bertram et al. (2000) stipulated three factors regarding the relative contribution of full-form route and segmentation route to the processing of a complex word: word formation type, affix productivity, and affixal homonymy. The first factor is related to whether an affix creates new lexical representations (i.e., derivational morphemes such as {ment}+ {govern}; {government}) or whether the affix only accounts for blending mechanism among different parts of the speech (i.e., inflectional morphemes such as tense and person markings of verbs). Affix productivity refers to the affix frequency of producing new instances of the same type. For instance, the affix {able} in the construction "{verb} + {able}" is highly productive (e.g., drink > drinkable, teach > teachable, photograph > photographable) in contrast to an unproductive suffix of {ly} "{adjective} + {ly}" (e.g., ready > readily, easy > easily, full > fully, empty > ?emptily). Bertram et al. proposed morpheme-by-morpheme decompositional processing for complex words with productive affixes and full-form storage with unproductive, meaning-variant affixes. Final component regarding the balance between the storage and computation of a complex word processing is the affixal homonymy, that is, whether one affix operates more than two semantic/syntactic functions. The affix {s} could be a good example to English

affixal homonymy as it functions both as a plural marker for nouns and third-person present singular verb inflection. According to Bertram et al., affixal homonymy triggers the activation of whole-word representations for inflected words.

There is substantial amount of research gauging frequency as the most significant factor in elucidating which route will be used during processing. Empirical support for the whole-word activation is obtained from the surface frequency effects while support for the segmentation route is obtained from base frequency effects (e.g., Baayen, Dijkstra, et al., 1997; Bertram et al., 2000; Niswander et al., 2000). The existence of only base frequency effects for some words bolsters up this model, which provides evidence for the segmentation processes that are in place while the existence of surface frequency effects for other words demonstrates the functioning of whole word access.

Arguments regarding the presence of either a single-route or a dual-route in the processing or complex words originally dwelled on the processing English past tense since it offered insights into both regular inflection patterns (e.g., kiss - kissed) and irregular inflectional patterns (e.g., drink - drank). Accordingly, a number of dual-mechanism models have centered upon the English past tense debate, that is whether complex words are segmented into stem and suffix (e.g., {talk} – {ed}) or processed as whole-units (e.g., talked) with regards to inflectional morphology. Many researchers following the Chomskyan tradition, have observed different patterns of regularly and irregularly inflected verb processing in various languages (e.g., for English, Münte et al., 1999; for Spanish, Rodriguez-Fornells et al., 2002; for German, Weyerts et al., 1996). In line with the principles of dual-mechanism models, several studies have yielded empirical support in favor of the computation (segmentation) of regular words by a system that works on the procedural knowledge and holistic retrieval of irregular words that is processed via a declarative system (e.g., Marslen-Wilson & Tyler, 1998; Pinker & Prince, 1988; Ullman, 2001).

In the modern version of the Chomskyan tradition, dissociations between regular and irregular morphology have been obtained from cognitive neuropsychology studies (e.g., Beretta et al., 2003; Jaeger et al., 1996; Marslen-Wilson & Tyler, 1998;

Sahin et al., 2006; Tyler et al., 2002). For example, Ullman et al. (2005; 1997) clearly differentiated between the processing of regular and irregular morphology in their declarative/procedural model. According to the model, irregular morphology resides in the left temporal structure that sustains a lexical "declarative" memory system, whereas regular morphology is situated in left-frontal structures that involve procedural memory system. Results obtained from studies that have investigated derivational morphology might speak in favor of Ullman's model, which further proposes less computational processing that involves grammar for L2 since it is more reliant upon lexical memory system and rely less on combinatorial structure. Silva (2008), for example, reported similar magnitudes of priming in identity (e.g., neat - NEAT) and derived (e.g., neatness - NEAT) conditions for L1 speakers of English but reduced priming effects in the derived condition for L2 speakers of English.

The most recent model of word recognition is proposed by Diependaele et al. (2011) and builds on previous accounts, suggesting lexical form representations could be triggered via two routes running in parallel so the input can be recognized either via representations of the word's constituent morphemes or via the whole-word representation. This model incorporates research findings that have demonstrated semantic influences on morphological processing with the evidence of a graded facilitation from both semantically transparent (e.g., worker - WORK) and semantically opaque (e.g., department - DEPART) and form (e.g., cashew - CASH) target-prime pairs (e.g., Diependaele et al., 2005, 2009; Feldman et al., 2009; Morris et al., 2007). Therefore, the model seeks to explain priming effects arising from both form and meaning features, and this morphological activation is depicted along with the form-then-meaning account in Figure 8. With respect to the figure, Panel A illustrates that initial stage of complex word processing is purely orthographic (sub-lexical) and compulsory (e.g., Rastle & Davis, 2008; Taft & Forster, 1975) before it is passed onto the lexical form level. At this abstract lexical level, the degree of semantic transparency is taken into consideration in the processing. Positive links facilitate the recognition of the transparent complex word (i.e., worker) with heavier morphemic activations, while there is no such potent links for the opaque complex word (i.e., corner) at this later stage of processing. This might account for empirical

evidence that has revealed robust priming effects with transparent and opaque primes at shorter exposure durations, whereas this effect has decayed and vanished at higher durations (e.g., Taft & Nguyen-Hoan, 2010).

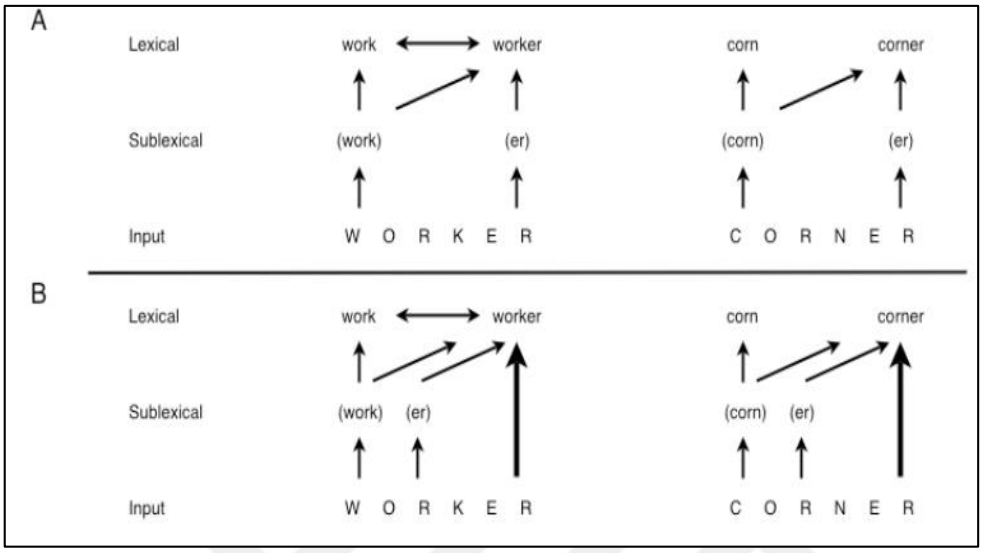


Figure 8. Dual-route Model of Morphological Processing (Diependaele et al., 2011)

Panel B shows how morpho-orthographic and morpho-semantic influences co-occur in parallel: While morpho-orthographic route decomposes complex words into the component morphemes and activates corresponding lexical representations, morpho-semantic route maps the complex words onto their corresponding full-form input representations. This is evident from the direct link between low-level orthographic representations and higher-level lexical representations that lead to sole morpho-semantic influences. Those activated lexical representations are then mapped onto a more abstract supra-lexical level which represents semantic relationships and involves stem morphemes. The extent to which these predictions were accurate was investigated in Diependaele et al. (2013) using letter transpositions. In their study, L1 English speakers responded to experimental targets preceded by either unaltered, transposed-letter or replaced-letter primes in semantically transparent, semantically opaque and form conditions. Findings revealed facilitation with transparent complex primes when two letters are reversed, while opaque prime-target pairs yielded inhibitory priming effects.

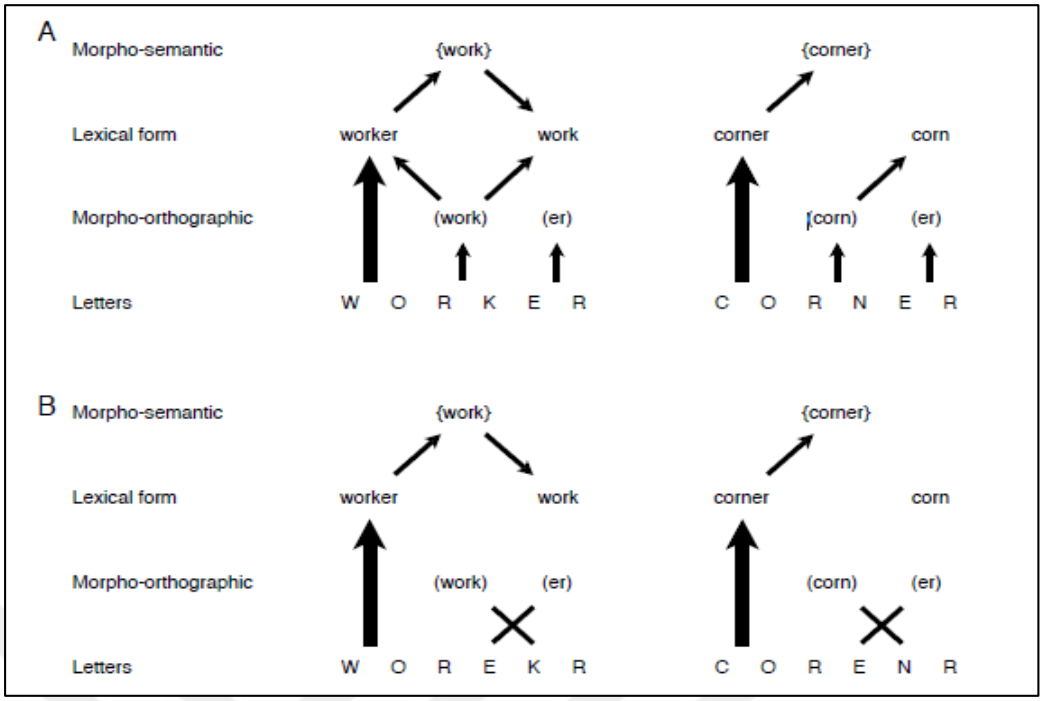


Figure 9. Dual-route Model of Morphological Processing (Diependaele et al., 2013)

The model (Diependaele et al., 2013), illustrated in Figure 9, makes a further distinction between two orthographic codes. It associates the morpho-orthographic parsing route with a fine-grained processing system that requires precise letter position coding for the input, whereas the whole-word route is less sensitive to the exact positioning of letters and therefore could provide fast access from the full-form lexical representations to the morpho-semantic representations. This latter coarse-grained route then activates words with letter transpositions since it offers flexibility in letter position encoding during word identification. The authors hypothesize that distinctive sensitivity of the two routes results in TL-effects (i.e., tolerance of letter imprecisions) where there are distinct levels of influences of letter transpositions on semantically transparent and semantically opaque words.

2.2. The Transposed-Letter Effect and Letter Encoding Models

Following from Diependaele et al. (2013) study, it could be argued that there are many cases, whether they be informal instances on social media or on more formal contexts such as e-mails, skilled readers tolerate minor alterations in written texts. The following sentence, for instance, “In line with the recommendations of the

specialists, seniors who execrise regularly do not allow the snipe to deform" might not disrupt the flow of reading for the majority of readers. If that is the case, this would be because of the fact that these readers would read the word *snipe* as *spine* and *execrise* as *exercise*. These instances, in both cases, raise questions as to whether the mechanism(s) of visual word recognition could tackle the visual stimulus with reversed letters and whether readers are insensitive to moderate letter alterations in the visual input particularly when this transposition occurs word-internally. TL nonwords such as *execrise* that produce form priming effects inform models of visual word recognition with respect to the imprecise coding of letters. These nonwords are misperceived as their base words which lead to transposed-letter confusability effects (e.g., Perea & Lupker, 2003a).

The presence of TL effects challenges computational models of visual word recognition which predict inflexible position-dependent assignment of letter identities and the letter positions. These TL effects provide significant insights into the mechanisms of visual word recognition specifically in two aspects: First, Andrews (1996) demonstrated that participants are slowed down while they process stimuli with transposed letters compared to match control words that form already existing letter sequences (e.g., dairy - diary). Second, numerous studies have documented the facilitative effects of TL-nonwords in relation to their orthographic substituted letter (SL) control condition formed by substituting the TLs with two different letters. This showed TL words resembled more to their original forms than the SL words. Thus, while transposed-letter confusability effects indicate that the letter position coding mechanisms are flexible enough to compensate for the reversed letters, the diminishing or disappearance of TL-priming effects in substituted control conditions implies that these mechanisms also obey the letter identity coding process.

Before this section further elaborates on models that could account for transposed-letter effects, earlier influential computational models will be discussed in the following section.

2.2.1. Models of Letter Encoding

Investigations into how letters are positioned within a word have informed about how the brain deals with the information at higher levels of cognitive processing. These involve the formation and organization of representation from the constituent entities and aim to answer how the brain represents the input such as “ARM”. Is it coded as first “A”, then “R”, and finally “M”, but not “R”, “M”, and then “A”, or first “M”, and “R”, and finally “A”? In line with this line of reasoning, two prominent approaches to the letter position encoding have been suggested. These two computational models of word recognition have differing views on whether and how letter positions are coded.

In slot-coding schemes, the positional encoding of each letter within a word is precise. The earliest model of slot-coding schemes is the Interactive Activation Model (IAM; McClelland & Rumelhart, 1981). In this model, the letter encoding mechanism allocates each letter to a specific position within a letter string where it is processed individually within its own slot. In line with this IA model, the coding of the letter string “ARM” would be A1R2M3 where the first slot is assumed by letter “A”, and the second slot by letter “R”, and the third slot is filled by “M”. Due to the precise slot assignment of letter identities, this model could differentiate between anagrams such as ARM and RAM which would be coded as R1A2M3. Therefore, according to the model, ARM and RAM are totally different entities since in the input R1A2M3, the first slot is represented by R, while A and M follow the second and third slots as opposed to the stimuli A1R2M3 where A occupies the first position and R the second. This model also accommodates the word superiority effect (WSE) which demonstrates readers better recognize letters when used within words compared to when letters are shown individually or within nonwords. Figure 10 below shows how letter position coding and word superiority effects are addressed within IAM.

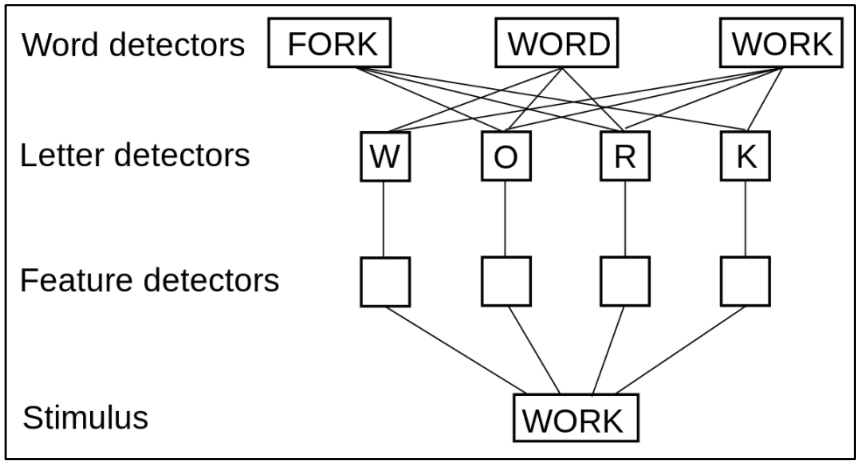


Figure 10. Interactive Activation Model (Rumelhart & McClelland, 1981)

According to this channel-specific interactive-activation model, there is one separate slot for each letter within the stimulus "work" where it would be represented by activating the four-letter codes W1, O2, R3, K4, with the with the letter W associated with the position 1 slot; letter O in position 2, letter R and K in positions 3 and 4 respectively. Once target letter is shown in a word, there is an activation of the feature detectors, letter detectors and word detectors, which would add to the final identification of the word. Nevertheless, in the case of the presentation of only the letter, there is an activation of the letter detector only. Hence, within a word, the visual input would be recalled more efficiently and recognized more accurately, resulting in the WSE. Other successor models include the activation-verification model (AVM; Paap et al., 1982), Dual Route Cascaded Model (DRC; Coltheart et al., 2001) and the multiple read-out model (MROM; Grainger & Jacobs, 1996). These models, following a similar principle to the IA model, propose position-specific coding schemes where each letter in a visual stimulus is appointed a location-specific slot and could only activate other stimuli when they have identical letters in the corresponding slots. For example, the word "dessert" is as similar to "deserts" as it is to "despair" because in both cases three identical letters are in the exact letter positions. Another example is the word "kid" that would only activate the lexical representations that also possess three-letters; thus, the lexical representation of "kind" would not be activated. However, there is a considerable amount of research that has documented counter evidence (e.g., Perea & Carreiras, 1998; Peressotti & Grainger, 1999). For example, Duñabeitia and

Carreiras (2011) reported the relative position priming effect where target word recognition is facilitated through a prime word that shares the consonants in the target word, keeping their letter position (e.g., csn as a prime for casino). Overall, these models could effectively differentiate between anagrams, but they demand a rather high degree of item redundancy, as they necessitate a definite representation of each letter in each possible slot. A further drawback of such schemes is that they are falsified and have failed to account for various phenomena and therefore are not consistent with more recent research. Many studies showed readers are tolerant of letter distortions such as TL effects (clods - colds), letter migrations (cloud - could), repeated letters (moose - mouse), or subset/superset effects (faulty - faculty). This line of research has shown the significance of the relative order among sets of letters, instead of the specific letter-position coding (e.g., Peressotti & Grainger, 1999), providing evidence in favor of priming across letter positions (e.g., Peressotti & Grainger, 1995).

Against this background, TL methodology is particularly informative because the presence of TL effects demonstrates letter position is flexible and hence provides evidence against slot-coding models of visual word recognition. These models include Interactive activation model (McClelland & Rumelhart, 1981) and dual-route cascaded model (Coltheart et al., 2001) that assume precise assignment of letters to a single position. These models envisage that TL words *govenr*, *govezc*, *goveos* would make it easier for the target word such as *govern* to be recognized to the same degree since they all share four letters that occur in the correct position. Nevertheless, a considerable amount of evidence has shown that participants found it more difficult to reject TL nonword such as *govenr* (i.e., transposed letter version of GOVERN than a SL nonword such as *govezc*. This finding provided evidence that "GOVERN" is recognized even though two of its letters are reversed and demonstrated visual word recognition system tolerates the jumbled-words, and it could still identify them (e.g., Duñabeitia et al., 2009; Lee & Taft, 2009; Lupker et al., 2008; Perea & Lupker, 2003a, 2004; Schoonbaert & Grainger, 2004).

In the last few decades, various other models of orthographic coding have been suggested particularly to explain transposed-letter priming effects by attaching

positional noise to letter-position coding mechanism that cannot otherwise yield these effects. In these models, the orthographic code comprises a set of units representing bigrams. In these open-bigram coding schemes, an input is represented with respect to all of its ordered letter pairs and could have contiguous or non-contiguous letter pairs (e.g., Dehaene et al., 2005; Grainger & Heuven, 2004; Grainger & Whitney, 2004; Whitney, 2001; Whitney & Berndt, 1999). For instance, the word "KID" has the contagious open-bigrams KI, ID and the non-contagious open-bigram KD. Therefore, these models could explain relative position priming effects as well as TL priming effects as they assume priming to be a function of orthographic similarity between the target word and the prime word with respect to the number of open-bigrams they share. For instance, the word "SPINE" has the following ten open-bigrams: SP, SI, SN, SE, PI, PN, PE, IN, IE, NE. The transposed-letter anagram prime "SNIPE" shares seven out of ten open-bigrams (OBs) SN, SI, SP, SE, NI, NP, NE, IP, IE, PE and superset and subset primes "SPINCE" share ten matches, with OBS SP, SI, SN, SC, SE, PI, PN, PC, PE, IN, IC, IE, NC, NE, CE whereas there are only three matches in the SL-control condition "SRILE": SR, SI, SL, SE, RI, RL, RE, IL, IE, LE. Hence, the superset prime and TL-prime are more comparable to the stimulus than the SL orthographic control prime, therefore yield greater sizes of priming effects.

Currently, many open-bigram models of visual word recognition prevail in the literature; however, they propose different hypotheses as to the relative distance between letter pairs and the order of bigrams. For example, Schoonbaert and Grainger (2004) in their "constrained-open bigram model" postulate that letter units that are either contagious or within two-letter distance could activate the corresponding bigram, but they will not activate the bigrams if the distance between the letter units is too large. Their model links open-bigrams with different activation levels. Hence, for a word such as "SPINE", the bigrams SP, SI, SN, PI, PN, PE, IN and IE would each have activities of 1, whereas remaining bigrams would be 0, implying that the bigram SE, for example, would not be activated by the stimulus SPINE while the OB SP could. In the later version of this model, the edge bigrams that consist of the initial and final letter in the stimulus (e.g., the bigrams SE in

SPINE) are weighted more and are coded by activities of 1 and will be activated during visual word recognition.

In another version of open-bigram coding, the Sequential Encoding Regulated by Inputs to Oscillations Within Letter Units Model (SERIOL; Whitney, 2001; Whitney & Berndt, 1999), the main difference between the earlier versions is the mechanism that activates the open bigram because it weights the distance between the two letters of the bigram differently and takes into consideration the separation between the letter pair. In this serial encoding model, letters fire sequentially and are labelled in line with their sequential order. For example, for the stimulus "KIND", letter K is tagged with 1, I with 2, N with 3 and D with 4. The representations of the individual letters are activated through the firing of letter units, informing open-bigram units where letter position within a given stimulus is contained. In the bigram level of the model, between the letter level and word level, the letters are converted into pairs through this firing pattern. For example, the bigrams for "KIND" would involve contiguous bigram units #K, KI, IN, ND and D# and non-contagious units KN, KD, ID where # indicates a word boundary. The strength of bigram activation diminishes with increasing distance between constituent letters and contiguous bigram units. For instance, bigram activation level for KI is stronger than KN where the weight of former would be 1.0, and the that of the latter would receive .8. If the open-bigram units are separated by two letters, the weight of this non-contiguous bigram would be .4 (Whitney, 2008).

In the unconstrained parallel open-bigram model, Grainger and Van Heuven (2003) proposed a hierarchical, parallel activation mechanism depicted in Figure 11. In the alphabetic array level, visual features are obtained from the visual input and then transferred to the alphabetic character detectors where connecting information from distinct processing slots provides a relative position code for letter identities. As there is an equal distribution of activation weight of the contiguous and the non-contiguous bigrams, ordered open-bigram pairs activate corresponding representations at the relative position map which in turn these open-bigram representations are activated at the whole-word level (O-words) through bidirectional excitatory connections.

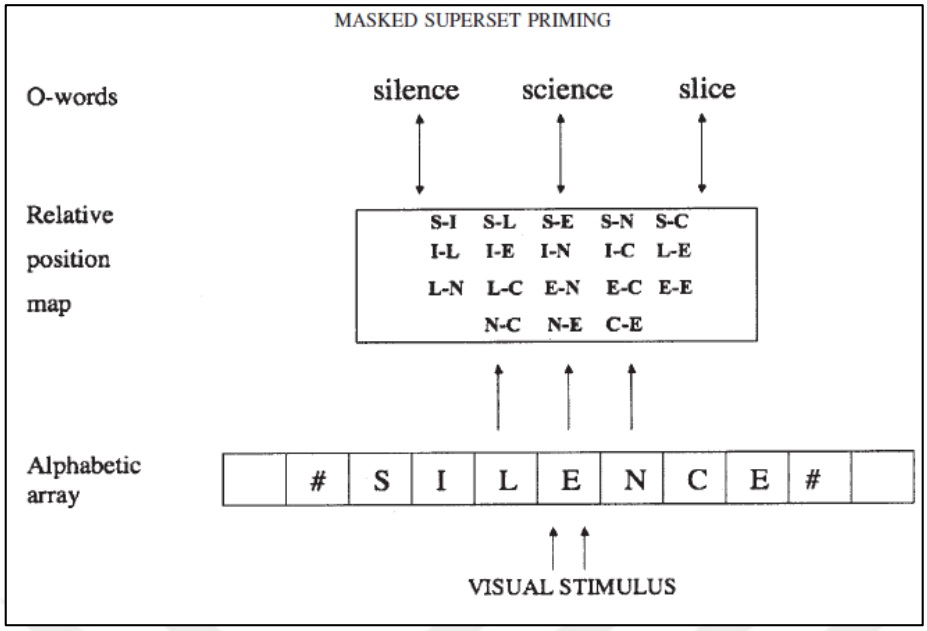


Figure 11. Unconstrained Parallel Open-bigram Model

Even though empirical investigations into these models have somewhat been challenging due to a number of different assumptions of open-bigram models (e.g., Lupker et al., 2015), Lupker and Davis (2008) presented evidence in their masked sandwich priming experiment where they presented the target itself for 33 ms between the forward mask and the prime. It showed that a reversed interior letter prime (e.g., cetupmor) primed a target (e.g., COMPUTER) relative to the control prime cifagnar. This finding could only be accommodated by the unconstrained parallel open-bigram model (Grainger & Van Heuven, 2003) since all potential bigrams would be activated of equal strength including the OBs CE, CT, CU and so forth, which are not present in cifagnar. However, consistent with the assumptions of alternative open-bigram models, since the only bigrams that are common both in *cetupmor* and *computer* are the edge bigrams of C and R, also existent within the control prime *cifagnar*; it would be predicted that similar magnitudes of priming would be obtained from both prime types. They would therefore fail to predict that *cetupmor* would be a better prime for the word computer than *cifagnar* (e.g., Lupker et al., 2015).

However, spatial-coding models such as self-organizing lexical acquisition and recognition model (SOLAR; Davis, 1999), could successfully accommodate this finding. In this model, not the bigrams but the codes' order in relation to the relative

activation letter identity are associated with the level of activation. Following this line of reasoning, the model predicts that the first letter in the visual stimulus would get the largest magnitude of activation, the second gets the second largest level of activation until the last letter has the lowest activation level. Letter position in this model affects the level of activation, but a contagious letter contains similar levels of activation, which is in line with the priming effects demonstrated in transposed-letter studies. Since the activation is predicted to be successive in the SOLAR model, reversed letters would still yield priming effects. This model could also account for the priming effects obtained in priming studies with anagrams. As seen in Figure 12, each letter in anagrams "STOP" and "POST" has a distinct level of activation resulting from ultimate encoding of letter positions. For instance, the letter T has more activation when presented in "STOP" than "POST" because the amount of activation is higher in the initial letters of a stimulus. On the other hand, the letter P receives the highest activation when read in "POST" compared to "STOP" as the level of activation would decrease towards the final letters.

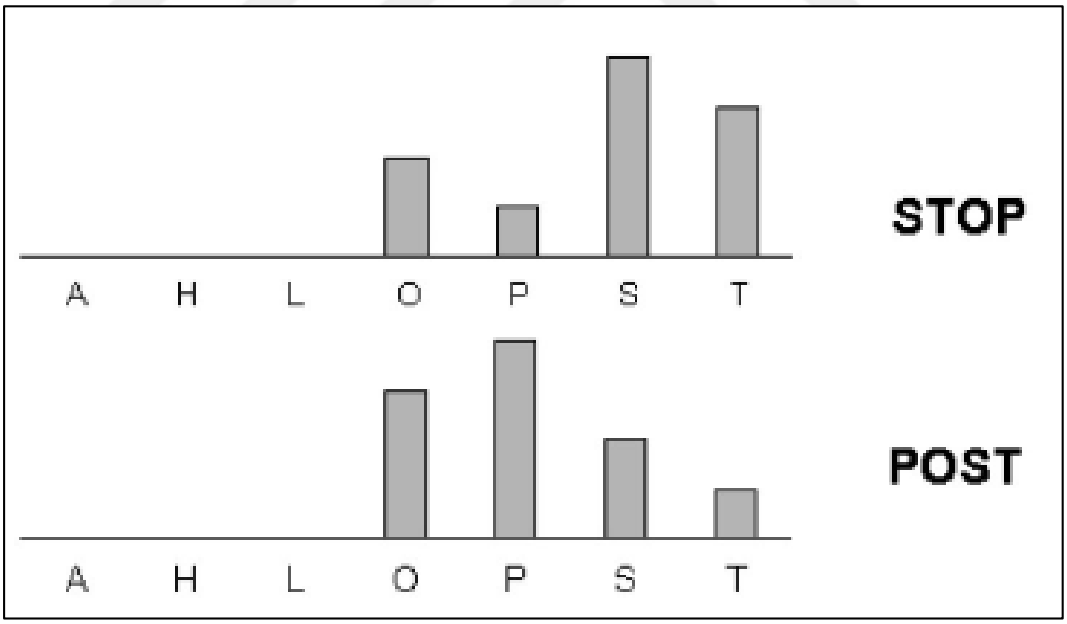


Figure 12. Spatial Coding for the Stimuli "STOP" and "POST"

Another prominent model that could deal with the transposed-letter effects is the Overlap Model (Gómez et al., 2008) where letter positions are assumed to be coded in a noisy manner so multiple positions could be associated with each letter within

a visual stimulus. For example, in the visual input “KIND”, the letter I is associated with position 2, but to a lesser degree with positions 1 and 3, and to even a lesser degree, with position 4. Letters in the input have distributions over positions that cause one letter representation to extend into other positions. Therefore, identities of the letters are purported to be normally distributed over position. Each letter position has a discrete standard deviation, and thus, the amount of overlap in letter position is coded as a standard deviation parameter.

Overall, a great deal of attention has been dedicated to understanding the role of letter identities and letter position coding in the visual word recognition. As a result of these studies, it is now widely accepted that individual letters have a significant role on the orthographic code; however, the theoretical positions that the computational models take indicate different approaches and predictions regarding how letters are coded and positioned in the processing of visual stimuli. Recently, transposed-letter effects have contributed substantially to the principles of position of flexibility and uncertainty and laid the foundations in many prominent models of visual word recognition by presenting evidence against position-specific coding schemes.

2.2.2. Transposed-Letter Effect and Morphology

In addition to the letter recognition and letter position assignment, several other processes underlie the recognition and processing of a morphologically complex word. These include the processes of morphological segmentation, lexical retrieval and access to semantics. However, these theoretical models discussed above do not consider the issue of morphological processing in their principles even though morphology is purported to tap into initial processes of visual word recognition (see Rastle & Davis, 2008 for a review). One relevant question is therefore whether letters are positioned in the same stage as when decomposition occurs and whether TL effects and morphology interact with one another.

To this end, the present study examined morphological TL effects to establish the relationship between letter position coding and morphological processing during

word recognition. Hence, in the present study, TL effects were investigated through transpositions that occurred both within and across morpheme boundaries to provide insights into identifying the processing of morphologically complex words. Thus, the transposed letters in primes could be either intra-morphemic, i.e., within the morpheme boundary, or cross-morphemic, i.e., could cut across the morpheme boundary. For example, in a TL experiment where the processing of a morphologically complex word like *government* is investigated, for the target word GOVERN, the prime *govenrment* involves transposed letters (TL) within the morpheme boundary, whereas the prime *govermnent* involves TL, cutting across the morpheme boundary. The transposed letter-effect is obtained when it takes participants longer to respond to a prime that contains substituted letters than to a prime that contains transposed letters. The difference between the reaction times in these conditions is taken as evidence for the measure of transposed-letter priming.

Theories of word recognition are informed by the results of TL studies that clarify the issue of morphological segmentation during word recognition. The results of TL priming studies are used to gain insight into whether morphological decomposition co-occurs with letter position encoding and whether cross-morphemic transpositions obstruct the complex word recognition. Also, the use of TL-primes helps address the nature of morphological processing by allowing further investigation into whether morphological decomposition still occurs when the morphologically complex word is a nonword. The presence of morphological priming with TL nonword primes would mean that the morphological decomposition is solely on basis of structural information. In other words, if morphological decomposition and the orthographic processing co-occur in the initial stages of word recognition (e.g., Beyersmann et al., 2011), cross-morphemic letter transpositions should disrupt word recognition more than intramorphemic letter transpositions.

Few studies have investigated morphological TL effects by eliciting the response times to morphologically complex words that involve both cross-morphemic and intra-morphemic transpositions (Christianson et al., 2005; Duñabeitia et al., 2007; Rueckl & Rimzhim, 2011; Sánchez-Gutiérrez & Rastle, 2013). The results largely support the obligatory decomposition model when transpositions across morpheme

boundaries have been more disruptive since the disturbance of the affix when transpositions straddle morpheme boundaries hinders the pre-lexical segmentation mechanism, as a result of which a complex word like *government* cannot be activated. Also, if the recognition of the complex word *government* occurs after the segmentation of the affix -ment from the stem *govern*, it could be assumed that the processing is obscured due to the disruption of the affix. This makes it harder to decide the target word GOVERN as a real word because it would not be primed by *govermnent* as much as the prime *government*. In other words, morphologically complex words must hold their full-form representations in the lexicon when the lexical status of these words is altered through letter transpositions that cross morpheme boundaries.

Using a masked primed naming task, Christianson et al. (2005), for example, demonstrated that the priming effects vanished when letter transpositions disrupted morpheme boundaries[1] in English compound words. Experiment 2 extended these findings to opaque compounds and showed this pattern was similar across both transparent and opaque compounds. This finding was replicated in the last experiment with transparent and opaque affixed words by substantiating the generalization that the position of transposition is detrimental to morpho-orthographic segmentation. However, the authors used a relatively long prime duration, thereby giving readers time to thoroughly process the prime. Therefore, if these results reflect the early mechanisms underlying morphological processing is highly questionable. Perea and Carreiras (2006) overcame this shortcoming by using a shorter prime duration (47 ms) in Basque language. Participants responded to compound and non-compound words preceded by identity, TL-across and SL-across primes. With SL-across condition as the baseline condition, significant transposed-letter effects were reported, contrasting the earlier evidence reported by Christianson et al. (2005). Nevertheless, this study examined the processing of compound words which is hard to compare with affixed words since the former consists of the

[1] This is also referred to as the "morpheme boundary effect".

combination of at least two stem morphemes (e.g., blue [stem] + berry [stem]), in contrast to affixed words where there is at least one affix attached to a stem.

Further evidence that letter transpositions across morpheme boundaries potentially inhibit the recognition of the target words and therefore eliminate the well-established TL-priming effects in simple words was presented in Duñabeitia et al. study (2007) who examined both suffixes and prefixes in three masked primed lexical decision tasks. Suffixed TL-across primes in Basque failed to facilitate the recognition of target words in experiment 1, and these results were replicated using prefixed primes in two conditions (TL-across and SL-across) in a typologically different language, Spanish (experiment 2), while non-affixed target words yielded TL-priming effects in both experiments. Spanish speakers, in the last experiment, were presented with word pairs that were preceded by either TL-within (meosnero-MESONERO), SL-within (meurnero-MESONERO), TL-across (mesoenro-MESONERO) or SL-across (mesoasro-MESONERO) primes. Significant transposed-letter effects were found only when transpositions occurred within morpheme boundaries, providing further evidence in favor of early mechanisms that guide morphological decomposition.

However, the findings obtained from Christianson et al. (2005) and Duñabeitia et al. (2007) were called into question in Rueckl and Rimzhim (2011) who carried out a series of masked primed LDT experiments with different SOAs (experiments 1-4, 48 ms; experiment 5, 80 ms). In experiment 1, participants' responses to English stem targets preceded by morphological and TL-within primes were compared with those preceded by SL within primes. The results showed facilitation from both morphological and TL-within primes. These results were corroborated in experiment 2 in which there was an equal size of priming from morphological and TL-across primes. In experiment 3, a direct investigation into morphological, TL-within and TL-across primes was made, which resulted in no significant differences between these conditions. Experiments 4 and 5 were carried out to investigate the potential influences of methodological differences from Christianson et al. (2005) and Duñabeitia et al. (2007). Participants responded to intact morphologically complex target words (WORKER) instead of stem targets (WORK), and the

findings pointed to no significant differences between target words that are complex or simplex. By using English stem targets, supporting evidence in favor of facilitatory effects of TL-across priming in English was also reported in Diependaele et al. (2013) who provided further evidence that this facilitation disappeared in the case of semantically opaque prime-target words (e.g., department - DEPART). The authors took this evidence to suggest that letter transpositions were more disruptive to the morpho-orthographic processing than to morpho-semantic processing. Sánchez-Gutiérrez and Rastle (2013), in a masked primed LDT with Spanish and English cognate complex targets (e.g., IDEALISTA-IDEALIST), tested if different magnitudes of TL-within and TL-across priming effects could be obtained as a function of cross-language differences. However, priming effects in both conditions were significant, suggesting that transposed-letter benefit did not vanish when letter transpositions crossed the morpheme boundary.

It needs to be pointed out, though, that the evidence obtained from TL studies in L1 so far is ambiguous, showing conflicting patterns of morphological processing. While one line of research has presented evidence in favor of the transposed letter effects obtained only from primes that had within-morpheme letter transpositions (Christianson et al., 2005; Duñabeitia et al., 2007), whereas another line of research has demonstrated that whether transpositions occur within or across the morpheme boundaries does not affect the level of TL-priming effects (Beyersmann et al., 2013; Diependaele et al., 2013; Perea & Carreiras, 2006; Rueckl & Rimzhim, 2011; Sánchez-Gutiérrez & Rastle, 2013). Importantly, it is not yet known whether similar results could be extended to L2 speakers since TL-priming effects have not, to date, been investigated in L2 processing. Therefore, the present study was one of the very first empirical masked priming study to investigate the masked morphological TL effects in L2 processing that also considered L1 processing.

2.3. Early Stages of Word Processing

A considerable number of studies have reported morphological decomposition during the early stages of complex word processing (e.g., Beyersmann, Ziegler, et al., 2016; Diependaele et al., 2011; Rastle et al., 2004; Rastle & Davis, 2008).

Research on visual word recognition has more recently shifted its focus from decomposition to the time of course of this decomposition and to when the later mechanisms are used in the activation of the actual meaning of a complex word. This shift made the role of semantic influences in this decomposition process one of the topics that received extensive attention. As a result of evidence accumulated through priming manipulations, there now exists a consensus that in the processing of morphologically complex words, morphology has an important part, and that morphological segmentation indeed occurs. Yet, there are still discussions around how and when this segmentation is achieved. Fundamentally, there are two accounts that seek to explain the time course of this decomposition: the form-then-meaning account and the form-with-meaning account. These accounts have different predictions regarding the influences of morpho-semantic information during the early stages of word processing but often converge on experimental manipulations they use by providing a basis for studying effects of semantic influences within the intra-lexical level. They utilize word targets that are preceded by semantically transparent, semantically opaque, and orthographically related but morphologically unrelated primes. Semantically transparent condition contains truly-affixed prime-target pairs whose meaning could be deducted from the constituents of the morphologically complex word. In the semantically opaque condition, however, the morphologically complex word does not have a true morphological relationship where the whole word is in no relation to the meaning of its constituents (e.g., the morphemic element *corn* is not semantically related to the meaning of *corner*). Hence, in these pairs, the participants could derive the meaning from its morphemic subunits (worker - WORK) or could not (department - DEPART) when measured against orthographic control condition (cashew - CASH). The control condition provides a basis for investigating the contribution of intra-lexical semantic information and specifically serves to conclude that the effects are particularly morphological. It contains form overlap items in which there is no semantic or morphological relationship between prime-target pairs (e.g., cashew - CASH). The absence of priming effects in this condition is taken as evidence for the facilitation from the transparent and opaque conditions that could not be ascribed to similarities in form between the items.

2.3.1. The Form-then-Meaning Accounts

Regarding the time course of morphological decomposition, even though some studies have suggested that morphological segmentation occurred at a later stage, running over semantic processes (e.g., Giraudo & Grainger, 2001; Marslen-Wilson et al., 1994; Plaut & Gonnerman, 2000), a substantial number of studies have pointed to an earlier processing of morphologically complex words (e.g., Beyersmann et al., 2011; Marslen-Wilson et al., 2008; Morris & Stockall, 2012; Rastle et al., 2000, 2004; Rastle & Davis, 2008). In most studies, the difference in priming effects obtained in semantically transparent and opaque prime-target pairs has formed the basis for the form-then-meaning account. In this account, it is stipulated that the initial stages of morphological processing are independent of the influences from semantics and that the decomposition of these forms into their morphemic constituents relies entirely on morpho-orthographic information. Hence, according to these accounts, there is fast-acting morphological decomposition on the basis of orthography, and this system initially segments any visual input that appears to be morphologically complex independently of semantic information. This account contrasts with the predictions of a "supralexical" account (e.g., Giraudo & Grainger, 2001) in which constituent morphemes are activated only after activation of the whole-word representation.

As stated above, research that seeks to elucidate the morpho-orthographic and morpho-semantic activation has generally compared the priming effects obtained in semantically transparent condition (e.g., worker - WORK) to the semantically opaque condition (e.g., department - DEPART) relative to the form condition (e.g., cashew - CASH). The form-then-meaning account predicts that if the orthography is the determinant of the representations, there should be an equal magnitude of priming in the transparent and opaque conditions, larger than that of the form condition. However, if it is the case that lexical representations are decomposed based on the semantic relationships, then the facilitation in transparent morphological condition should be larger than that of the opaque condition.

Dominguez et al. (2002) tested the influences of semantic information in a Spanish masked lexical decision task where participants responded to target words primed by semantic (e.g., pena - LUTO [sadness - MOURNING]), orthographic (e.g., rato - RATA [moment - RAT]) and morphological (e.g., loco -LOCA [madman - MADWOMAN]) words at the 32- and 64-ms stimulus onset asynchronies (SOAs) along with unmasked primes at a 250-ms SOA. They documented similar magnitudes of priming effects from both orthographically and morphologically related pairs at the 32 ms; however, there was larger facilitation from the morphological primes at 64 ms SOA. The semantic facilitation occurred only at the longest SOA (250 ms) as opposed to the morphological facilitation seen at the shortest SOA (32 ms). Authors, thus, proposed that there was the influence of semantics as a function of increased prime duration and that access to the morphological information was early and irrespective of semantic relatedness, which only had a role in morphological processing at longer prime durations.

Another initial support came from French data using a 46 ms SOA by Longtin et al. (2003). In their first experiment, prime-target pairs were presented in four different conditions. Their findings demonstrated that there was an influence of semantic information only in the later stages of word recognition but that early processing depended exclusively on orthographic information since the pre-lexical decomposition process was potentially activated by surface level morphology. They further stated that morphemic decomposition would happen only when the morphemic composition of a morphologically complex word was semantically transparent, allowing morphemic units to stay activated. In a subsequent study, using masked primed English lexical decision task, Rastle et al. (2004) replicated these findings by investigating the priming effects of semantically transparent and opaque morphological pairs relative to form prime–target pairs in English at a 42-millisecond prime duration. However, they emphasized that the behavior of semantically opaque words should be made clear since semantically opaque words originally referred to words in which there was no semantic relationship but a morphological relationship using etymological characterizations (e.g., witness - wit; Marslen-Wilson et al., 1994). Orthographic prime–target words referred to items in which there was neither semantic nor historical morphological relationship even if

these pairs were guided by the appearance of morphological complexity (e.g., corner - CORN). Rastle et al. indicated that a semantically opaque morphological relationship could only be attributed to pairs when they possessed a surface morphological relationship with no semantic relationship (e.g., corner - CORN; department - DEPART) and a merely orthographic relationship in which primes cannot be segmented into a stem and affix (e.g., cashew - CASH). Rastle et al. further stated that morphological decomposition mechanism that is free of influences of semantic information should show sensitivity to the appearance of a morphological complexity rather than etymology. In line with this reasoning, contrary to Longtin et al. (2003), Rastle et al. did not consider opaque and pseudo-derived words as different conditions but included both in a single opaque condition. The results demonstrated that the morphologically related primes irrespective of their semantic transparency facilitated the recognition of the target words relative to the nonmorphological primes. This was taken as an indication of a rapid decomposition that depends on a morphological relationship and that operates on any complex word.

In a meta-analysis study, following the findings of Rastle et al. (2004), priming effects in transparent, opaque and form overlap conditions were averaged across all studies, and it was revealed that there was an overall 30-ms facilitation in transparent prime-target pairs and 23 ms in opaque pairs and 2 ms facilitation in form pairs (Rastle & Davis, 2008). This concluded that there was no statistically significant difference in the facilitation obtained in the semantically transparent and opaque prime-target pairs relative to the non-morphological form prime-target pairs. As a result, they proposed a fast-acting morphological segmentation mechanism that is dependent only upon orthographic information that would take place in any stimulus that appears to be morphologically complex. In an incremental priming study, the findings of Rastle et al. (2004) were further replicated by Marslen-Wilson et al. (2008). The prime duration initiated at 36 ms in Experiment 1a and increased to 48 ms and then to 72 ms in Experiment 1c. They documented similar magnitudes of facilitation in pairs in the transparent and opaque conditions with no facilitation in the control condition at any prime durations. Their results therefore yielded evidence in favor of an early morpho-orthographic analysis independent of semantic

influences. Additional evidence in favor of early influences of morphology during visual word recognition was provided in Beyersmann et al. (2016) who, following Rastle et al. (2004) and Baayen et al. (2011), employed a more robust experimental design and used more tightly controlled materials. Their stimuli consisted of targets that were primed by either transparent (e.g., hunter - HUNT), completely opaque (e.g., department - DEPART) or form overlap words (e.g., cashew - CASH) at 50 ms SOA. Their findings revealed a similar level of facilitation in the transparent and opaque conditions, pointing to an automatic, rapid morpho-orthographic decomposition mechanism that segmented complex words into their constituent morphemes. Empirical evidence that garnered support for morpho-orthographic account is not limited to Indo European languages such as Spanish and English. Using Russian stimuli, for example, Kazanina et al. (2008) conducted a masked-priming experiment using morphologically complex Russian nouns in transparent, opaque and non-morphological form conditions. It is important to note that their primes comprised a stem plus multiple suffixes to confirm that semantically blind morphological segmentation existed also for words that involve multiple affixes. In line with the previous study, they found that primes in the transparent and opaque conditions but not in the form condition facilitated the recognition of target words, suggesting that morphological segmentation is fast and is not mandatorily triggered by semantic information.

Empirical studies reviewed above as well as a considerable number of other studies (e.g., Beyersmann et al., 2013; Grainger & Beyersmann, 2017; Solomyak & Marantz, 2009; Taft, 2003) have presented evidence that speaks in favor of the form-first account and proposed a visual stimulus' orthographic form is processed without influences from semantics during the processing of morphologically complex words. Semantic properties of the stimulus are assumed to affect the processing only at later stages when the orthographic information has already been processed. The semantic influences in this process are hypothesized to occur after around 80 ms upon the presentation of the complex word. To test this, Diependaele et al. (2005), in their Experiment 2, used French stimuli and compared transparent, opaque and form conditions to an unrelated condition at 26-, 53-, and 80-ms stimulus onset asynchronies (SOAs). In their incremental priming study, the prime duration

initiated at 26 ms, and they gradually increased the prime duration to determine the time course of morphological processing within the same condition. The findings indicated facilitation from semantically transparent primes occurred at 53 ms SOA; however, there was no facilitation in the opaque condition until 80 ms SOA. Results also showed greater facilitation in the transparent condition in comparison with the opaque condition. Even though it was noted that the use of backward masking might have interfered with the letter codes and diminished the level of activation of the prime, these results conflicted with those of Rastle et al. (2004) and Longtin et al. (2003) in which equal amount of facilitation effects was reported for transparent and opaque primes using a SOA of around 40 ms.

2.3.2. The Form-with-Meaning Accounts

Within the framework of form-with-meaning accounts, a visual stimulus' orthographic form is mapped onto meaning concurrently, counter to the claims from form-then-meaning accounts. Theoretical grounds for this line of reasoning were obtained from empirical evidence that showed both morphology and semantics were active and had a simultaneous influence on the complex word processing (e.g., Feldman et al., 2004, 2009; Giraudo & Grainger, 2001; Marelli & Luzzatti, 2012). Initial evidence came from Diependaele et al. (2005), who, in the first experiment, examined reaction times to Dutch targets preceded by transparent, opaque and orthographically related primes relative to the unrelated primes at 53 ms SOA in a masked visual priming paradigm as well as masked cross-modal priming paradigm. Their results yielded robust facilitation in favor of transparent prime-target items both when participants saw targets visually and auditorily. Opaque prime-target pairs, on the other hand, yielded weak facilitation only in the visual priming paradigm. Further evidence was provided by Meunier and Longtin (2007) who examined morphological processing within morphologically complex French nonwords in a cross-modal priming paradigm. To determine whether semantics exerted early influences during the processing they conducted four experiments in three prime-target conditions. In these conditions, they manipulated the extent to which pairs were semantically interpretable. In experiment 1, they focused on the semantically non-interpretable pseudowords, which were illegal combinations of a

stem and a suffix. They hypothesized that if semantic relationships triggered morphological segmentation, there would be greater magnitudes of facilitation from real suffixed prime-target pairs than non-interpretable illegal pseudoword prime-target pairs. In their experiment 2 they used semantically interpretable pseudowords. These non-existent but well-formed derived words would allow them to examine whether semantically interpretable pseudowords would yield similar facilitation to the real derived words. In experiment 3, the nonwords were synonymous with existing complex words. And finally in experiment 4, they focused on non-morphological pseudowords to uncover priming patterns for morphologically complex pseudowords. They reported that priming was obtained only with the morphologically complex pseudowords that were interpretable and synonymous with a real affixed form. They took the facilitation from pseudowords as evidence against theoretical accounts that hypothesize whole-word representations as the only way to gain access to the lexical representations since these words are non-existent in the mental lexicon. Another outcome of their study was the important role of semantic interpretability since non-interpretable and interpretable pseudowords displayed distinct priming patterns, showing that the semantic interpretability was accommodated during processing. However, it should be noted that the same stimuli were used in Longtin and Meunier (2005) in a series of masked priming lexical decision experiments, and their data revealed that the segmentation process was blind to the semantic interpretability because non-interpretable and interpretable pseudowords facilitated the processing as efficiently as real derived words, while no such facilitation was obtained from non-morphological pseudowords. These results therefore were taken to suggest that the early stages of visual complex word recognition were driven purely by morpho-orthographic influences. They suggested that the distinct priming results found in the masked priming and the cross-modal experiments could not be attributed to different modalities, but to the time-course of processing consistent with the findings of Rastle and colleagues (2000) who reported different facilitation at different prime durations. Combined together, they put forward a continuous two-stage processing mechanism of decomposition and semantic integration in which a very early initial mechanism would be insensitive to semantic influences and that would segment any morphologically complex word

into its morphemic subunits irrespective of whether it is a real word or a pseudoword, followed by the accommodation of the semantic information.

Primary support for continual interaction between form and meaning during complex word processing was presented in a masked lexical decision task by Feldman et al. (2009). Greater facilitation from semantically transparent than opaque prime–target pairs provided evidence against the assumption that the morpho-orthographic information informs the early stages of word processing before semantic information becomes available. In their more recent study, Feldman et al. (2015) compared facilitation between semantically similar and dissimilar prime-target pairs relative to the unrelated pairs. It is important to note that the dissimilar pairs contained semantically opaque primes that were related etymologically to the target (e.g., sneaker - SNEAK) and pseudo-morphemic relatives (e.g., ratify - RAT). In their first experiment, they examined whether the degree of semantic transparency affected decomposition of a complex word into morphemic constituents across randomly presented five SOA(s) (i.e., 34, 67 and 84 ms, Experiment 1A; 48 and 100 ms, Experiment 1B). Transparent primes yielded larger magnitudes of facilitation than the opaque primes. In Experiment 2, a homogeneous SOA of 48 ms was employed to replicate the effect of semantic interpretability reported in Experiments 1A and 1B at a prime duration of 48ms. According to Amenta and Crepaldi (2012), this stimulus onset asynchrony of a prime tapped not only into morpho-orthographic but also semantic properties of the prime in early processing. The results of this experiment also pointed to larger priming effects from semantically similar items than semantically dissimilar items. Experiment 3 was designed using prime duration at only 34 ms SOA to ensure that the reported priming effects existed even at a very short SOA of 34 ms. They analyzed the results by combining data from Experiment 2 and 3 (that used 34 and 48 ms SOA values, respectively). Their conclusion was that the impact of semantic interpretability was statistically significant even at a uniform 34 ms SOA. However, one limitation of their data was that it did not include the form overlap condition, thus leaving open the possibility that the effects were not purely semantic. Similarly, Rastle et al. (2004) emphasized that non-morphological form condition is required if the effects were to be specified as meaning dependent or meaning independent. In

another study, Zhang et al. (2017) tested morphological processing in L2 English and compared semantically transparent derived (e.g., hunter - HUNT), semantically opaque (e.g., department - DEPART), and semantically related prime-target pairs (e.g., choice - SELECTION) using 2 different SOA(s): 40 ms and 80 ms in Experiments 1 and 2, respectively. Chinese learners of English responded faster in the transparent condition at 40 ms SOA, and facilitation in the opaque condition was reported only when SOA was 80 ms, providing further support for the activation of morpho-semantic information in the initial stages of processing. Authors, therefore, argued in favor of form-with-meaning account of L2 processing.

Overall, literature suggests evidence that garners support for both accounts, showing contradictory evidence in the complex word processing literature with regards to the relative strength of priming from transparent and opaque derived primes. On the one side, it is argued that later stages of word processing take into account the semantic properties of the stem but that early effects are merely morpho-orthographic. On the other side, researchers acknowledge the concurrent influences of orthography, morphology and semantics. More recently, with regards to the influences from both pre-lexical form representations and semantic influences, an interactive account was put forward that would reconcile evidence that prevails the literature.

With regards to the potential influence of morpho-semantic representations, Grainger and Ziegler (2011) introduced a dual account of morphological processing that allowed influences from both morpho-orthographic and morpho-semantic representations in the initial stages of word recognition. This dual account which depicts how a transparent morphologically complex word (i.e., farmer) is processed is illustrated in Figure 13 below. The structure of a complex word is characterized at three different levels. The morphologically complex word that is semantically related to its stem is simultaneously processed by two processing mechanisms: Fine-grained orthography mechanism requires precise letter position coding and operates on the sublexical morpho-orthographic segmentation. Via this segmentation, affixes such as “er” are detected, which then sends activation forward to the whole-word orthography level. Through this mechanism, the model could successfully explain priming effects obtained not only in truly-derived words such as “farmer” but also

in pseudo-derived words such as “corner”. The other processing mechanism, coarse-grained orthographic processing, accepts open-bigram coding schemes and sends activation to whole-word orthographic representations. It has the fastest route from orthography to semantics. Therefore, the morpho-semantic facilitation is provided by this mechanism.

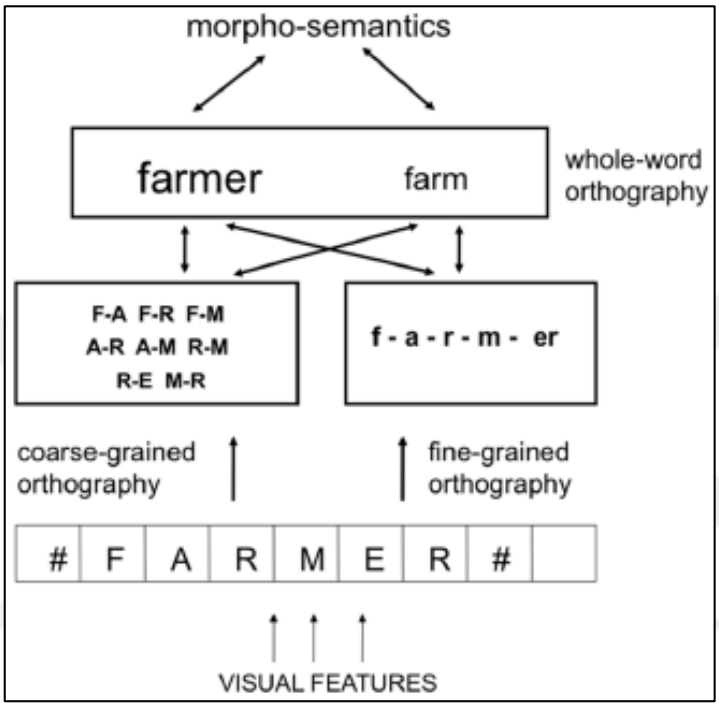


Figure 13. Grainger and Ziegler’s (2011) Dual-route Approach to Orthographic Processing

These activated whole-words (farmer, farm) receive top-down feedback from morpho-semantics. At this point, a truly-derived input such as “farmer” receives more activation in contrast to an input that does not share morpho-semantic relationship to its stem such as “corner”. Therefore, priming effects will moderately be decreased in the case of opaque target-prime pairs. This model could also explain TL-priming effects through coarse-grained orthography mechanism. This route has an imperfect letter position coding system where the activation of orthographic forms is guided by the flexibility of letter position and hence could accommodate TL-effects.

Diependaele et al. (2009) in their hybrid model of morphological processing also examined masked semantic transparency and morphological priming using prefixed words in L1 speakers of Dutch. They reported significant larger priming effects in semantically transparent prefixed prime-target pairs (e.g., gegil - GIL [screaming - SCREAM]) than semantically opaque prefixed prime-target pairs (e.g., gebed - BED [prayer - BED]) compared to orthographic overlap prime-target pairs (barok - ROK [baroque - SKIRT]). Comparing L1 speakers of English with Spanish - English and Dutch - English bilinguals, Diependaele et al. (2011) used the same stimuli as Diependaele et al. (2009) and examined the priming effects in a masked morphological priming lexical decision task using three priming conditions: transparent (e.g., worker - WORK), opaque (e.g., department - DEPART) and form (e.g., cashew - CASH). They reported a graded pattern of facilitation where transparent prime-target pairs yielded the greatest facilitation.

In an Event-Related Potentials (ERP) study using the same conditions using the masked priming paradigm, Morris et al. (2007) investigated the role of semantic information. N/P250 component is indicative of form level processing, mapping pre-lexical forms onto whole word forms, while N400 effect represents the influence of semantic factors and is reduced when the meaning of a word could be integrated with a higher order representation of the preceding word. Their electrophysiological results yielded both N250 and N400 effects with pairs in the transparent condition yielding greater priming than opaque or orthographic conditions. This finding demonstrated that priming effects depended upon morphological structure as well as semantic transparency. Therefore, instead of only bottom-up pre-lexical activation or only top-down semantic activation, reinforcement between pre-lexical (bottom-up) and lexical-semantic (top-down) representations was observed (also see Holcomb et al., 2002). This finding was not consistent with either a pre-lexical decomposition (e.g., Taft & Forster, 1975) or a supralexical account (e.g., Giraudo & Grainger, 2001) of complex word processing. Instead, their data supported an interactive process that contained both pre-lexical form representations and semantic representations. The N250 ERP data found in Morris et al. (2007) demonstrated the initial effects of the top-down information on on-going pre-lexical

processing. Semantic transparency remained as a factor that affected later processing shown through the N400 effects and overt behavioral responses.

In a very recent model of complex word recognition, the word and affix model, Beyersmann and Grainger (in press) accommodated these results by proposing a model where orthographic representations are mapped onto their semantic representations via bidirectional connections that provide both top-down and bottom-up transfer of information. It proposes two mechanisms of (non-morphological) embedded word activation and (morphological) affix activation that run in parallel. While the embedded word activation mechanism activates both whole words (allowable, corner, cashew) and their embedded words (allow, corn, cash), affix activation mechanism activates the affixes (_able, _er). The model operates on the morpho-orthographic full decomposition principle that checks for the length of the input to be activated and decreases the lexical inhibition between active representations in the orthographic lexicon (following the principles of Interactive Activation Model that proposes lateral inhibition between co-active word units). Note that this principle is not sensitive to minor deviations in the word units (insanity - insane). However, in cases where affix cannot be detected such as *cashew* (where -ew is not an affix), this principle does not operate, resulting in the inhibition, hence, less activation of the word *cash*. Finally, the model expects the degree of lateral inhibition to be reduced when there is a semantic relationship between units (farmer - farm), explaining the graded effects with semantically transparent items that produce the higher facilitation than the semantically opaque items.

All in all, over the last years, word recognition literature has enjoyed an exponential increase in studies that have sought to uncover the influence of semantic information during morphological processing. The results of these studies highlight three different lines of theoretical accounts with competing views: On the one side, there are models that argue for early automatic and purely morpho-orthographic influences on morphological processing, while other models hypothesize that complex word recognition is not blind to semantic influences but is susceptible to full-form effects and to top-down processes. On the other hand, the more recent

accounts propose the simultaneous access to sub-lexical orthographic and semantic information through the mapping of word forms onto semantics.

2.4. L1 and L2 Processing of Morphologically Complex Words

Decades of research has extensively examined the processes involved in the visual word recognition in L1. Despite incongruent results, there is rich literature on what mechanisms are available during morphological processing and on linguistic as well as non-linguistic factors that might modulate those processes in L1 word recognition. Yet, turning to L2 processing studies, there are few studies that directly compared the performance of L2 speakers to that of L1 speakers. These studies that sought to uncover the mechanisms used in L1 and L2 language morphological processing of inflectional and derivational phenomena primarily focused on the dual- versus single-mechanism debate. Research that aimed to establish how these complex words were processed was conducted in different languages using various methodologies. In these studies, regular and irregular inflection served to test the associative versus rule-based accounts of morphological processing using morphological (e.g., fell - FALL), and identity (e.g., fall - FALL) conditions compared with an unrelated condition (e.g., swim - FALL) (for a review; see Clahsen et al., 2003; Marslen-Wilson, 2007). Evidence regarding whether bilinguals use morphological information in derivational morphology was also obtained from masked priming studies that manipulated prime-target relatedness across three conditions: semantically transparent (e.g., hunter - HUNT), semantically opaque (e.g., department - DEPART), and form overlap (e.g., cashew - CASH). Until recently word recognition was largely neglected in the domain of non-native language processing. However, as a consequence of the ever-growing number of L2 English speakers, researchers have recently started to explore processing of English in L2 speakers.

Despite the growing number of research endeavors, there still remains much to be investigated as regards to what mechanisms are used in L2 morphological processing. Crossley and colleagues (2012) state that L2 speakers are infamous for having smaller mental lexicons and for making morphosyntactic errors in speaking

their L2s (e.g., Bailey et al., 1974; Larsen-Freeman, 1978) as well as for being less sensitive to morphological markers compared to L1 speakers (e.g., Dekeyser et al., 2010). This implies that due to the challenges L2 speakers have during morphological segmentation, they are led to employ the full-form processing during the complex word recognition. Therefore, at the center of the available studies in L2 processing lies the major question of whether the general mechanisms that are used in L1 processing are similar to those that govern L2 processing. Views that have dominated those discussions have fallen into one of two camps. These two accounts of morphological processing vary in the claims they make about whether L2 processing uses the similar mechanisms as L1 processing. According to one view, L1 and L2 speakers share general processing mechanisms (e.g., Chen et al., 2007; Diependaele et al., 2011; Sabourin & Haverkort, 2003). Differences between performances are due to the orthographic, phonological and/or morphological structure of L1 (e.g., Basnight-Brown et al., 2007; Hernandez et al., 2005; Portin et al., 2008) or the cognitive demand of L2 processing (e.g., McDonald, 2006). Various other studies, however, have questioned the view that L2 processing operates on fundamentally similar mechanisms as L1 processing and argue that L1 transfer and more demand for cognitive operations are insufficient to account for processing differences. Accordingly, the following section will focus on these two competing views that the current evidence stands on and will review studies that have provided evidence for both sides.

2.4.1. Similar Mechanisms Approach

According to this view, L2 speakers could segment morphologically complex words like L1 speakers do, and similar principles govern both L1 and L2 processing (e.g., Ciaccio & Clahsen, 2020; Dal Maso & Giraudo, 2014; Diependaele et al., 2011; Feldman et al., 2010; Foote, 2017; Gor & Jackson, 2013; Jacob et al., 2018; Kahraman, 2021; Kirkici & Clahsen, 2013; J. Li et al., 2017; J. Li & Taft, 2020; M. Li et al., 2017; Silva & Clahsen, 2008; Viviani & Crepaldi, 2019). Differences between processing patterns for the L1 speakers and L2 speakers are due to the structure of L1 influences on morphological processing in L2. Proponents of this side also argue that the efficacy of L1 processing mechanisms that are also used to

process information in L2 is diminished since L2 processing are less automatic, and the knowledge of additional L1 linguistic system impedes the use of L2 processes.

The studies to be reviewed in this section have employed different types of experimental paradigms (e.g., grammaticality judgement, cross-modal priming, lexical decision, eye-tracking) to investigate three morphological phenomena (regular inflection, irregular inflection and derivation) in L2 speakers that come from various L1 backgrounds. For instance, Basnight-Brown et al. (2007) compared the performance of L1 speakers to the two groups of L2 English speakers (i.e., Serbian-English and Chinese-English) in the processing of regular and irregular verb forms. They focused on facilitation levels for past participle verbs whose form is altered (e.g., bought - BUY) and for irregular nested verbs where stems do not change (e.g., arisen - ARISE), hence keeping a larger level of form and phonological overlap. Their design included the primes that were past tense forms that were regular (e.g., guided - GUIDE), irregular nested (e.g., drawn - DRAW), irregular change (e.g., swung - SWING) as well as an unrelated condition (e.g., swept - SWING). The use of Serbian and Chinese languages in this study provided an important piece of information as they represented two distinct language structures: Serbian possesses a regular grapheme phoneme correspondence and is an inflected language. Chinese, on the other hand, uses characters that are similar in form but do not necessarily have similar phonology or close meaning and represents an analytic type with no case morphology. For native speakers, similar levels of facilitation were obtained though the largest priming effects came from the regularly inflected verbs. Both groups of non-native speakers showed facilitation in regularly inflected verb condition; however, the only priming for irregular forms was obtained for the nested verbs in Serbian-English speakers. Responses of Chinese-English bilinguals were not facilitated by irregular inflected word priming compared to bilinguals with an Indo-European language. Therefore, the degree of facilitation obtained from the irregular nested verbs revealed the Chinese speakers of English could not exploit partial form similarity whereas the Serbian bilinguals could. Authors concluded that similar mechanisms across L1 and L2 speakers were used during morphological processing, but some differences between the L1 and L2 processing could be explained by typological distance between L1 and L2. However, Jacob et al. (2013)

argued that as this study did not utilize an identity condition in its experimental design, it could not be ensured whether the purported priming effects were due to stem activation from the prime word or due to whether this priming effect was morphological in nature or due to semantic relatedness.

Similar results were reported in Portin et al. (2008) who demonstrated that the recognition of inflected nouns was influenced by L1 features. In this study, they investigated the processing of inflected words with two groups of late L2 Swedish speakers (i.e., Hungarian and Chinese). Hungarian is a largely inflected agglutinative language whereas Chinese is an isolating language with virtually no inflections. The experimental stimuli were selected from three frequency levels of low, medium and high. It took speakers of Hungarian longer to respond to low and medium frequency words but not to high frequency words, pointing to the segmentation processes used in the processing of low and medium frequency inflected words in L2 Swedish. Equivalent response latencies were documented for the Chinese group at all frequency levels, showing that these groups of speakers used full-form processing of all the inflected Swedish words. Overall, authors noted the use of two different processing routes for the Swedish stimuli. Chinese group was devoid of morphological decomposition that could be indicative of L1 effects from the Chinese language, and in a similar vein, the segmentation process that was observed in the Hungarian group could be attributed to morphological characteristics of L1 Hungarian. These two studies together revealed segmentational costs incurred in the recognition of complex words.

Other research has reported L2 speakers use similar processing mechanisms to L1 speakers, but it has been noted that lower working memory capacity, decoding difficulties or processing speed could have an impact on the processing. For instance, in McDonald (2006), a group of late L2 speakers and native speakers performed tasks of English working memory, decoding, and speed, and a grammaticality judgment task in Experiment 1, and native speakers were found to be more competent in all tests than L2 speakers. In Experiment 2, however, stressors were introduced to the native speakers with regards to memory, decoding, or speed during a grammaticality judgment test. Overall goal was to investigate whether the

challenges in basic non-syntactic cognitive processes could result in poor performance on grammatical tasks like L2 learners experienced. Native speakers performed similarly to late L2 speakers under noise or memory stress, demonstrating that the cognitive demands of L2 processing prevented access to working memory and other attentional and decoding skills, thus resulting in non-native-like processing in the L2.

Comparable facilitative effects were reported in L1 and L2 speakers of English with Serbian as L in Feldman et al. (2010) and L2 speakers of French with English as L1 in Coughlin and Tremblay (2015), demonstrating similar mechanisms governing L1 and L2 processing. Gor and Jackson (2013) took this result one step further and showed that at all proficiency levels decompositional mechanisms governed the processing of high frequency regular, semi-regular, and irregular verbs in L1 and L2 speakers of Russian with L1 English. Lehtonen et al. (2006), using a visual lexical decision paradigm, presented behavioral data that looked at the processing of inflected words using three pairs of word lists, each appearing in a different frequency group: high, medium and low. They obtained comparable results for both L1 Swedish monolinguals and Finnish-Swedish bilinguals that showed morpheme-based recognition only in the low frequency group, revealing that both groups of speakers developed whole-word representations with more frequent inflected words and therefore employed the full-form processing. These results were replicated in Portin et al. (2007) that suggested Swedish low frequency inflected words were segmented into their morphemic constituents, while high frequency words were recognized through their whole-word representations.

With regard to derivational processing, L2 speakers have been documented to process derivationally complex words similarly to native speakers (e.g., Ciaccio & Clahsen, 2020; Dal Maso & Giraudo, 2014; Diependaele et al., 2011; Jacob et al., 2018; Kahraman, 2021; Kirkici & Clahsen, 2013; J. Li et al., 2017; J. Li & Taft, 2020; M. Li et al., 2017; Silva & Clahsen, 2008; Viviani & Crepaldi, 2019). For instance, Diependaele et al. (2011) tested processing differences in complex word recognition in monolingual English speakers and highly proficient Spanish-English and Dutch-English bilingual speakers in a masked primed lexical decision task at 53

ms SOA. Participants responded to English monomorphemic target words paired with unrelated and related primes in transparent, opaque or orthographic overlap prime conditions. English native speakers participated in Experiment 1 that served as the baseline. Significant priming effects were reported both for the transparent (36 ms) and opaque (15 ms) conditions with no facilitative effects in the form condition (1 ms). In experiment 2 in which Spanish-English bilinguals responded to the prime-target pairs, and similar magnitudes of priming effects were obtained across conditions: largest facilitation for the transparent pairs (35 ms), and weaker effect for the opaque (25 ms), and smallest facilitation in the form (14 ms) conditions. Turning to Dutch-English speakers (Experiment 3), authors replicated the graded priming pattern: the stimuli in the transparent condition provided the highest level of facilitation (35 ms), then the opaque condition (26 ms) with the items in the form condition providing the lowest level of facilitation (14 ms). The findings clearly pointed out to the use of similar mechanisms in L1 and L2 complex word processing. They then further merged the data from three experiments in the next analysis and compared the data from native speaker to the combined data of two bilingual speaker groups and reported no qualitative differences between L1 and L2 morphologically processing. These results were replicated in Viviani and Crepaldi (2019) who reported significantly more priming in the transparent and opaque conditions when the form overlap condition was the control condition, which also yielded facilitation in L1 Italian speakers of English. Their priming pattern for L2 speakers mirrored Diependaele et al. (2011) except for the finding that L2 form priming was somewhat smaller in Viviani and Crepaldi (2019).

In another study that focused on L2 derived word processing, Dal Maso and Giraudo (2014) employed a masked primed lexical decision task at a 50 ms prime duration. Target words that were primed by the two types of suffixes (-ità and -ezza) and by two types of surface frequency primes (high and low frequency) were presented in three conditions: identity, orthographic and unrelated. Findings showed morphological priming effects in L2 speaker group, which was similar to the facilitation pattern obtained in L1 Italian speaker control group. They also pointed out that L2 speakers were indeed sensitive to morphological information, but this was restricted to words having a high surface frequency with a very productive

suffix. The authors, in conclusion, interpreted their results as a matter of different degrees of language proficiency between two speaker groups, rather than as a matter of "substantial differences" in processing mechanisms.

These studies, overall, revealed that similar mechanisms governed morphological processing in L1 and L2 speakers, and processing differences were attributed to domain-general cognitive resource constraints (e.g., McDonald, 2006) or influences of one language over the other, as shown by the cognateness influence on L2 word processing (e.g., Comesaña et al., 2018).

2.4.2. Different Mechanisms Approach

Another line of research proposes that unlike native speakers, L2 speakers are more reliant upon lexical storage in complex word processing, and they therefore employ largely full-form processing (e.g., Clahsen et al., 2010; Ullman, 2004, 2005). This account derives major support from the declarative/procedural model introduced by Ullman (2004). Within the general framework of this model, two memory systems of human cognition, procedural and declarative memory elucidate how lexicon and grammar are organized and processed in human languages and involved in the processing of linguistic knowledge. According to the model, the declarative memory system is responsible for the mental lexicon in which lexical knowledge is stored (e.g., irregular past verb forms, "saw"). This system underlies the whole-word storage of complex words. The procedural memory system, on the other hand, administers grammatical structure building that involves the merging of two stored lexical forms (e.g., regular past verb forms, "{touch} + {ed}"). The model proposes that the division of task varies depending on whether it is L1 or L2 processing since the use of procedural memory system facilitates the processing of grammar in the native speakers. On the other hand, declarative memory system initially subserves non-native grammar processing, specifically in the early stages of proficiency, and as speakers get more skills in the language, procedural memory system might start to underlie the processing of L2 grammar (e.g., Morgan-Short et al., 2014), making it more similar to L1 grammar processing. Ullman (2005) additionally proposes that the two memory systems both cooperate and compete in the learning and use of a

new language. As a result, reliance on declarative memory in the processing of L2 grammar might then shift towards the use of procedural memory with the L2 speakers gaining more expertise in the language. Hence, the model predicts that bilinguals would store complex words as full forms, instead of decomposed forms, and they therefore would not demonstrate higher processing costs during morphological processing like L1 speakers, because of the greater dependance upon the declarative rather than procedural memory during the processing of all language structures.

As for the processing of inflectional words, some researchers concluded that L2 processing made use of declarative memory, and therefore L2 processing was governed by whole-word representations and seldom used procedural memory (e.g., Babcock et al., 2012; Clahsen & Neubauer, 2010; Jacob et al., 2013; Neubauer & Clahsen, 2009). Jacob et al. (2013), for instance, examined the inflected word forms in German in a cross-modal priming. German language provided a comparison between -t affixed regular forms with an intact stem and -n affixed irregular forms with (often) stem changes. Advanced L2 speakers of German with Russian as L1 and a group of German L1 speakers attended this study. Experimental target words were preceded by three types of prime: (1) regular -t participles with an intact stem (gesteckt - STECKE, [stuck - STICK]), (2) -n participles with an intact stem (gefangen - FANGE, [slept - SLEEP] (3) -n participles with stem changes (gebogen - BIEGE, [bent - BEND) and appeared in a test (gesteckt - STECKE), identity (stecke -STECKE), and unrelated (scheitern - STECKE [fail - STICK]) condition. Their findings demonstrated different levels of facilitations across L1 and L2 speakers of German. Facilitation from inflected verbs were obtained for -t participles and partial facilitation for both -n participles in native speakers of German. That is, the same amount of facilitation was obtained in the test condition and the identical condition, which both yielded shorter RTs than unrelated condition. However, for the non-native speakers of German, only partial facilitation (i.e., longer RTs in the test condition than the identical condition) for both -t participles and for -n participles with stem changes were reported, but there was no priming for -n participles with an intact stem. These results showed that L2 speakers tended to be more dependent upon full-form processing and less on segmentational processing

in comparison to L1 speakers. However, note the similar patterns of facilitation reported across L1 and L2 groups for both regularly inflected and irregularly inflected verbs with stem changes where the only different results were about full versus partial priming effects. At this point, it is important to emphasize that a large number of other studies typically compared the RTs in test condition with those in unrelated condition and therefore used partial priming as evidence in favor of same or different mechanisms approach.

Previous studies with highly proficient bilinguals also examined the past tense constructions in German. For example, in Neubauer and Clahsen (2009) study, L1 and L2 speakers of German responded to targets followed by either regular -t participles or irregular -n participles in the related condition. There was no apparent semantic relationship between prime-target pairs in unrelated condition. Findings demonstrated full facilitation from primes that included regular inflection in L1 German, but not in L2 speakers of German as well as partial facilitation for irregular inflection in the two participant groups. Additional evidence came from Clahsen and colleagues (2010) that focused on regular and irregular morphology as well as derivational morphology in L2 speakers from various L1 backgrounds. They reported that L2 speakers did not use morphological information as much as L1 speakers do, and hence they relied more upon full-form processing than on morphological decomposition.

In another study that compared the processing of derived vs. inflected verbs, Jacob et al. (2018) used the same target word in L1 German monolinguals and competent L2 speakers of German with Russian as L1. Their results for the L1 group demonstrated parallel facilitative effects for both inflected and derived verbs. For the L2 group, however, facilitation was documented only in derived word forms but not in inflected words. These findings are also in compliance with Ellis' weak interface model (2008) where explicit knowledge and implicit knowledge are distinguished as distinct processes in their content and form. Implicit knowledge of the L2 is regarded as intuitive, and procedural knowledge is fluent and automatic in language. In contrast, explicit knowledge is conceptualized as more as conscious and controlled and rely on the declarative knowledge of the L2.

One key study that presented evidence in favor of the "different-mechanisms approach" is the work of Silva and Clahsen (2008). Using four experiments, they aimed to clarify early automatic processes by directly investigating both inflectional (i.e., -ed in Experiments 1 and 2) and derivational (-ness in Experiment 3, and -ity in Experiment 4) processes in L1 speakers of English and German and Chinese L2 speakers of English using masked primed lexical decision task using an SOA of 60 ms (Experiment 1) and with only 30 ms SOA (Experiment 2). The first experiment asked participants to respond to targets that were preceded by identity, test and unrelated primes. Results revealed distinct facilitation patterns in L1 and L2 speakers: Significant priming effects were obtained in L1 speakers, whereas there was no significant facilitation reported for L2 speakers. These results were corroborated using a shorter SOA of 30 ms in Experiment 2. Regarding the derivational processes, Experiment 3 examined whether priming effects would be obtained with the suffix -ness. Both groups of speakers yielded robust priming effects; however, the magnitude of the priming effects were more robust in L1 speakers. These results were replicated with a different productive suffix in Experiment 4. The authors concluded that L2 processing was more laborious and less automatic and was fundamentally different than L1 processing.

Similarly, the inflectional and derivational processing was investigated in Kırkıcı and Clahsen (2013) using a masked primed lexical decision task. L1 and L2 speakers of Turkish with a variety of L1 backgrounds made visual lexical decisions to prime-target pairs that consisted of deadadjectival derivations (i.e., the formation of nominals from adjectives) and Aorist inflections. Inflected and derived primes both facilitated the recognition of targets in L1 speakers. However, in L2 speakers robust facilitation was obtained only for derived primes with no significant priming for inflected verb forms. Similar to the conclusions Silva and Clahsen (2008) derived, they suggested subtle differences between L1 and L2 morphological, arguing for different underlying cognitive mechanisms.

Overall, these findings are consistent with the declarative-procedural model (Ullmann, 2001, 2005) that postulates two distinct memory subsystems for language processing that are vulnerable to puberty effects: a declarative system that underlies

lexical knowledge facilitates the storage function of memorized words and a procedural system that processes rules of language and grammar. As the ability to use procedural memory decreases as a function of age, L2 learning is proposed to be more dependent upon the declarative memory. And the rules of grammar used by L1 speakers through procedural memory do not exist or function differently in L2 speakers. However, as L2 learners get higher proficiency levels in a language, they might utilize both memory subsystems like L1 speakers do. But this is impacted by various factors such as age of acquisition and L2 exposure. Clahsen and Felser (2006), similarly, argue that morphological processing in L2 is more reliant on lexical memory, and this absence of ability to use grammatically based segmentation persists even for highly proficient language speakers. Another evidence that spoke clearly in favor of different mechanisms approach was obtained in Heyer and Clahsen (2015) that directly compared orthographically related and derived prime-target pairs in advanced speakers of English with German as their L1. Both primes yielded the same amount of facilitation in L2 speakers; however, native speakers demonstrated only morphological priming. The authors concluded non-native speakers were heavily influenced by the word's orthography, suggesting a greater reliance on form processing in L2 in during word recognition.

Taken all together, some studies have reported substantial differences in morphological processing between L1 and L2, showing that effects of morphological structure are weaker in L2 than L1, possibly due to a larger dependence on storage than on combinatorial processing in L2 learners (e.g., Clahsen et al., 2010; Neubauer & Clahsen, 2009; Silva & Clahsen, 2008). Others have reported comparable effects of morphological processing across L1 and L2 (e.g., Dal Maso & Giraudo, 2014; Diependaele et al., 2011; Feldman et al., 2010; Foote, 2017), suggesting that the underlying morphological processing mechanisms in L1 and L2 are equally automatic and combinatorial.

Whether morphological processing differs across L1 and L2 depends on several different factors (e.g., Basnight-Brown et al., 2007; Feldman et al., 2010)8; Kırkıcı & Clahsen, 2013). For example, there appears to be a divide between studies examining derivational morphology compared to those examining inflectional

morphology. Investigations of irregular inflectional morphology show that both L1 and L2 speakers tend to decompose inflected words (e.g., Basnight-Brown et al., 2007; Feldman et al., 2010; Gor & Jackson, 2013), whereas L2 regularly inflected words might more likely be processed holistically (e.g., Jacob et al., 2018; Kirkici & Clahsen, 2013; Neubauer & Clahsen, 2009; Silva & Clahsen, 2008, but see Basnight-Brown et al., 2007; Coughlin & Tremblay, 2015; Gor and Jackson, 2013; Feldman et al., 2010; Foote, 2017; Jacob et al., 2013 for contrasting evidence). On the other hand, investigations of derivational morphology reveal that derived words are rapidly decomposed into morphemic subunits in both L1 and L2 (e.g., Ciaccio & Clahsen, 2020; Dal Maso & Giraudo, 2014; Diependaele et al., 2011; Jacob et al., 2018; Kahraman, 2021; Kirkici & Clahsen, 2013; J. Li et al., 2017; J. Li & Taft, 2020; M. Li et al., 2017; Silva & Clahsen, 2008; Viviani & Crepaldi, 2019), lending support for the sublexical "morpho-orthographic" segmentation account in which decomposition takes place whenever a letter string has a morphologically complex structure (e.g., Rastle et al., 2004).

The review of studies and above discussions indicate that the processing of derived words has only been investigated in a few studies, which has also been noted by many researchers (e.g., Diependaele et al., 2011). In this context, the current study sought to address the mechanisms involved in the representation and processing of derived words in L1 English, and it also extended morphological processing to non-native L2 speakers.

Based on the studies reviewed above, it is important to emphasize that studies that have compared the performance of L2 speakers to the performance of L1 speakers have mostly used Indo-European languages such as English, Spanish and Dutch. Therefore, support for similar-mechanisms or different-mechanisms approach using non-Indo-European languages such as Turkish remains scarce. Given the lack of studies that have focused on bilinguals with non-Indo-European languages as their L1, the aim of the current study was to further investigate the language processing in both L1 and L2 with an emphasis on tentatively explaining the factors that might influence derivational processing.

2.5. Individual Differences in Masked Morphological Priming

It is apparent from the review of studies above that research into complex word processing in L1 and L2 processing has yielded mainly contradictory results. In order to address these different findings from available TL priming and morphological processing studies in the L1 and L2 literature, the present study compared both L1 and L2 language processing with an emphasis on tentatively explaining the factors that might influence derivational processing. A significant factor that needs to be considered in word recognition studies is the individual differences. Specifically, several individual-level factors might cause variability in L2 processing (e.g., Tanner et al., 2014). To avoid the prevailing "uniformity assumption" in experimental psycholinguistic studies that it is possible to draw inferences about lexical processing on the basis of averaged data (e.g., Andrews & Hersch, 2010), the current study focused on individual differences as potential explanatory factors.

Individual differences are well captured in the Lexical Quality Hypothesis (e.g., Perfetti, 2007). According to this, tasks which involve some sort of word identification including reading, spelling, reading speed and vocabulary are influenced by the degree of variation in the quality of lexical representations. Therefore, high-quality representation of words is an important requirement of competent reading, so differences between skilled readers and poor readers could be explained by the variability in these lexical representations. Reading mainly involves words (Perfetti & Hart, 2002), and hence readers with less quality representations would retrieve imprecise information about the words they read. Moreover, studies that investigate word recognition processes mostly utilize visual lexical decision tasks. In these tasks, since participants read visually presented target words, variability among their responses could be explained by differences in these lexical representations. The lexical quality hypothesis proposes that the quality of representations determines the efficient retrieval of phonological and semantic information from orthographic forms (Perfetti, 1992) so that a valid, compatible and consistent high-quality representation is retrieved easily and efficiently. Figure 14 below depicts a high-quality representation which illustrates a closely linked set of constituents- the orthographic, phonological and semantic identification of the word "gate" (Perfetti & Hart, 2002).

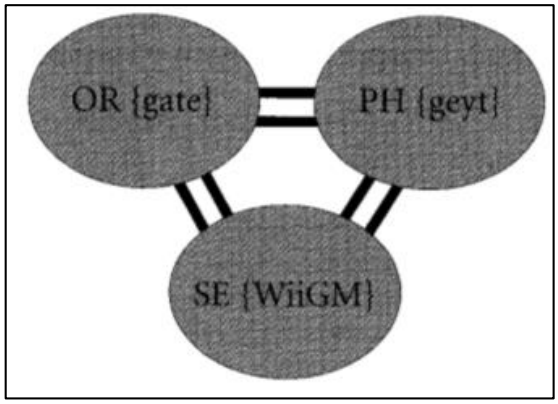


Figure 14. Well-integrated Orthographic (OR), Phonological (PH), and Semantic (SE) Constituents of a Lexical Entry "gate"

When there is a well-integration among word constituents like the word *gate* in the figure above, the lexical quality is high, preventing any potential problems for tasks that require word recognition such as reading, spelling, reading aloud and reading with speed. As the vocabulary size and quality of lexical representations increase as the connections between phonological, orthographic, and semantic information are tight and automatized. These characteristics of precise high-quality lexical representations lead the individual to retrieve the single correct word instead of only some parts of it which could belong to parts of some other words, which minimizes uncertainty about its meaning and form. This leads to the inhibition from other competing candidate representations and to the activation of the correct representation (Andrews & Hersch, 2010). The quality of these constituents and a tight bond among them enhance automatic retrieval of a lexical entry and its integration into a mental model of the text (Perfetti, 2007). As a result, reading comprehension is enhanced and successful.

Using a masked priming lexical decision task, Andrews and Lo (2013) examined how individual differences in spelling and vocabulary proficiency could modulate the processing of morphologically complex English words in skilled readers. They used vocabulary test scores and spelling test scores to index participants' semantic and orthographic knowledg. While individuals with relatively higher vocabulary than spelling scores were associated with a "semantic profile", those with higher spelling than vocabulary scores were associated with an "orthographic profile". The general

analysis demonstrated greater magnitudes of facilitation for items in the transparent condition than the items in the opaque and form conditions. Nevertheless, the analysis of individual variability data in vocabulary and spelling proficiency revealed participants in orthographic profile demonstrated similar magnitudes of facilitation for opaque and transparent items. Conversely, participants with higher vocabulary than spelling scores yielded greater facilitative effects for transparent compared to items in the opaque and form condition. This categorization of participants was based on the findings obtained by Yap et al. (2009) in which participants with higher vocabulary knowledge demonstrated additive effects of word frequency and larger semantic priming. Also, in the grouping of individuals according to their levels of spelling ability, the study on expert Scrabble players by Hargreaves et al. (2012) was used, which demonstrated when individuals had more enhanced skills to encode orthographic information, the reliance on the meaning of words was minimized. A similar study (Perea et al., 2016) also demonstrated that expert scrabble players showed dramatically smaller sizes of TL effect than non-players.

In another study that investigated the potential role of individual differences, Medeiros and Duñabeitia (2016) grouped their participants as fast and slow readers using their speed of reading. Slow readers demonstrated larger masked suffix priming (e.g., colorful - CAREFUL) whereas faster readers showed only negligible facilitative priming. Beyersmann et al. (2016) offered additional evidence in favor of modulation of embedded stem priming effects in French (e.g., crispful - CRISP) by individual proficiency in reading speed. Increased facilitation was reported with individuals with faster reading speed (i.e., when individuals responded to target words faster in the lexical decision task), and strong facilitation in slower readers was observed only in the affixed conditions (i.e., precrisp, crispful), revealing that these groups of participants were mainly using morpho-orthographic decomposition processes. On the contrary, faster participants mainly employed full-form processing, showing that they activated embedded stems with pseudo-affixes. These results were taken to suggest that affix-stripping theories should be modified to accommodate embedded stem priming effects. Likewise, using reaction times to the LDT to explore if magnitudes of transposed letter priming with within-morphemes and between-morphemes are moderated, Duñabeitia et al. (2014) obtained larger priming effects

for TL-within-morphemes than TL-across-morphemes for faster participants, while no difference was observed for slower readers. They took this evidence to suggest that morphological decomposition processes in faster individuals were fast-acting and automatic.

Other studies also found evidence for the impact of individual differences using reading and spelling test scores. Andrews and Hersch (2010) identified individual differences as a factor that modulates the precision of lexical representations among participants with different proficiency levels in reading and spelling. The authors obtained supportive findings in masked form priming (e.g., jury - FURY), which showed that participants with higher spelling scores exhibited inhibition for high-neighborhood words, whereas less proficient spellers displayed facilitation. A further investigation of the effects of individual differences on masked priming using spelling and vocabulary measures was conducted by Beyersmann et al. (2015). In their study, French participants with higher language proficiency were found to display greater non-suffixed non-word priming (e.g., sadald - SAD), while the size of priming was reduced with less proficient users. Finally, in a more recent study, the modulation of masked repetition priming and semantic priming effects by individual differences was reported (Tan & Yap, 2016). It was shown that the patterns of masked repetition priming were predicted by the vocabulary knowledge where those effects were greater for participants with more vocabulary knowledge.

Regarding the modulation of priming effects in L2, to the researchers' knowledge, there is a single study which reported the modulation of masked priming effects by individual differences. In their study, Viviani and Crepaldi (2019) investigated masked priming effects in semantically transparent, opaque, or purely orthographic prime-target pairs. For the proficiency measures, they used a battery of tests that included tests of phonemic fluency, morphological awareness, spelling, phonemic discrimination, vocabulary, reading comprehension and oral comprehension. The results demonstrated that the group level priming patterns were modulated by individual differences in L2 phonemic fluency. Facilitation from transparent item pairs was consistent across the phonemic fluency spectrum, while with growing fluency there was a decreasing facilitation in opaque and orthographic pairs.

CHAPTER 3

THE PRESENT STUDY

3.1. Significance of the Study

The aim of the present study was to compare the early automatic processes involved in the recognition of derived word forms in L1 English and L2 English and to investigate whether the priming effects, if any, are modulated by individual differences. The study also sought to clarify whether orthographic contributions to morphological priming existed and to investigate whether the process of morphological decomposition co-occurred with letter position coding at very early stages of visual-word recognition using the same stimuli across different conditions.

As has been discussed in previous sections, for more than four decades, a substantial body of evidence has been generated with regards to how morphologically complex words are represented and processed in L1 visual word recognition literature. Though research on the performance of L2 speakers could provide valuable insights into enriching our understanding of complex word processing, the L2 processing literature has received relatively less attention and is therefore less understood. Furthermore, existing research that focused on the recognition of complex words in L1 and L2 processing has generally been restricted to L2 speakers of English (e.g., Coughlin & Tremblay, 2015; Gor & Jackson, 2013), of Serbian (Basnight-Brown et al., 2007; Feldman et al., 2010), of Italian (Dal Maso & Giraudo, 2014; Viviani & Crepaldi, 2019), of German (Jacob et al., 2013; Silva & Clahsen, 2008) and of Chinese (Basnight-Brown et al., 2007; Portin et al. 2008; Silva & Clahsen, 2008). Therefore, the current study sought to fill this gap by focusing on L1 speakers of English and L2 speakers of English with Turkish as their L1 within the framework of the same-mechanism vs. different-mechanism approach. Turkish is classified as

a non-Indo-European language with a rich and productive morphology and a shallow orthography (e.g., Özgür et al., 2004). The current study thus aimed to offer evidence on how speakers of a morphologically rich native language process a second language which is morphologically less productive compared to native speakers of the same language.

In the light of these contradictory results and conclusions concerning morphological processing in L1 and L2, examining morphological TL priming effects in both speaker groups could provide new insights. The literature largely lacks evidence of the morphological TL effects in the L2 processing of derivational morphology, and current models of morphological TL priming effects have mainly used data from L1 speakers. Therefore, these models might not be used to explain the mechanisms involved in L2 processing since gaining access to lexical representations in these group of speakers requires the cross-language activation of lexical entries that might influence orthographic coding (e.g., Dijkstra & van Heuven, 2002; Lin et al., 2015). Additionally, there are possible other significant aspects of L2 processing that might not directly relate to L1 contexts such as age of acquisition, L2 proficiency, L1-L2 similarities/differences in orthographic neighborhood size and the amount of exposure to L2 (e.g., Bosch et al., 2019; Clahsen et al., 2010; Lin & Lin, 2016). The current study used the masked morphological priming paradigm where targets were preceded by morphological primes (e.g., braveness - BRAVE) and transposed letter primes that involved both intratranspositions (e.g., braevness - BRAVE) and intertranspositions (e.g., bravneess - BRAVE). This study was, to researcher's knowledge, the first masked priming study to extend the masked morphological TL priming paradigm to L2 speakers. Studying letter position coding is informative particularly because the two routes offered in dual-pathway models makes different predictions regarding the extent of precision that letter information is utilized to access the corresponding representation in mental lexicon. The morpho-orthographic parsing route employs a fine-grained processing and is associated with a precise letter position coding for the stimulus, in contrast to the whole-word route that is less sensitive to the precise position coding of letters. This implies that the coarse-grained route activates a word even when its letters are transposed since it has flexibility in letter position encoding during lexical identification. Hence, the

use of both morphological primes and morphological transposed-letter primes would inform us whether the current models of L2 visual word recognition could successfully accommodate the findings.

The results of the aforementioned studies indicate that priming effects in native speakers may be modulated by individual differences in spelling, reading and reading speed. However, the modulation of priming effects is still not fully understood, particularly in L2 processing contexts. Following the contention of Andrews and Lo (2013), using average RT data obtained from a small sample to characterize the mental architecture of skilled reading only helps founding the basis for the overarching principles of lexical processing. Therefore, this study also tried to fill this considerable gap in the literature by providing a detailed exploration of individual differences through a broad assessment of individuals' reading proficiency by using nine subtests. Within the context of individual differences, available studies used various approaches and measures (e.g., Andrews & Lo, 2013; Beyersmann et al., 2015) with contradictory findings, and this section of the current research made an exploratory attempt to gain newer and deeper insights into the moderation of L2 priming effects using several tests. Therefore, a broad assessment of individual variability in reading performance was conducted through nine reading-proficiency-related tests.

All in all, the current study aimed to add to the existing body of evidence regarding L1 morphological processing using confirmatory data-analytic techniques and further expanded it to L2 processing by focusing on the early processes used during complex word recognition using two experimental paradigms: masked morphological priming and masked morphological transposed-letter priming. The second aim of the study was to further investigate if L2 processing is moderated by individual differences in individual reading performance. This part of the study was driven by the recent empirical evidence that individual differences in reading proficiency could predict the influences of morphological information during reading and provide an explanation for the inconsistent results. Given the theoretical importance of considering individual differences in morphological processing

studies, the present study addressed this critical question by exploring whether average priming effects are moderated by different reading proficiency profiles.

3.2. Research Questions and Predictions

In line with these aims, the current study sought to answer the following research questions:

1. What are the early automatic processes involved in the recognition of morphologically complex word forms in L1 English and L2 English?
2. Are there quantitative and qualitative differences between L1 and L2 English regarding the general mechanism(s) underlying the processing of these words?
3. Are the morphological priming effects modulated by individual differences?
4. Are the transposed-letter priming effects modulated by individual differences?
5. Does the process of morphological decomposition co-occur with letter position coding?

As for the morphological priming effects, it was predicted that a briefly presented morphologically related word (e.g., braveness - BRAVE) would be segmented in the early stages of word recognition consistent with its morphological structure ({brave}{ness}), hence stripping off the stem, which would then "open the doors" (Duñabeitia & Molinaro, 2013) for the target word identification (BRAVE) in L1 and L2 speakers of English, reiterating the results obtained from Diependaele et al. (2011). If this affix stripping process is facilitated by the orthographic, and phonological effects of the prime, then it was expected that neither TL-within nor TL-across priming effects would arise as the use of TL primes would reduce the similarity of prime to the target word orthographically and phonologically. It was predicted that morphological priming and TL-priming effects would be obtained and modulated by individual variability in reading. However, the direction and size of those priming effects was further explored in the current study as none of the earlier studies has so far investigated TL effects in L2 speakers. Also, whether and how the magnitudes of priming effects might be modulated by different indexes in L2 reading proficiency was also explored. Lastly, if L2 speakers use similar

morphological processing mechanisms to L1 speakers, comparable sizes of morphological and TL- priming effects across conditions were expected.

3.3. Measures of Individual Differences: The Reading Skills Battery

In order to investigate early automatic processes involved in the recognition of derived word forms in L1 English and to find out whether the priming effects are impacted by individual differences in participants' reading proficiency, a reading skills battery was designed that measured university students' reading abilities (see Appendix A for the battery). The individual differences tests used in the present study were selected and adapted for two reasons: The first was to use as many different tests as possible to assess how various skills significantly contributed to the moderation of priming effects in morphological processing studies. The second reason was to inform the literature with data to manipulate factors to clarify discrepant findings in prior research in language processing. A central assumption in forming this battery was that individuals differed in their reading skills, and that these variations might predict these skills and explain distinct priming effects found in word recognition studies. Grabe and Jiang (2013) highlight factors that profoundly impact reading abilities and explain individual differences in reading performance based upon research in L1 and L2 contexts:

1. efficient word recognition processes;
2. vocabulary knowledge;
3. grammar knowledge under time constraints;
4. the ability to present the main ideas of a text;
5. the ability to use strategic processes while reading more difficult texts;
6. the ability to use background knowledge appropriately;
7. the ability to interpret text meaning critically;
8. the efficient use of working memory abilities;
9. the efficient use of reading fluency skills;
10. the ability to engage in reading, to expend effort, to persist in reading without distraction, and achieve some level of success with reading.

The Report of the National Reading Panel (2000) acknowledges that the incorporation of phonemic awareness, phonics, fluency, vocabulary, and comprehension leads to the best reading instruction; therefore, in an endeavour to design tests that assess reading skills, a comprehensive reading assessment should measure readers' decoding and receptive language skills. In the current battery, the decoding part of the assessment involved tests of word identification, reading nonwords, spelling nonwords, fluency, reading comprehension and spelling. The receptive part of the assessment included tests that measure vocabulary and listening comprehension.

3.3.1. Review of Tests

The measures used in the current battery were taken from measures widely acknowledged in the literature that tap into several facets of an individuals' reading network. Also, they have consistently been shown to be associated with reading. The measures devised and their hypothesized roles in reading are reviewed below. Since these measures in the literature have different testing purposes and test formats, most subtests in the current battery were formed as used in Woodcook-Johnson III Tests of Achievement (Wendling et al., 2009) and Kaufman Test of Educational Achievement- Second Edition (Kaufman & Kaufman, 2004). These tests are valid, reliable and standardized tests and evaluate academic achievement in reading, written language, and oral language.

3.3.1.1. Test 1: Word Identification

Word identification is viewed as the most commonly "recurring cognitive ability" in reading (Perfetti, 2007, p. 357), and researchers acknowledge its centrality to reading because in the absence of word identification, fluent and accurate reading would not take place (e.g., Just & Carpenter, 1980; Macalister, 2010). Fast and efficient word identification, word encoding, and lexical access are needed for constructing meaning (e.g., M. Adams, 2013), which makes the difference between skilled and less skilled readers (e.g., Bernhardt, 2005; Nassaji, 2003). Wolf and

Katzir-Cohen (2001) defined word identification as a combination of accuracy and speed of meaning access while decoding a stimulus in print.

The relationship between word recognition skills and reading comprehension among children has been well-established. Stanovich et al. (1986) and Aaron et al. (2008) revealed that substantial variability in reading comprehension could be predicted by word-identification skills. Other correlational studies supported the finding that word identification was the strongest predictor and primary determinant of reading comprehension ability (e.g., Joshi & Aaron, 2000; Zinar, 2000). However, for older readers, word recognition has not been consistently found to affect reading comprehension (e.g., Walczyk & Raska, 1992). In fact, a meta-analysis demonstrated convincing evidence that the influence of decoding skills on reading comprehension decreased across development (e.g., García & Cain, 2014). Also, there is empirical evidence that showed the dissociation of word decoding skill and reading comprehension and that having word identification skills could still lead to comprehension problems (e.g., Nation, 2005; Perfetti, 2007). However, Landi (2005) provided striking evidence that word identification skills were insufficient but still necessary for good text comprehension, an important finding that needed to be addressed in the current battery.

While in various studies researchers have used such standardized tests that measure word identification skills of individuals as the Word Identification subtest of the Woodcock–Johnson III Psycho- Educational Battery—Revised (WJ III ACH), other researchers have designed their own instruments. Commonly used tasks in these measures are naming tasks that ask individuals to read both/either real words and/or pseudowords aloud. In the word identification subtest of the current battery, individuals read real words out loud in isolation. The items were of increasing difficulty and were chosen from SUBTLEX-UK corpus (Van Heuven et al., 2014), which contains 160,022 word forms with frequency values calculated from a 201.7-million-word corpus of subtitles from nine British TV channels broadcast between January 2010 and December 2012.

3.3.1.2. Test 2: Reading Fluency

Rasinski (2006) and the National Reading Panel (2000) describe fluency as the ability to read with speed, accuracy, and proper expression, making the reader focus on the content, rather than on decoding individual words in the text. With regard to the relationship between reading fluency and reading comprehension, Seabra et al. (2017) and Neddenriep et al. (2011) provided evidence of their correspondence and suggested the use of reading fluency test as a component of reading comprehension models. Other studies also revealed the significant contribution of reading fluency tests to the prediction of reading comprehension (e.g., Hudson et al., 2005; Johnston & Kirby, 2006; Klauda & Guthrie, 2008; LaBerge & Samuels, 1974). Turkyılmaz et al. (2014) stated that reading fluency is an important feature of skilled reading and that it differentiates good readers from poorer readers. Also, Nathan and Stanovich (1991) acknowledge the lack of reading fluency as a reliable predictor of reading comprehension problems.

Despite the widespread agreement on the relevance of reading speed for reading competence, there is less agreement on how to conduct the measurement for the reading speed. Some studies used naming speed (e.g., Aaron et al., 2008; Johnston & Kirby, 2006; R. Malatesha Joshi, P. G. Aaron, 2000) while some other studies used word reading rates (e.g., Klauda & Guthrie, 2008; Turkyılmaz et al., 2014) and prosody (e.g., Martins & Capellini, 2014). In measures where reading speed is measured through reading a text under time constraints, there are alternative strategies test developers use to ensure that the test taker has actually comprehended the text: some tests ask test takers to draw lines separating words with no spaces and punctuations and printed in uppercase (Turkyılmaz et al., 2014), while asking true/false type questions at the end of each paragraph of the text (WJ III ACH),or circling the relevant word among options (Andrews & Hersch, 2010) is also used. Torgesen (2000) and Hudson et al., (2005) argued that the components of fluency that could be reliably assessed were rate and accuracy. Therefore, in the current study, reading speed test took into consideration both reading rate and accuracy in reading connected text through true/false type questions and finding the relevant word to the paragraph among alternative options.

3.3.1.3. Test 3: Spelling

In their fMRI investigation of the neural bases of reading and spelling, Rapp and Lipka (2011) provided evidence of shared components of these two cognitive functions and revealed that both reading and spelling shared specific left hemisphere substrates. These results are in line with the findings of Holmes and Carruthers (1998) and Burt and Tate (2002) who demonstrated participants were slower and less accurate in lexical decision tasks where the words that they could not spell correctly were used.

The relationship between spelling and reading was reported through other cognitive neuropsychological investigations (e.g., Caramazza et al., 1987; Rapp & Caramazza, 1989; Tainturier & Rapp, 2003), precisely establishing the shared processes between the two domains. Lesion-deficit studies (e.g., Philipose et al., 2007; Rapcsak & Beeson, 2004) and functional neuroimaging studies (e.g., Menon & Desmond, 2001; Norton et al., 2007) also provided evidence concerning the association of spelling and reading. The index of spelling ability in these studies was obtained from spelling production task that required participants to write to dictation (e.g., Beyersmann et al., 2015; Burt, 2006; Burt & Fury, 2000; Hasenäcker et al., 2015) and from spelling recognition task where participants were asked to select the correctly spelled item among incorrect options (e.g., Andrews & Hersch, 2010; Andrews & Lo, 2013; Tan & Yap, 2016). The current battery made use of these two spelling tasks (dictation and spelling recognition) in line with the tasks used to assess spelling skills in the literature.

3.3.1.4. Test 4: Reading Comprehension

As an answer to what makes one a good reader, Kintsch and van Dijk (1978) suggested that variations in reading performance were caused by factors at both a micro level, in processing syntax of textual elements, and at a macro level, in comprehending the meaning of a passage as a whole. Only after a reader decomposed individual words and sentences in a passage at the micro level, could they proceed into forming holistic inferences and propositions. Variations in reading

comprehension among skilled readers were captured at this macro level in their success in generating accurate inferences as opposed to less-skilled readers (e.g., Palmer et al., 1985). In an effort to capture those variations, most studies aimed at revealing macro-level influences on reading comprehension through combined components such as reading strategies, reading fluency and vocabulary as predictors of variation in reading comprehension (e.g., Aaronson & Ferres, 1986; Alptekin & Erçetin, 2010; Baddeley et al., 1985; Burton & Daneman, 2007; Palmer et al., 1985) while some other researchers used standardized tests such as the Nelson-Danny Reading Test (e.g., Alptekin et al., 2014), Verbal SAT (e.g., McVay & Kane, 2012), the Reading Comprehension subtest of the Nelson Reading Skills Test Form 3, Level B (e.g., Hanna et al., 1977).

It is evident that various test formats have been used in constructing reading comprehension tests. However, the reading comprehension tests in the current battery were adopted from two major standardized language proficiency assessment programs: IELTS (the International English Language Testing System) where greater recognition of the discourse structure of texts, identification of main ideas, careful reading skills, facility in reading multiple text genres and a larger amount of reading are required through complex matching tasks of various types, multiple choice items, short response items (Grabe & Jiang, 2014) and YDS (Language Proficiency Test) where the cloze test procedure is effectively used, through which the combined assessment of vocabulary, grammar, recognition of contextual clues and careful reading is achieved. The reason why different tests with different test items were used in the current reading comprehension subtest is that multiple assessment tasks could allow the researcher to capture most of the variance associated with individual variability in reading comprehension performance.

3.3.1.5. Test 5: Reading Nonwords

Reading nonword skills refer to the "sounding out" of words in print using knowledge of letter-sound relationships, which is known as phonological recoding. Individuals with phonological recoding skills can successfully read out nonwords, which are made-up words with conventional spelling patterns such as *yirn* and

kewmap. Many theoretical models of reading have highlighted the significance of the phonological recoding skill that is measured by nonword reading accuracy. The dual-route model of reading, for example, proposes a nonlexical route where letters are converted into sounds through grapheme-to-phoneme correspondences (Coltheart et al., 2001).

The significance of reading nonwords in reading was illustrated by Herrmann et al. (2006) who found that deficiency in nonword reading skills is the leading cause of reading difficulties, presenting nonword decoding tests as an essential source of diagnostic information about participants' reading skills. The particular method to assess phonological recoding deficits is nonword decoding tasks where participants are presented with a list of novel forms and asked to read them out loud. The tasks used in the studies were either originally designed by the researchers (e.g., Baddeley et al., 1982; Holligan & Johnston, 1988; Keenan et al., 2008; Manis et al., 1988; Snowling, 1981) or taken from standardized tests such as Bryant Decoding Skills Test (e.g., Manis et al., 1990; Vellutino et al., 1994), Word Attack subtest of Woodcock Johnston Psychoeducational Battery (e.g., Felton & Wood, 1992; Pennington et al., 1990), Word Attack subtest of Woodcock Reading Mastery Test-Revised (e.g., Badian, 1997; Greenberg et al., 1997; Stanovich et al., 1997) or Phonemic Decoding subtest of TOWRE (e.g., Torgesen et al., 1999). With regard to the Nonword Reading Test in the current battery used for L2 speakers, first 14 items were adopted from the Diagnostic Reading Test for Nonwords (DiRT) (Colenbrander, Kohnen, & Nickels, 2018), and the last 6 items were designed by the researcher through Wuggy software in an attempt to introduce more challenging novel words into the test. The skill required to successfully take the current test required the mapping of morpho-phonemic letter- patterns onto underlying phonological representations.

3.3.1.6. Test 6: Listening Comprehension

Listening comprehension could be viewed as an individual's capacity in understanding what they hear in the absence of cognitive demands of having to decode text. Good listening skills first involve the understanding of individual words

and sentences in a story. But Kintsch and Kintsch (2005) describe individuals with good listening skills as those who build a mental model that could accommodate the story's propositions and previous knowledge into a whole. In a review article, Hogan et al. (2014) provided evidence of the dominating impact of listening comprehension on reading, and they highlighted the importance of involving listening comprehension in reading assessments. Cattset al. (2005) also investigated the unique and shared contributions of word identification and listening comprehension to reading and found that while the unique variance explained by word recognition decreased gradually at each grade, the variance explained by listening comprehension increased substantially. Similarly, Adlof et al. (2006) showed that listening comprehension and reading comprehension formed a unitary construct by the eighth grade. This finding was reinforced by a more recent longitudinal study that demonstrated poor oral language skills lead to poor reading skills (Elwér et al., 2013).

Tests that measure such a complex construct have substantially used various test formats. In some measures such as the Contrastive Test of Listening and Reading Comprehension (Capovilla & Seabra, 2013), participants listen to increasingly difficult sentences, and they need to select the correct figure among options that best describes the sentence. In other measures, participants listen to a paragraph or a text and are asked to answer comprehension questions. Other tests require test takers to make inferences by combining the information they hear with their prior knowledge. In the listening comprehension subtest of the present battery designed by the researcher, participants were required to listen to 17 thematically unrelated sentences and/or 2-sentence-long-passages and provide the missing word at the end of each sentence, similar to the format used in the Oral Comprehension subtest of Woodcook Johnson Achievement Test.

3.3.1.7. Test 7: Vocabulary Knowledge

Understanding a text requires the reader to understand the words used in it. Therefore, a substantial number of studies yielded significant correlations between vocabulary and reading comprehension (e.g., Anderson & Freebody, 1983;

Cameron, 2002; Read, 2006), and showed vocabulary could be a predictor of one's overall reading ability (e.g., Braze et al., 2007; Hargrave & Sénéchal, 2000; Storch & Whitehurst, 2002) because the presence of many unknown words could hinder comprehension (e.g., Curtis, 1987; Landi & Perfetti, 2007; Nation, 2005).

The theoretical model that the current study drew upon, the Lexical Quality Hypothesis (Perfetti, 1992; Perfetti & Hart, 2002), claims that variability in the quality of lexical representations is the crucial determinant of skilled readers and poor readers. According to the model, reading comprehension is facilitated as vocabulary size and quality of lexical representations increase as the connections between phonological, orthographic, and semantic information are enhanced and automatized. The significant role of vocabulary is also evident in readability indexes where vocabulary is included as a major component. Though there is lack of consensus on what it means to know a word and how it is measured, and there is no generally accepted model of vocabulary acquisition, many researchers construct tests which assess how well individuals know a word, quality of their knowledge or depth of word knowledge (e.g., Qian, 2002; Qian & Schedl, 2004; Read, 2006). Heaton (1988) suggests the use of more receptive vocabulary tests that could be in the forms of word formation, completion, word associations, synonyms, antonyms and definition unlike common receptive tests that requires individuals to simply select an option. The assessment type used in the vocabulary subtest of the present battery was the productive one which asked readers to write down synonyms, antonyms of word items in a specific context and to have a deeper knowledge of word associations.

3.3.1.8. Test 8: Reading Span Test

The reading span test (RST) is a common verbal memory span task used for investigations of working memory, context-based vocabulary learning (e.g., Daneman & Green, 1986) and for hypotheses generation (e.g., Dougherty & Hunter, 2003), listening and reading comprehension (e.g., Daneman & Carpenter, 1980; Daneman & Merikle, 1996) and for investigations of cognitive processing. These tests combine a processing component (i.e., judging the correctness of sentences)

and a storage component (i.e., memorizing a series of letters or words for subsequent recall). In a similar vein, in the current test, participants were typically asked to read thematically unrelated simple sentences aloud and then to judge the truthfulness of the sentences and recall the letters shown to them in the correct order after the sentence disappeared. The number of letters and sentences in the sets increased from two to six. In their seminal work, Daneman and Carpenter (1980) revealed the strong correlation of reading span test with the measure of reading comprehension and verbal SAT. Daneman and Merikle's meta-analysis (1996) also demonstrated that individual variability in participants' working memory capacity (WMC) significantly predicted variations in reading. A substantial body of research also provided evidence of the positive influence of WMC on reading for both young (e.g., Cain et al., 2004; Joseph et al., 2015; Seigneuric et al., 2000; Seigneuric & Ehrlich, 2005) and adult participants (e.g., Georgiou et al., 2008; Turner & Engle, 1989), independent of word decoding and word recognition (e.g., A. Baddeley et al., 1985; Cain et al., 2004). These differences were shown to result from the lesser capacity of participants with lower WMC to integrate information from the text into a mental model (e.g., Hannon & Daneman, 2001).

In addition to Turner and Engle (1989) who investigated whether WMC is task dependent, Alptekin et al. (2014) also studied the influence of differences in RST task design (semantic vs. morphosyntactic) and the language of the task (L1 vs L2). Semantic version of the task involved semantically plausible and anomalous sentences while morphosyntactic version used grammatically correct and incorrect sentences in both L1 and L2. They found that WM's storage function was essentially language- independent, while its processing function was task and language-sensitive, which suggested that construct equivalency could be compromised. The current reading span test was obtained from Randall Engle's lab who provided free version of the test which was programmed in E-Prime on their website (http://englelab.gatech.edu/tasks.html) and used a semantic task design.

3.3.1.9. Test 9: Nonword Spelling

Nonword spelling subtest measures an individual's ability to use phonologically based strategies by applying their knowledge of sound-to-letter correspondences and phonemic awareness (Pogorzelski & Wheldall, 2005). Therefore, in these tests, readers divide words into their constituent phonemes and use the process of sound-to-spelling conversion (e.g., Leask & Hinchliffe, 2007; Martin & Barry, 2012; Oerlemans & Dodd, 1993). The use of novel words instead of real words in spelling is shown to be more advantageous in that novel words require an individual to rely solely upon their phonological strategies, hindering their use of learned letter sequences or visual strategies (e.g., Neilson, 2003). In these studies, the measures used to assess participants' nonword spelling skills typically require test takers to spell novel forms such as "thax". Shankweiler argues that to learn to read, learners should realize that all words could be segmented into their phonological (1999, p. 114).

There is a line of evidence suggesting the pivotal role of phonological awareness, which is the ability to know that words are composed of sounds in reading (e.g., M. J. Adams, 1990; Byrne & Fielding-Barnsley, 1990; Stanovich, 2000). Prominently, Bishop (2001, p. 189) identified a "language learning disability" where reading disability was seen as a part of larger phonological language disorder (e.g., Shankweiler et al., 1996; Share, 1995; Torgesen & Wagner, 1998). Based on Report of the National Reading Panel (2000) and Lovett et al. (1994) not only children but also adults benefit from instruction in phonemic awareness in terms of their overall reading and spelling success. An extensive body of evidence corroborated the finding that phonological processing skills had a significant place in spelling and reading ability (e.g., M. J. Adams, 1990; Ball & Blachman, 1991; Bradley & Bryant, 1983; Hatcher et al., 1994; Torgesen et al., 1992; Wagner & Torgesen, 1987). Nonword spelling test is widely used with young adults to assess how well they could apply their phonological awareness proficiency to a spelling context (e.g., Dodd, 1996; Gillon, 2018). The nonwords used in the current battery were taken from Kohnen and Nickels (2010).

3.3.2. Reading Skills Battery: Descriptions of Cognitive Processes Necessary for Performance in Each Subtest

Table 1
Description of the Cognitive Processes

TEST	NARROW ABILITIES	COGNITIVE PROCESSES
Test I: Word Identification	Reading decoding	Identification of visual words and phonological access to pronunciations linked to visual word forms
Test II: Reading Fluency	Reading speed Semantic processing speed	Fast semantic decision-making which requires reading ability and generic knowledge
Test III: Spelling	Spelling ability	Retrieval and use of orthographical knowledge of full forms by mapping full-form phonology onto full-form orthography by translating phonological segments into graphemic units
Test IV: Reading comprehension	Reading comprehension	Construction of propositional representations; Integration of syntactic and semantic properties of visual words and sentences into a representation of the whole text
Test V: Reading Nonwords	Reading decoding Phonetic coding	Grapheme-to-phoneme translation and accessing pronunciations of visual word forms not listed in the mental lexicon
Test VI: Listening Comprehension	Listening ability Working memory	Construction of propositional representations through syntactic and semantic integration of orally presented texts
Test VII: Vocabulary Knowledge	Lexical knowledge Reading comprehension	Lexical activation and semantic access; semantic matching
Test VIII: Reading Span Test	Reading decoding Working memory	Storage and processing reading elements of working memory
Test IX: Nonword Spelling	Spelling ability Phonetic coding	Phoneme-to-grapheme translation Translating spoken elements of nonwords into graphemic units

3.3.2.1. Test 1: Word Identification

In this subtest, the participant read 16 words aloud in isolation. The items were provided in a list form with no context and were of increasing difficulty. The difficulty of items was ensured by the use of lower frequency and longer length items as well as the use of some items with foreign origins. As also seen from the Table 2 below, item frequency levels ranged between 3,27 (i.e., higher frequency of occurrence) and 1,17 (lower frequency of occurrence) as indicated by Zipf values in SUBTLEX-UK corpus (Van Heuven et al., 2014). Zipf values were used for the measure of frequency in the study because they provided the researcher with a standardized measure independent of the corpus size (Zipf, 1972). The number of syllables ranged between 1 and 5, and 3 items out of 16 were of the French origin. Items were presented one at a time through a PowerPoint presentation on a DELL computer, and the testing session was tape-

recorded. For scoring, the experimenter transcribed the participant's answers on the Scoring Sheet (see Table 3) and scored by writing 4 for a correct response or 1 for an incorrect response or 0 for no response in the "Score" column of the scoring sheet.

Table 2
Item Characteristics in the Word Identification Test

Item No	Words	Zipf	APA Transcription	Type of difficulty
1	frequent	3,62	Brit /ˈfriːkw(ə)nt/ Am /ˈfrikwənt/	Problem segment- /kw/
2	cause	4,83	/kɔːz/	Problem segment- /z/
3	awkward	4,19	Brit/ˈɔːkwəd/ Am /ˈɔkwərd/	Problem segment- /ɔː/
4	indigenous	3,47	Brit /ɪnˈdɪdʒɪnəs/ Am /ɪnˈdɪdʒənəs/	lengthy word
5	skepticism	1,17	/ˈskɛptɪsɪz(ə)m/	lengthy word + Rare Word
6	gelatine	3,25	Brit /ˈdʒɛlətɪn/ Am /ˈdʒɛlətn/, /ˈdʒɛlətən/	Lengthy Word + French borrowing
7	volcanologists	2,06	/vɒlkəˈnɒlədʒɪsts/	Rare Word+Lengthy Word
8	alter	3,68	Brit /ˈɒltə//ˈɔːltə/ Am /ˈɔltər/	irregularity in phonology
9	decisive	3,83	/dɪˈsʌɪsɪv/	irregularity in phonology
10	requisitioning	1,65	/ˌrɛkwɪˈzɪʃ(ə)nɪŋ /	Rare Word+Lengthy Word + French borrowing
11	circumstances	4,53	Brit /ˈsəːkəmstansɪz//ˈsəːkəmst(ə)nsɪz//ˈsəːkəmstɑːnsɪz/ Am /ˈsərkəmˌstæns/	lengthy word +French borrowing
12	energetically	2,23	Brit /ˌɛnəˈdʒɛtɪkli/ Am /ˌɛnərˈdʒɛtɪkli/	lengthy word
13	utilize	1,47	/ˈjuːtɪlʌɪz/	rare word
14	deteriorate	3,26	Brit /dɪˈtɪərɪəreɪt/ Am /dɪˈtɪriəˌreɪt/	lengthy word
15	compunctious	1,17	/kəmˈpʌŋkʃəs/	Rare Word+Lengthy Word
16	transcendentalism	1,17	/ˌtrɑːnsɛnˈdɛnt(ə)lɪz(ə)m/ /transɛnˈdɛnt(ə)lɪz(ə)m/	Rare Word+Lengthy Word

Note. Brit indicates British English, and Am indicates American English.

Table 3
Scoring Sheet for Word Identification Subtest

No	Word	APA	Response	Score
1	frequent	/ˈfriːkw(ə)nt/		
2	cause	/kɔːz/		
3	awkward	/ˈɔːkwəd/		
4	indigenous	/ɪnˈdɪdʒɪnəs/		
5	skepticism	/ˈskɛptɪsɪz(ə)m/		
6	gelatine	/ˈdʒɛlətɪn/		
7	volcanologists	/vɒlkəˈnɒlədʒɪsts/		
8	alter	/ˈɒltə//ˈɔːltə/		
9	decisive	/dɪˈsʌɪsɪv/		
10	requisitioning	/ˌrɛkwɪˈzɪʃ(ə)nɪŋ /		
11	circumstances	/ˈsəːkəmstansɪz/ /ˈsəːkəmst(ə)nsɪz/ /ˈsəːkəmstɑːnsɪz/		
12	energetically	/ˌɛnəˈdʒɛtɪkli/		
13	utilize	/ˈjuːtɪlʌɪz/		
14	deteriorate	/dɪˈtɪərɪəreɪt/		
15	compunctious	/kəmˈpʌŋkʃəs/		
16	transcendentalism	/ˌtrɑːnsɛnˈdɛnt(ə)lɪz(ə)m/ /transɛnˈdɛnt(ə)lɪz(ə)m/		

3.3.2.2. Test 2: Reading Fluency

This test used a passage which readers were asked to read for meaning in 1 minute. To ensure they comprehended the text, at intervals of about 60 words, readers selected the option among three that was coherent with the text or indicated whether the given statement was correct or incorrect. For scoring of this test, the number of words that participants could read in 1 minute was calculated, and if they selected a false option, 50 words was subtracted for every incorrect selection. The text was taken from Select Readings Upper Intermediate Book published by Oxford University Press.

3.3.2.3. Test 3: Spelling

Two subtests were used in the spelling test; Spelling dictation test comprised of 44 words that were read aloud by a native American professor at a normal speed and included in a sentence to clarify ambiguities. These sample sentences were obtained from Oxford Living Dictionaries Online. Participants were reminded that they would first hear each item, and a sentence with it and the item again only once and that there would not be other repetitions. The words were selected from items used in Burt and Tate (2002) which were correctly spelled by between 10% and 90% of their samples of Australian freshman students. There were 3 words that the researcher designed for the test: hierarchy, insatiable and homicidal. Common sources of spelling difficulty were the low frequency of words and irregularity in sound-spelling correspondences (e.g., pseudonym). Hesitancy about the use of consonant doubling (e.g., mayonnaise) and ambiguity about problem segments (e.g., abstinence, labyrinth) were the difficulties with regular words that even adult spellers have (Burt & Tate, 2002). The score for the test was the number of correctly spelled words.

In the spelling recognition test, participants were presented with 44 words and asked to circle the correctly spelled word out of 3 options. Misspellings only changed one to three letters of the word and retained the correct pronunciation of the word (e.g., ?assymetry [asymmetry], ?glyserin [glycerin]). They were asked to choose the correct spelling in 10 minutes. 21 out of 44 items in the test were taken from Experiment 2 in Burt and Tate (2002). The rest of the items was designed by the researcher such that the

variety of problem segments in the test would be increased through the use of items that included silent /h/ and required correct vowel selection. It was ensured that none of the items in the Spelling Test appeared in any part of the battery. The number of items that contained the problem segments that relate to spelling difficulty are shown in Table 4 below.

Table 4
Frequencies for Spelling Difficulty and Sample Items

Freq.	Spelling difficulty	Sample Item (correct form/incorrect form)
5	consonant doubling m/l/r/n/p	mayonnaise / mayonaisse
4	"c"/'s" confusion for /s/	conciliate/ consiliate
4	Vowel selection e/i	homogeneity/ homoginity
4	Foreign Borrowing	rendezvous / rendevous
2	silent p	receipt/ receite
2	"ant" / "ent" confusion	cognizant/ cognizent
2	"ch"/'sh"/ "c" confusion for /tʃ/	pistachio/ pistachio/ pistacio
2	"er" / "or" confusion	precursor/ precurser
1	g/dg confusion for /dʒ/	lodgers/logers
1	"naire" / "naire"/ "ner" confusion	doctrinaire/ doctrinare
1	"c"/'s" / "z" confusion for /s/	precipice/precipise/precipize
1	"Cy" / "sy" confusion	ecstasy/ ecstacy
1	"Cy" / "sy" / "sie" confusion	idiosyncrasy/idiosyncracy/idiosyncrasie
1	"sence" / "scence"/ "cence" confusion	coalescence/coalesence/coalescense
1	"ence" / "ance" confusion	occurrence/occurrance/ occurence
1	"rh"/ "r" confusion	rhapsody/ rapsody
1	"que"/ "k" / "ke" confusion for/k/	grotesque/ groteske/ grotesk
1	ible/able confusion	digestible/ digestable
1	Vowel selection a/u/o	truculence/traculence/troculence
1	Vowel selection a/o	phenomenal/ phenamenal
1	Vowel selection o/au/ou	hydraulic/hydrolic/hydroulic
1	Vowel selection e/a	vernacular/ vernecular
1	silent /l/ /p/ /s/ /z/	psalm/psam/salm
1	"y" used as a vowel	hypocrite/ hipocrite
1	Diphthong selection /eɪ/	champagne/ champaign

3.3.2.4. Test 4: Reading Comprehension

This test used 2 passages to assess reading proficiency. The first reading test was taken from Test 2 Cambridge University Press IELTS 9 Book since IELTS is a standardized paper-pencil test that could be reliably and feasibly administered as a part of Reading Skills Battery. It was an informative text of 903 words, long enough to assess reading proficiency and short enough to be completed under time constraints. The text was about iconoclasts, extraordinary people that could achieve things others say cannot be done. The text was followed by a total of 14 questions: 5 multiple-choice, 6 Yes/No/Not Given and 3 sentence completion questions assessing comprehension of the passage.

The skills to successfully finish the test included the recognition of the discourse structure of the text, the recognition of the main idea and explicit details and making inferences and conclusions. Each item was worth 1 point this subtest.

Items in the second reading passage were in an open-close test type that required participants to supply the missing word to sentences in the passage. The passage was about emotional intelligence with 73 words and had 6 missing words. Among 6 correct answers, the use of 2 nouns, 2 verbs and 2 adverbs were required. The passage was taken from the cloze test in KPDS that took place in May 2006. The skills being tested were to understand main and explicit ideas, have a knowledge of grammatical rules and provide an appropriate word in an appropriate form using contextual clues. Each item in this subtest was scored out of 8 points, taking into consideration both the fit and grammatical accuracy of the answer. For the two reading comprehension tests, participants were asked to respond to as many questions as possible in 20 minutes. The sum of correctly answered questions contributed to the total reading comprehension scores considering both speed and accuracy.

3.3.2.5. Test 5: Reading Nonwords

Skills of decoding, pronouncing, and understanding non-existent words were required in this test. Items asked participants to pronounce nonwords, and the session was tape-recorded. In the test, participants were shown 20 nonwords, which assessed the knowledge of over 20 sound-letter correspondences, and no corrective feedback was given during the testing process. First 14 nonwords were selected from Colenbrander, Kohnen, and Nickels (2018), while the last 6 items were designed by the researcher though Wuggy software (Keuleers & Brysbaert, 2010). For scoring, participants' responses were transcribed in the spaces on the scoring sheet (see Appendix I). The response was deemed correct when it matched the pronunciation provided on the scoring sheet and was given 4 points. There was no penalty for variations in pronunciation because of speech impediments or regional accents.

3.3.2.6. Test 6: Listening Comprehension

In the test, there were 17 thematically unrelated sentences that had a missing word at the end of each sentence. Participants supplied the appropriate word that would fit to the end of the sentence. Great care was taken by the researcher so that the test items allowed only restricted number of options. Listening tracks were voiced by a native American speaker, and the quality of these tracks was enhanced through the software of Audacity. In the test, there were items of varying length. While some had only 3 words, some included a set of sentences. All sentences were factual statements that did not require the subjective evaluation of the participant. Sentences were adapted from reading passages, lectures and articles from newspapers. There were 6 items that required a single correct answer, and there were 11 items that had alternative correct/synonymous answers. Alternatives for answers were noted on the scoring sheet, and any of these alternatives was accepted as correct and scored on a scale of 4 points. For scoring, 4 points was given for each correct answer, and 4 point was for its grammatical accuracy. Two examples to the listening items are as follows:

Example Item 1: Beavers generally live in family clusters consisting of 6 to 10 _____.

Correct: members

Example Item 2: In old age, elephants die because of the loss of final set of molars. When this last set of teeth is gone, the elephant dies from malnutrition because it is unable to obtain adequate _____.

Correct: nourishment, food, nutriment

3.3.2.7. Test 7: Vocabulary Knowledge

Vocabulary Knowledge Test measured a participant's ability to provide synonyms and antonyms and to complete word associations. In the first test, Test of Similar and Opposite Meanings, participants were presented with 32 items in which they were required to examine the words and expressions in bold in the sentences and write ONE word that had the similar or opposite meaning in the same context. In the test, participants were required to supply 13 adjectives, 5 nouns, 12 verbs, and 2 adverbs in 15 minutes. As there might be more than one synonym or antonym available for a given

word in that particular context, each item was scored on a scale of four points. If the participant answer matched the context of the given sentence, it was marked four points. If the answer was somewhat related to the context, it was scored three points. If the answer did not match the context at all, participants received one point. Two experts scored the same answers, and reliability coefficients were calculated.

Example Item 1 (of similar meanings): Some plants, such as beans, benefit the soil in which they are planted.

4-point answer: enrich, nurture;
3-point answer: feed;
2-point answer: contribute;
1-point answer: take advantage

In the second test named Word Associations, participants completed each of the sentences with one adjective, noun or a verb in 15 minutes. In the test, participants were required to supply 8 adjectives, 6 verbs and 2 noun associations. The missing word was one that was often used (i.e., it collocates) with the nouns and/or adjectives and/or adverbs in italics. Though participants were not given options, the first and last letter of each word were provided along with a sample sentence where the word perfectly fit. Test items were selected from the book entitled Check Your English Vocabulary for TOEFL by A & C Black Publishers Ltd. For scoring, 1 point was given for the correct answer. A sample item is given below:

Example Item 1: I_____T is often followed by the nouns aspect, element, factor, feature, issue, part, or point. It is often preceded by the adverbs crucially, extremely, particularly, terribly, or vitally.

(Sample sentence: It is vitally _____ to disconnect the appliance from the power supply before dismantling it).

Answer: important

3.3.2.8. Test 8: Reading Span Test

This test showed how efficient the verbal working memory was and involved sets of letters (ranging from 2 to 6) which individuals were asked to memorize and sentences which participant judged the plausibility of. In the test, they were given one sentence to read. Once they made their decision about the plausibility of the sentence, a letter

appeared on the screen. After the letter disappeared, they were presented with another sentence and a letter. They made attempts to recall the letters at the end of each set.

3.3.2.9. Test 9: Nonword Spelling

This subtest measured an individual's proficiency in utilizing sound and spelling knowledge. Individuals were required to listen to and spell 23 non-words. Test items were adopted from Kohnen and Nickels (2010). There was a scoring sheet (see Table 5) to score a participant's responses. The experimenter wrote 4 in the Accuracy column if the whole nonword was spelled correctly or wrote 0 in the Accuracy column if the nonword contained any errors. Alternatives for some nonwords were noted on the scoring sheet, and any of these alternatives was accepted as correct. Also, both upper- and lower-case letters were accepted as correct.

Table 5
Scoring Sheet for the Test of Nonword Spelling

No	Pronunciation IPA	Item	Other acceptable responses	Response	Initial PGC	Medial PGC	Final PGC	Accuracy (whole item)
1	næm	**nam**	knam, knamb, namb		n/kn	a	m/mb	
2	hʌd	**hud**			h	u	d	
3	sʌg	**sug**			s	u	g	
4	ðɒb	**thob**			th	o	b	
5	**si:b**	**seeb**	seab,sebe, ceeb, ceab, cebe		s/c	ee/ea/e-e	b	
6	kwi:d	**queed**	quead,quede		qu	ee/ea/e-e	d	
7	ju:m	**yoom**	ume, yume, youm *Note*: if ume, then no grapheme for /j/ required)		y	oo/u-e/ou	m	
8	lɛŋ	**leng**			l	e	ng	
9	ʃʌs	**shuss**			sh	u	ss	
10	jɛk	**yeck**			y	e	ck	
11	kwu:tʃ	**quooch**			qu	oo	ch	
12	lɜ:θ	**lurth**	lerth, lirth		l	ur/er/ir	th	
13	zaɪ	**zie**	zy		z		ie/y	
14	ʃaɪf	**shife**			sh	i/e	f	
15	hɔɪlt	**hoilt**	hoiled		h	oi	l t/l ed	
16	ʤɜ:b	**jerb**	gerb,jirb, girb, jurb		j/g	er/ir/ur	b	
17	glaɪ	**gly**	glie		gl		y/ie	
18	Ðɔ:ʃ	**thorsh**	thawsh, thaush		th	or/aw/au	sh	
19	ʃlaɪ	**shly**	shlie		sh l		ie/y	
20	ʤaɪs	**jise**	jice, gise, gice		j/g	i-e	s/ce	
21	waʊl	**whoul**	woul, wowl, whowl		w/wh	ou/ow	l	
22	zəʊʤ	**zoge**	zoage		z	oa/o-e	ge	
23	θraɪp	**thripe**			th r	i-e	p	

3.4. Methodology

The study utilized two masked primed lexical decision experiments with 6 priming conditions:

1) a morphological prime (braveness),
2) a TL-within prime (braevness),
3) an SL-within prime (braocness),
4) a TL-across prime (bravneess),
5) an SL-across prime (bravruess),
6) or an Unrelated prime (directness).

Experiment 1 examined the recognition of derived word forms in L1 English, and Experiment 2 was designed to investigate the recognition of word forms in L2 English, yet two experiments both assessed the role of letter position coding during the complex word processing and tapped into individual variability in reading skills.

CHAPTER 4

EXPERIMENT 1: MASKED PRIMING IN L2 ENGLISH

4.1. Participants

Experiment 1 focused on the investigation of priming effects in L2 speakers of English. Twenty-nine students (22 females; age: mean=26.14, SD=3.16, min=20, max=32) at Middle East Technical University took part in the experiment. All participants were L1 Turkish speakers of L2 English. They had all learned English through formal instruction after the age of 10 (mean length of English instruction: 16.3 years, SD: 3.23). They did not have any history of neurological impairments and/or learning disabilities and had normal or corrected-to-normal vision.

4.2. Materials

4.2.1. Stimuli

For the masked primed lexical decision experiment, 58 English target words were selected (see Table 6 for characteristics and Appendix B for the entire list of stimuli). All targets were the simple stem words (e.g., BRAVE) of derived words and were preceded by six primes:

1) a morphological prime (braveness),
2) a TL-within prime (braevness),
3) an SL-within prime (braocness),
4) a TL-across prime (bravneess),
5) an SL-across prime (bravruess),
6) or an Unrelated prime (directness).

Table 6
Psycholinguistic Characteristics of Stimuli (SDs)

	Related	Unrelated	TL-within	SL-within	TL-across	SL-across
Bigram frequency	**274**(42)	**258**(45)	**244**(51)	**359**(49)	**211**(73)	**199**(50)
Stem Bigram Frequency	**1141**(861)	**1266**(1119)				
Stem Frequency	**4.34 (**0.7)	**4.39** (0.8)				
Word Frequency	**2.08 (**0.8**)**	**2.07**(0.7)				
Stem Length	**5.39(**0.6**)**	**5.52**(0.7)				
Word Length	**9.24(**0.4**)**	**9.37**(0.5)				
Stem Orthographic Neighborhood	**2.33 (**2**)**	**2.33**(2)				
Orthographic neighborhood	**0.15(**0.4**)**	**0.17(**0.4**)**				

Note. Word frequency counts were obtained from the SUBTLEX-UK database (Van Heuven et al., 2014) using the Zipf values (log10 occurrences per billion).

Unrelated primes were matched as closely as possible to related primes on 8 characteristics: stem length, stem frequency, stem bigram frequency, stem orthographic neighborhood, word length, frequency, bigram frequency, and orthographic neighborhood using N-Watch software. The same derivational suffix was used in related and the unrelated primes (e.g., braveness, directness) to avoid the potential effect of the suffix. The majority of letter transpositions contained a vowel and a consonant (e.g., Lupker et al., 2008), and great care was taken to ensure that the transpositions did not create a real word. SL-control prime words included the two new letters of similar resemblance and height to the transposed letters (e.g., braevness, braocness). They were matched with TL primes on length, bigram frequency, and orthographic neighborhood. 42 real word and 100 orthographically legal and pronounceable nonword filler targets were constructed for the purposes of the lexical decision task. The first and last letter of a real word were altered to create the nonword targets (e.g., lenciv from pencil). They were matched with real word targets on length, position-specific bigram frequency, Coltheart's N and primed by an unrelated word. Twelve lists were created in a Latin square design so that each participant saw each target in a different priming condition and in a different order. The order of target presentation within each list was randomized across participants.

4.3. Procedure

Participants were tested individually in a silent room. Stimulus presentation was randomized using E-Prime (Schneider et al., 2002). Participants first saw the forward mask of hash marks for 500 ms, which were followed by the prime word in lowercase letters for 50 ms. The target stimulus then appeared on the screen in uppercase letters for a maximum of 3000 ms or until the participant responded. Participants were told to press “right key” on a gamepad if the visual target was a real English word or “left key” if it was a nonword as quickly and accurately as possible. The whole experiment lasted for about 8 minutes.

4.4. The Reading Skills Battery

To assess individual variability in reading proficiency, the Reading Skills Test Battery was constructed and conducted in paper-and-pencil format. On the first page of the battery, participants were asked about their background information (e.g., their age, number of languages they speak as their native language, namely L1 number, and as their foreign language, namely L2 number). There were nine tests in the battery that measured several facets of reading in English: Word Identification Test, Test of Reading Fluency, Spelling Test, Reading Comprehension Test, Test of Reading Nonwords, Listening Comprehension Test, Test of Vocabulary Knowledge, Reading Span Test, and Test of Nonword Spelling. These tests contributed to the thorough assessment of various reading skills in L1 and L2 and tested if individual variability contributed to the facilitative effects of primes during the early stages of morphological processing. Participants' score distributions for each battery subtest were presented in Appendix C, and characteristics of L2 English speakers in Experiment 1 as well as descriptive statistics for the distribution of proficiency measures were presented in Appendix D.

The researcher and an expert in Linguistics scored individual responses to the test items in Nonword Spelling, Reading Nonwords and Word Identification. The interrater reliability coefficients (*a*) were =0.99, 0.97 and 0.99, respectively. Two experts in language teaching scored individual responses to the test items in Listening, Vocabulary and Reading Comprehension. Interrater reliability coefficients were found to be 0.98,

0.98 and 0.94, respectively. All subtests in the battery were paper and pencil tests but the Reading Span, Word Identification and Reading nonwords subtests: Reading span test was conducted on E-prime software, and Word identification subtest was administered on MS PowerPoint on a DELL computer. Word Identification and Reading nonwords subtests were tape-recorded. Participants were tested individually in a silent room, and total administration time was approximately 1 hour and 25 minutes, depending on the examinee's personality, mood, and rapport with the examiner. In order to control for the fatigue effects, the battery was given either at the beginning or at the end of the lexical decision task following a sequential order.

4.5. Results

4.5.1. Reaction Time Analyses

Four target words (i.e., DEMURE, TENDER, PERISH, PUNISH) were excluded as they contained pseudo-suffixes. Reaction time (RT) analyses were conducted on only correct trials after the omission of incorrect trials (2.37 % of the data points). Based on the distribution of the data, individual data points below 350 ms or above 2000 ms were treated as extreme values and hence omitted (3 datapoints; 0.2 % of all data). Data points whose standardized residuals were greater than 2.5 in absolute value (Baayen, 2008) were removed (2.55 % of all data). There were 1486 data points remaining for the analysis. Table 7 shows mean RTs, error rates and standard deviations across conditions.

Table 7
Mean RTs and ERs (SDs) across Conditions

Condition		***RTs***	***ER %***	***Example***
Morphological	Unrelated	612 (116)	0.03 (0.16)	(*directness* - BRAVE)
	Related	591 (121)	0.02 (0.15)	(*braveness* - BRAVE)
	effect	**21**		
Intra-transposition	SL-Within	612 (131)	0.01 (0.11)	(*braocness* - BRAVE)
	TL-Within	615 (126)	0.03 (0.16)	*(braevness* - BRAVE)
	effect	**-3**		
Inter-transposition	SL-Across	591 (111)	0.04 (0.19)	(*bravruess* - BRAVE)
	TL- Across	598 (116)	0.02 (0.12)	(*bravneess* - BRAVE)
	effect	**-7**		

Note. Significant facilitation was only obtained in the Morphological Condition. TL-priming effects were absent irrespective of whether the transpositions crossed morphemic boundaries. RT = reaction time; ER% = error rate; SD = Standard Deviation.

The boxcox transformation revealed that inverse transformation was the best approximation to normalize the dependent variable. Therefore, inverse RTs (-1000/RT) were calculated and were then analyzed through linear mixed-effect (LME) modeling (Version 1.2.1335, RDevelopmentCoreTeam, 2019) through the lmerTest package (Kuznetsova et al., 2017). The final model included "Prime Type" (Morphological, TL-within, SL-within, TL-across, SL-across and Unrelated) as a fixed effect and "Subjects" and "Items" as random effects factors (random intercepts). A maximal random slope structure (Barr et al., 2013) was attempted, but because of the complex structure of the model, the inclusion of random slopes did not converge and therefore was not included in the final model structure.

Post-hoc comparisons between experimental and control conditions (i.e., Unrelated vs Morphological; SL-within vs TL-within; SL-across vs TL-across) and the interaction between intramorphemic and intermorphemic transpositions were carried out using the emmeans package (Lenth, 2019) in R. The number of languages individuals could speak as their L1 and L2 as well as their age were also included in the model as fixed effects. But these were omitted from the structure since they did not significantly contribute to the model's goodness-of-fit using the stepwise selection procedure.

Table 8
Summary of Fixed Effects in the Final Model

	-1000/RT		
Predictors	***Chisq***	***df***	***p value***
(Intercept)	32.2502	1	p <.0001
PrimeType	16.0809	5	p <.001
L1_number	0.9055	1	0.341309
L2_number	0.0656	2	0.967751
age	0.1115	1	0.738451

df = Degrees of Freedom.

The final model included one fixed effect factor (Prime Type) and two random effects factors (random intercepts for subjects and items). The model [2]for the L2 data showed a significant main effect of Prime Type, $\chi 2(5) = 16.086$, p <.001. Post

[2] The lmer syntax for the final model was: -1000/RT ~ PrimeType + (1|subject) + (1|target), data=dataHL2

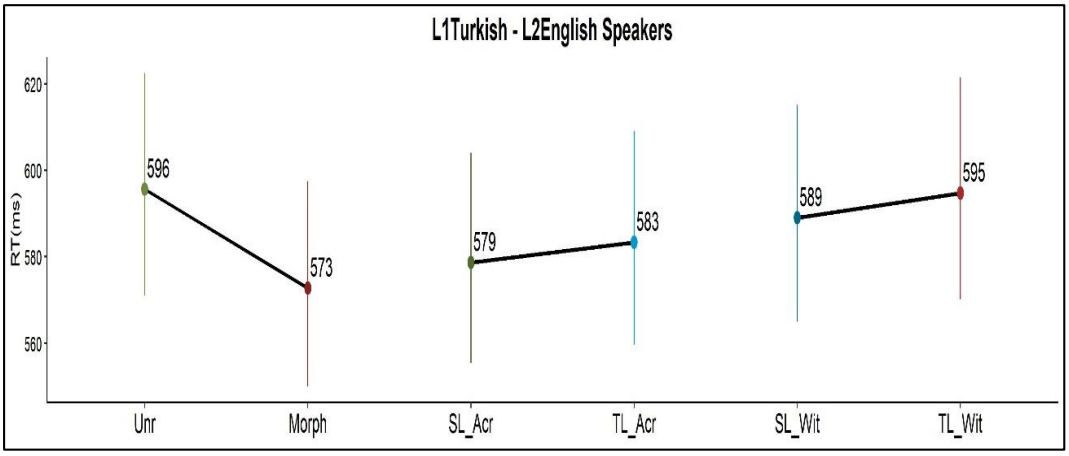
hoc comparisons for correct responses are shown in Table 9. Responses to target words preceded by morphologically related primes (e.g., braveness - BRAVE) were significantly faster than targets preceded by unrelated primes (e.g., directness - BRAVE), yielding a 21-ms facilitation, *t[1401]* = -3.201, *p*=0.001.

Table 9
Post hoc Comparisons between Experimental and Control Conditions

contrasts	***Estimates***	***SE***	***df***	***t. ratio***	***p***
Morphological vs Unrelated	-0.06721	0.021	1401	-3.201	0.001
TL within vs SL within (Intratransposition)	0.01647	0.0209	1401	0.788	0.430
TL across vs SL across (Intertransposition)	0.01374	0.0211	1401	0.652	0.514
SL across vs Unrelated	-0.04915	0.0211	1401	-2.324	0.02
SL within vs Unrelated	-0.01897	0.0209	1403	-0.906	0.365
Morphological vs TL within	-0.06471	0.021	1402	-3.079	0.002
Intratransposition* Intertransposition	0.00273	0.0297	1401	0.092	0.926

SE = Standard Error.

No significant difference was found between TL-within and the SL-within conditions, *t*[1401]= 0.788, *p*=0.43. Moreover, the difference between the TL-across and SL-across conditions was not significant, *t*[1401]= 0.652, *p*=0.51. Also, the direct analysis of the interaction between intratranspositions and intertranspositions yielded a non-significant result, *t*[1401]= 0.092, *p*=0.92. A statistically significant difference was found between the SL-across and the Unrelated prime-target pairs (*t*[1401]= -2.324, *p*=0.02). There were significantly faster responses to the SL-across primes than to the Unrelated primes by 21 ms. Yet, the SL-within primes did not differ from those of Unrelated condition (*t*[1403]= -0.906, *p*=0.36). A statistically significant difference was obtained between the non-transposed morphologically related primes and TL-within primes, *t*[1402]= -3.078, *p*=0.002, which was due to faster RTs to targets preceded by morphological primes. The model-based estimates of response times for each condition are displayed in Figure 15.



Note. Unr, Unrelated; Morph, Morphological; SL_Acr, SL-Across; TL_Acr, TL-Across; SL_With, SL-Within; TL_With, TL-Within Conditions.

Figure 15. Model–Based Estimates of Response Times Per Condition. Error Bars are 95% Confidence Intervals

4.5.2. Individual Differences Analyses

Score distributions for each reading test are shown in Figure 23 (see Appendix C). A wide scale of score distribution was obtained through various tests that assessed distinct areas of reading proficiency. For the individual differences analyses, each test score was standardized and added to the model[3] one at a time using the stepwise selection procedure to assess if each test score significantly improved the model's goodness of fit. Then, a direct analysis into the interaction of each proficiency test with morphological priming (i.e., Unrelated condition vs Morphological condition), TL-within priming (i.e., SL-within condition vs TL-within condition), and TL-across priming (i.e., SL-across condition vs TL-across condition) was carried out through contrasts in the emmeans package in R. Significant results regarding the interaction between each priming type and each test are shown in Table 10 through estimates for each contrast, standard error, t-ratio and p values across low, medium proficiency and high proficiency levels.

[3] The interaction of each test with prime type was calculated in a separate model to avoid excessive collinearity. One example to lmer syntax is:
-1000/RT ~ PrimeType * Spelling.c + (1|subject) + (1|target), data = dataL2

Table 10
Contrasts for Proficiency Levels for TL-within Priming

Priming type	***Tests***	***Contrasts***	***Estimates***	***Standard Error***	***t ratio***	***p***
TL-within Priming	*Reading Nonwords*	Low vs High	0.213	0.06	3.306	p=0.001
		Low vs Medium	0.081	0.02		
		Medium vs High	0.132	0.04		
	Nonword Spelling	Low vs High	0.157	0.08	1.913	p=0.05
		Low vs Medium	0.071	0.04		
		Medium vs High	0.085	0.04		

Note. Low, Medium and High refers to the Low Proficiency, Medium Proficiency, and High Proficiency Levels.

4.5.2.1. TL Priming Modulation for Within-Morpheme Transpositions

There was a significant interaction between TL-within priming and the tests of Reading Nonwords (t[1417]= 3.306 , p=0.001) and Nonword Spelling (t[1419]= 1.913, p=0.05) regarding three proficiency profiles (see Table 10). This interaction pointed to the significant TL-within priming effects in individuals with low proficiency. Figure 16 demonstrates the influence of different proficiency levels in nonword reading on the magnitude of TL-within priming. Furthermore, Figure 17 provides the scatterplot of real priming effects with overlaid trend lines from the predicted model.

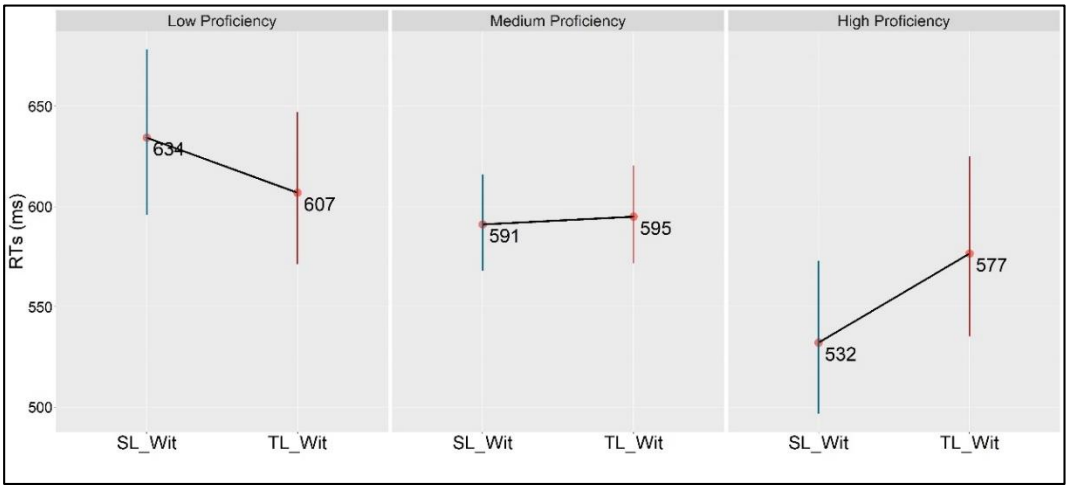
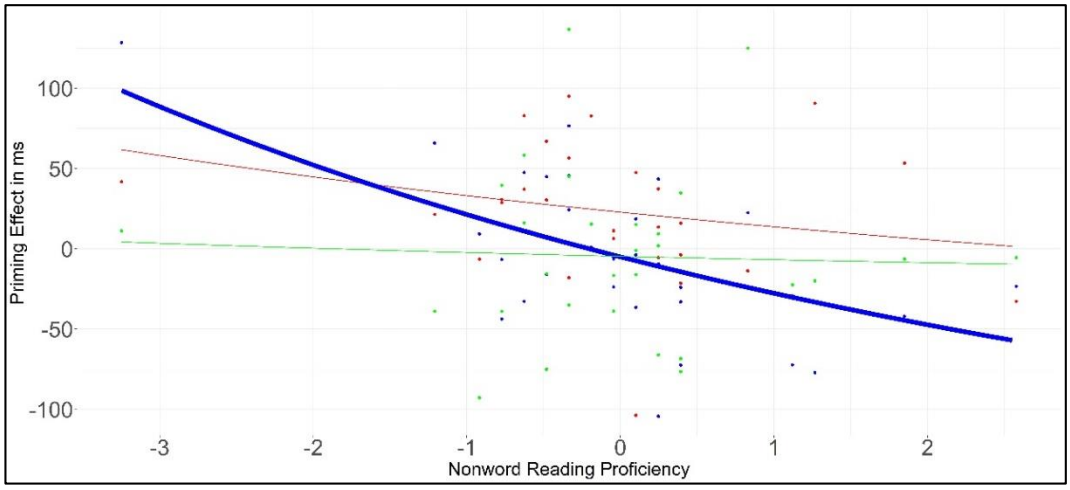


Figure 16. Model-based Estimates in Reading Nonwords



Note. The "observed values" in the scatterplot show raw RT scores; however, the model is fitting inverse RT scores. Red line indicates Morphological Priming, whereas blue line and green line demonstrate TL-within Priming and TL-across Priming, respectively. Thicker line indicates the significant interaction.

Figure 17. The Scatterplot of Real Priming Effects with Overlaid Trend Lines from the Predicted Model in Reading Nonwords

As both figures suggest, the size of facilitation dramatically decreased as the speakers got more proficiency in nonword reading skills, showing how the proficiency in reading nonwords contributed to the TL-within priming effects. The influence of different proficiency levels of nonword spelling on the size of the priming is demonstrated in Figures 18 and 19.

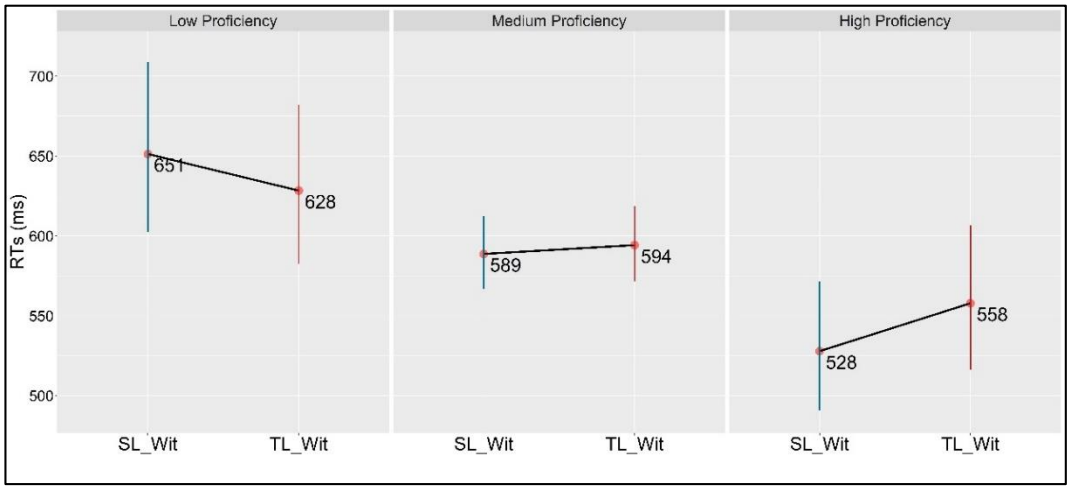
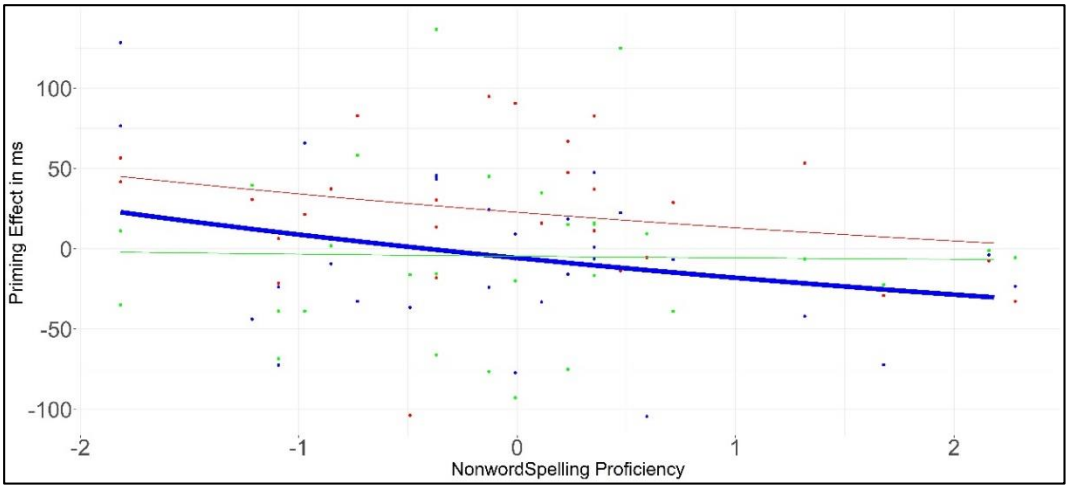


Figure 18. Model-based Estimates in Nonword Spelling



Note. Red line indicates Morphological Priming, whereas blue line and green line demonstrate TL-within Priming and TL-across Priming, respectively. Thicker line indicates the significant interaction.

Figure 19. The Scatterplot of Real Priming Effects with Overlaid Trend Lines from the Predicted Model in Nonword Spelling

Figures 18 and 19 above demonstrate a similar modulation pattern of TL-within effects by nonword spelling proficiency. While priming effects obtained from the intertranspositions were robust in low proficient participants, the effects disappeared with the growing proficiency.

4.6. Discussion

Experiment 1 sought to investigate morphological processing in L2 using confirmatory data-analytic techniques. The current experiment provided further evidence to the existing and emerging findings that suffix-derived primes in L2 were robust primes whereby the presentation of a morphologically complex word as a prime (e.g., braveness) facilitated the recognition of a monomorphemic stem target (e.g., BRAVE). This finding lends support to Voga et al.'s (2014) results in Experiment IB where derivation primes produced significant facilitation (31 ms) relative to the unrelated condition in Greek learners of English and is consistent across studies in the literature that has amply shown solid facilitation from genuine derivations (see Amenta & Crepaldi, 2012 for a review).

At the group level, results based on average reaction time data revealed that transposed-letter primes within morpheme boundaries or across morpheme boundaries were not efficient primes since no facilitation arose from the reversed-letter primes. This inhibition, when the RT data were analyzed on average data, implies that segmentation mechanism(s) in L2 take into account the benefits of letter position coding and that letter transpositions have an impact on the size of the priming. However, as also explored by the reading differences measures, lower proficiency nonword readers and spellers could overcome the inhibitory impact of letter transpositions on morphological processing. It is important to note that these results deviated from the generally observed pattern reported in L1 literature for the following two reasons: First, in the present study, TL-effects were examined in L2 speakers, which has so far been very scarce. Therefore, the results of the current study should be assessed along with those of a limited number of attempts to investigate TL effects in L2 speakers and, therefore, require further elaboration with other L2 cohorts. Second many of the TL effects reported in the literature come from studies in which Indo-European languages were tested. In the current study, in contrast, all participants were L2 English speakers with an L1 Turkish background.

The current experiment also explored individual variability in reading skills and showed that differences in reading profiles might indeed be moderating the morphological TL priming effects. Individual differences in reading proficiency, in this case reading nonwords and nonword spelling, could modulate masked TL-within priming effects. These findings are in line with recent evidence provided by Beyersmann et al. (2016), Medeiros and Duñabeitia (2016) that showed distinct reading proficiency levels moderated the qualitatively distinct ways individuals use morphological information during complex word processing. Regarding the modulation of TL-priming effects by different reading profiles, results of the exploratory analyses also demonstrated that TL-within priming effects were obtained in L2 speakers with poorer nonword spelling (23 ms) and reading nonwords skills (27 ms). But they dramatically vanished in skilled nonword spellers (- 30 ms) and readers (- 45 ms). Low proficient readers and spellers could elicit morphological information only from TL-within primes, likely because the lower proficiency nonword readers and spellers might have less precise letter decoding

skills and are hence less dependent upon orthographically-driven decomposition mechanism that is less susceptible to transposed-letters. Therefore, current findings also support Andrews and Lo's (2013) contention that more empirical investigations needed to consider individual variability and that systematic analyses into individual variability had significant implications for models of word recognition. But it is important to note that these results will be elaborated in greater detail together with the theoretical implications in the general discussion section of the study.

CHAPTER 5

EXPERIMENT 2: MASKED PRIMING IN L1 ENGLISH

5.1. Participants

A group of 50 native English speakers (14 males; age: mean=20.73, SD=5.99, min=17, max=53) with normal or corrected-to-normal vision attended Experiment 2. One participant was removed since they did not make any decision on the targets. All participants studied at Macquarie University and reported English as their L1 at the time of the testing. They had no history of language or learning disabilities.

5.2. Materials

The same stimuli as in Experiment 1 were used in Experiment 2 except that four target words that contained pseudo-suffixes were excluded prior to data collection. 54 orthographically legal and pronounceable nonword filler targets were constructed for the purposes of the lexical decision task. The nonwords were constructed in the same way as in Experiment 1.

5.3. Procedure

Participants were tested individually in a silent room. Stimulus presentation was randomized using DMDX (Forster & Forster, 2003). Participants first saw the forward mask of hash marks for 500 ms, which were followed by the prime word for 50 ms. The target stimulus then appeared on the screen for a maximum of 3000 ms or until the participant responded. Prime words were presented in lower case letters, and targets were in uppercase letters. Participants were told to press "M" on the computer keyboard if the visual target was a real English word or "Z" if it was a nonword as quickly and accurately as possible. The whole experiment took about 8 minutes.

5.4. Reading Skills Test Battery

With regards to the individual differences measures, the tests of vocabulary, spelling, word identification (TOWRE- Sight Word Efficiency, see Appendix E) and reading nonwords (TOWRE- Phonemic Decoding Efficiency, see Appendix F) were used, thereby making the administration of battery more feasible and further avoiding fatigue effects. These tests have been widely used to examine the modulation of individual differences in L1 word recognition literature. Characteristics of L1 English speakers in Experiment 2 were presented in Appendix H (see also Appendix G for descriptive statistics for the distribution of proficiency measures).

5.5. Results

5.5.1. Reaction Time Analyses

The error rates for two targets (i.e., PALATE and LAMENT) were more than 50 %, and hence omitted. Reaction time (RT) analyses were conducted on only correct trials after the omission of incorrect trials (2.4% of all data). Based on the visual inspection of RT distribution, individual data points below 350 ms or above 2000 ms were treated as extreme values and hence omitted (5 datapoints; 0.02 % of all data). Data points whose standardized residuals were greater than 2.5 in absolute value (Baayen, 2008) were removed (2.9 %). There were 2408 data points remaining for the analysis. Table 11 shows mean RTs, error rates and standard deviations across conditions.

Table 11
Mean RTs, ERs (SDs) across Conditions

Condition		**RTs**	**ER %**	**Example**
Morphological	Unrelated	591 (114)	0.05 (0.23)	(directness - BRAVE)
	Related	568 (112)	0.04 (0.18)	(braveness - BRAVE)
	effect	**23**		
Intra-transposition	SL-Within	591 (113)	0.05 (0.21)	(braocness - BRAVE)
	TL-Within	565 (117)	0.05 (0.21)	(braevness - BRAVE)
	effect	**26**		
Inter-transposition	SL-Across	577 (112)	0.05(0.21)	(bravruess - BRAVE)
	TL- Across	571 (113)	0.04 (0.19)	(bravneess - BRAVE)
	effect	**6**		

The boxcox transformation showed that inverse transformation was the best approximation to normalize the dependent variable. Therefore, inverse RTs (-1000/RT) were calculated and were then analyzed through linear mixed-effect modeling (Version 1.2.1335, RDevelopmentCoreTeam, 2019) through the lmerTest package (Kuznetsova et al., 2017). The final model included "Prime Type" (Morphological, TL-within, SL-within, TL-across, SL-across and Unrelated) as a fixed effect and "Subjects" and "Items" as random effects factors (random intercepts). A maximal random slope structure (Barr et al., 2013) was attempted, but, because of the complex structure of the model, the inclusion of random slopes did not converge and therefore was not included in the final model structure.

Post-hoc comparisons between experimental and control conditions (i.e., Unrelated vs Morphological; SL-within vs TL-within; SL-across vs TL-across) and interaction between intramorphemic and intermorphemic transpositions were carried out using the emmeans package (Lenth, 2019) in R.

The model[4] for the native English data revealed a significant main effect of Prime Type, $\chi 2(5) = 37.67$, $p < .0001$. Post hoc comparisons for correct responses are shown in Table 12. Morphologically related prime-target pairs were responded to significantly faster than unrelated prime-target pairs, pointing to a 23-ms morphological priming effect, $t[2306] = -4.158$, $p < 0.0001$.

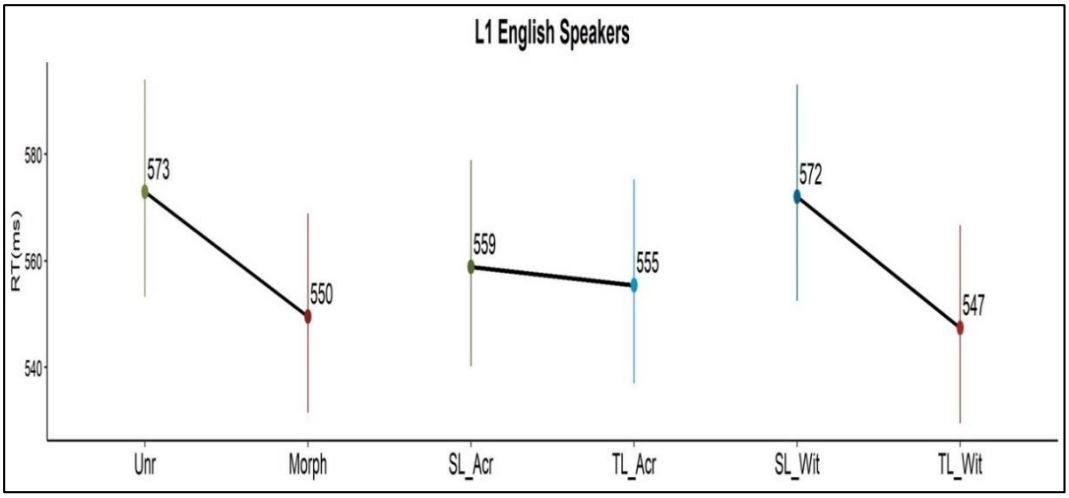
Table 12
Post hoc Comparisons between Experimental and Control Conditions

contrasts	***Estimates***	***SE***	***t. ratio***	***p***
Morphological vs Unrelated	-0.07426	2306	-4.158	<.0001
TL within vs SL within (Intratransposition)	-0.07868	2308	-4.372	<.0001
TL across vs SL across (Intertransposition)	-0.01108	2308	-0.618	0.5369
SL across vs Unrelated	-0.04379	2307	-2.438	0.0149
SL within vs Unrelated	-0.00258	2307	-0.144	0.8856
Morphological vs TL within	0.00701	2308	0.391	0.6956
Intratransposition* Intertransposition	-0.0676	2307	-2.664	0.0078

There was a statistically significant difference between the TL-within and the SL-within conditions, $t[2308] = -4.372$, $p < .0001$, due to faster responses to TL-within

[4] The lmer syntax was: -1000/RT ~ PrimeType + (1|subject) + (1|target), data=dataL1

primes. However, TL-across and SL-across conditions did not differ from each other, *t*[2308]= -0.618, *p*=0.53. Also, a direct analysis was carried out within the same model regarding the interaction between intratranspositions and intertranspositions, resulting in a significant two-way interaction, *t*[2307]= -2.664, *p*=0.007. There was a marginally significant difference between the SL-across and the Unrelated conditions (*t*[2307]= -2.438, *p*=0.01). The responses to words preceded by SL-across primes were significantly faster than to those preceded by the Unrelated primes by 14 ms. The estimated reaction times for each condition are shown in Figure 20.



Note. Unr, Unrelated; Morph, Morphological; SL_Acr, SL_Across; TL_Acr, TL-Across; SL_With, SL-Within; TL_With, TL-Within Conditions. Error bars are 95% confidence intervals.

Figure 20. Model–based Estimates of Response Times per Condition

5.5.2. Cross-Language Analyses

The data from Experiment 1 and 2 were merged for cross-language analyses and analyzed using the LME model in R, following the same methodological aspects of Experiment 1 and 2. There were two fixed effects factors (Prime Type: Morphological, TL-within, SL-within, TL-across, SL-across and Unrelated; Group: L1, L2) and their interactions and two random effects factors (Subjects and Items)[5].

[5] The lmer syntax for the cross-language model was: -1000/RT ~ PrimeType * group + (1|subject) + (1|target), data= L1L2data

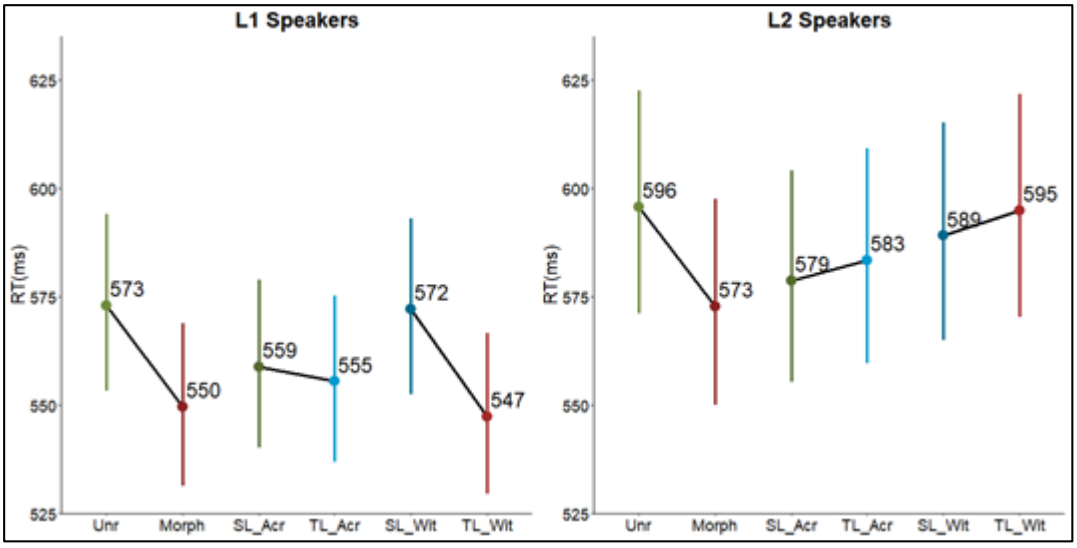
A maximal random slope structure (Barr et al., 2013) was attempted; however, the inclusion of random slopes for each fixed factor and their interactions did not converge due to the complex model structure. Hence, it was not included in the final model.

The interaction between prime type and group was significant, $\chi 2(5) = 13.375$, $p < .01$, suggesting that the magnitude of priming differed in L1 and L2 groups in some experimental conditions. Pairwise comparisons were computed to directly investigate morphological priming, TL-within priming and TL-across priming between L1 and L2 (see Table 13 for pairwise comparisons).

Table 13
Pairwise Comparisons of Conditions Between Groups

contrasts	***Estimates***	***SE***	***z. ratio***	***p***
Morphological vs Unrelated vs Group	0.00414	0.0284	0.146	0.884
TL within vs SL within vs Group	0.09199	0.0284	3.244	0.0012
TL across vs SL across vs Group	0.02634	0.0285	0.925	0.355

The cross-language analysis results revealed no significant differences between L1 and L2 speakers in morphological priming (p=0.88) and in TL-across priming (p=0.35), confirming that the priming patterns across these experimental conditions were the same in L1 and L2, as depicted in model-based estimates for L2 English and L1 English groups in Figure 21. A statistically significant difference was found in TL-within priming, confirming the robust priming effects reported only in L1 speakers.



Note. Unr, Unrelated; Morph, Morphological; SL_Acr, SL_Across; TL_Acr, TL-Across; SL_With, SL-Within; TL_With, TL-Within Conditions. Error bars are 95% confidence intervals.

Figure 21. Model–based Estimates of Reaction Times for L1 English and L2 English Speakers

As shown in the figure, L2 English and L1 English speakers yielded similar magnitudes of priming in all conditions except the TL-within condition. It is also evident that L1 English group demonstrated faster RTs in each condition, irrespective of whether primes were morphologically related or had letter transpositions.

5.5.3. Individual Differences Analyses

Score distributions for each reading test are shown in Figure 24 (see Appendix G). A wide scale of score distribution was obtained through various tests that assessed distinct areas of reading proficiency. For the individual differences analyses, each test score was standardized and added to the model[6] one at a time using the stepwise selection procedure to assess if each test score significantly improved the model's goodness of fit. Then, direct analyses into the interaction of each proficiency test with morphological priming (i.e., Unrelated condition vs Morphological condition), TL-within priming (i.e., SL-within condition vs TL-within condition), and TL-

[6] The interaction of each test of the battery was calculated in a separate model to avoid excessive collinearity. One example to lmer syntax is:
-1000/RT ~ PrimeType * Spelling.c + (1|subject) + (1|target), data = dataL1

across priming (i.e., SL-across condition vs TL-across condition) were carried out. Significant results regarding the interaction between morphological priming and individual differences measures are shown in Table 14.

Table 14
Estimates for Each Proficiency Contrast

Priming type	*Tests*	*Contrasts*	*Estimates*	*Standard Error*	*t ratio*	*p*
Morphological priming	*Spelling*	Low vs High	-0.13	0.06	-2.177	0.029
		Low vs Medium	-0.083	0.04		
		Medium vs High	-0.046	0.02		
	Vocabulary	Low vs High	-0.123	0.06	-2.030	0.042
		Low vs Medium	-0.077	0.04		
		Medium vs High	-0.046	0.02		

Note. Low, Medium and High refers to the Low Proficiency, Medium Proficiency, and High Proficiency Levels.

5.5.3.1. Morphological Priming Modulation

Table 14 shows the significant interaction between morphological priming and the spelling test, (t[2324]= -2.177, p=0.02), suggesting that the size of morphological priming increased as spelling proficiency grew (also see Figure 22 for a visual representation of the model-based estimates and Figure 23 for the scatterplot of real priming effects with overlaid trend lines from the predicted model in Spelling).

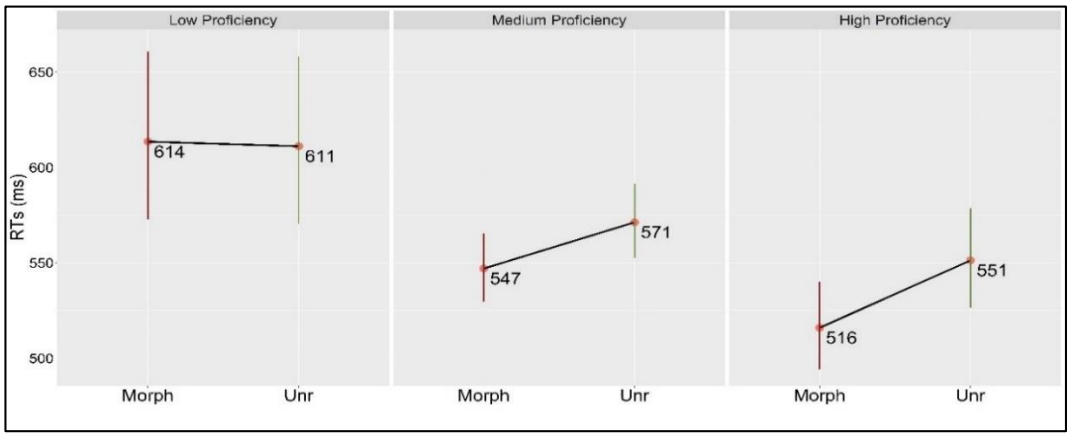
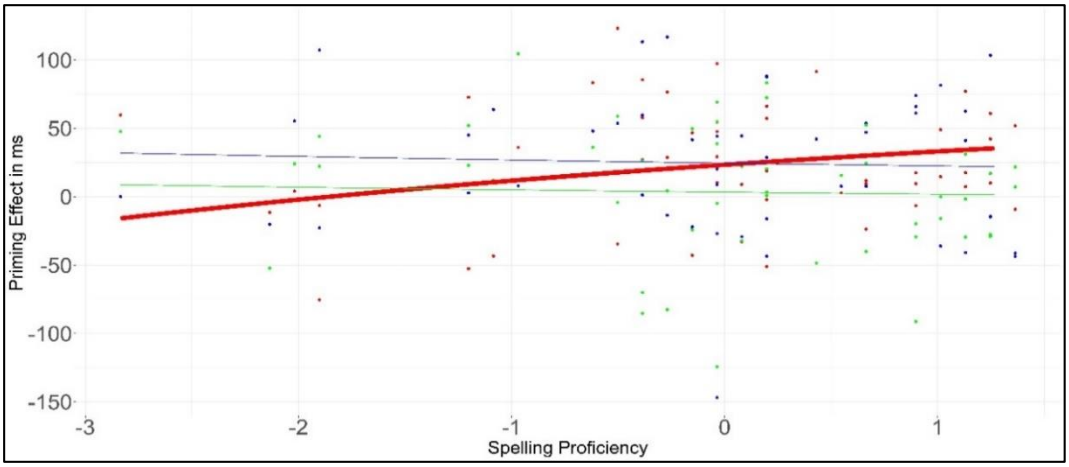


Figure 22. Model-based Estimates for Spelling



Note. Red line demonstrates significant Morphological Priming, while blue line and green line demonstrate TL-within Priming and TL-across Priming, respectively. Thicker line indicates the significant interaction.

Figure 23. The Scatterplot of Real Priming Effects with Overlaid Trend Lines from the Predicted Model in Spelling

Additionally, the interaction between morphological priming and the vocabulary test was significant (*t[2328*]= -2.030, *p*=0.04*)*. Similar to the pattern observed in the modulation of morphological priming effects by the spelling test, the size of morphological priming grew as a function of the vocabulary knowledge (also see Figure 24 for a visual representation of the model-based estimates and Figure 25 for the scatterplot of real priming effects with overlaid trend lines from the predicted model in Vocabulary).

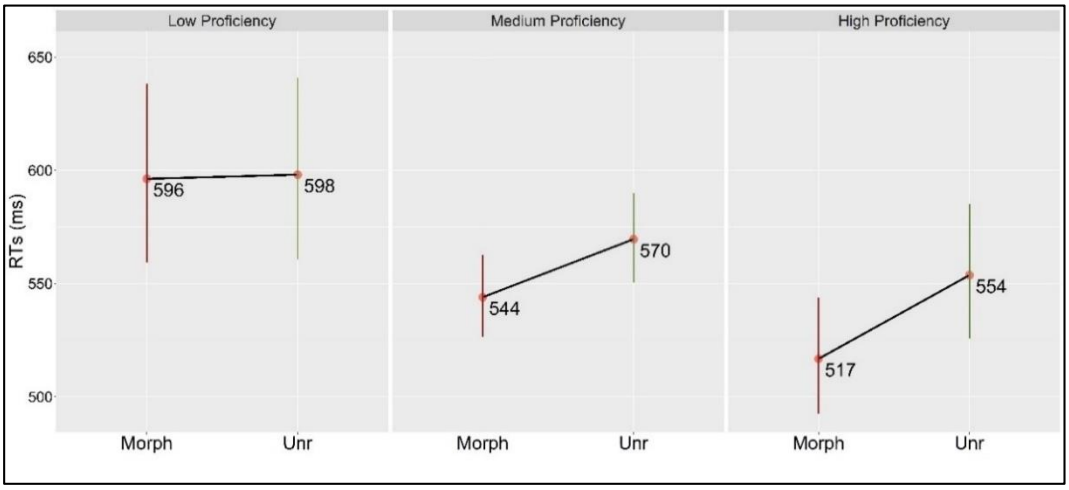
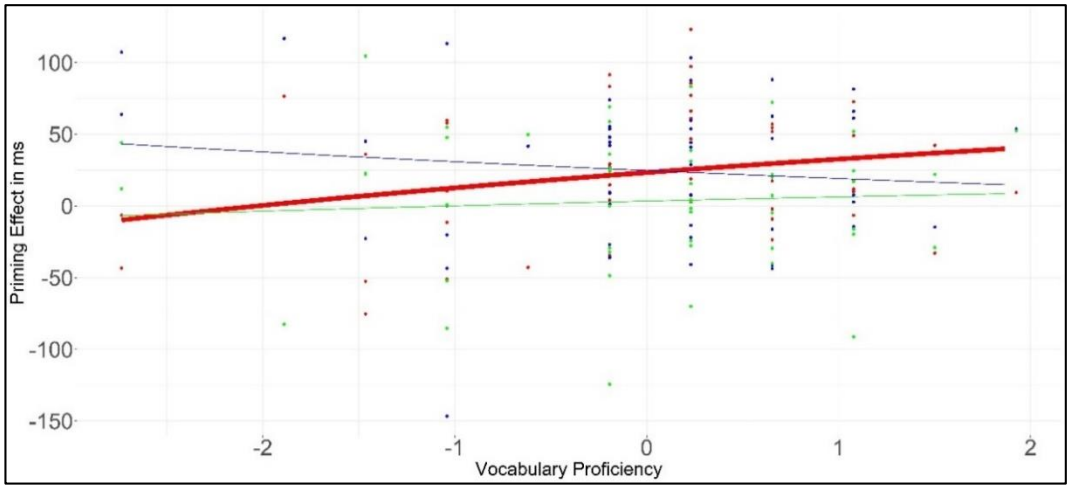


Figure 24. Model-based Estimates for Vocabulary



Note. Red line demonstrates significant Morphological Priming, while blue line and green line demonstrate TL-within Priming and TL-across Priming, respectively. Thicker line indicates the significant interaction.

Figure 25. The Scatterplot of Real Priming Effects with Overlaid Trend Lines from the Predicted Model in Spelling

As the figures further suggest, the modulation of morphological priming effects was reported only in highly skilled spellers and readers with proficient vocabulary knowledge, and the size of the facilitation was comparable when spelling and vocabulary skills were considered (35ms and 37 ms, respectively).

5.6. Discussion

The goal of Experiment 2 was to explain the workings of L1 morphological processing and investigate potential influences of individual variability on the priming effects. In line with this aim, analysis on the averaged data showed a robust facilitation in morphological condition (23 ms; braveness - BRAVE) and in TL-within condition (26 ms; braevness - BRAVE). No significant TL-across priming was found. In accordance with a large number of previous studies, analysis on general group-level reaction time data revealed that, in the early stages of processing, a morphologically complex word would initially be segmented into its constituent morphemes triggered by its morphological structure ({brave}{ness}) (e.g., Beyersmann et al., 2016; Rastle et al., 2000).

Furthermore, the direction and magnitude of TL priming effects in L1 were investigated in the current study. Following results obtained from Experiment 2, while significant TL priming for within-morpheme transpositions were obtained, TL priming for cross-morphemic transpositions failed to reach significance level, demonstrating that the lexical decision task engages lexical access processes that are triggered by the morphological structure of the stimulus. The disappearance of letter transposition effects when the transpositions straddled the morpheme boundaries provides further evidence that morphological decomposition processes occur pre-lexically and obligatorily (e.g., Longtin et al., 2003; Taft, 2004) at the initial stages of word recognition and supports a lexical processing mechanism that follows orthographically based decomposition of morphologically complex words. The disruption of the affix in TL-across condition showed that a morphologically complex word is accessible only when its stem could be isolated from a detectable affix (e.g., Taft & Nillsen, 2013). In other words, the absence of TL-across priming effects invalidates the supralexical accounts of morphological segmentation that essentially propose that the activation of full-form representations is required before the access to morphological information. This finding is consistent with the data reported by Christianson et al. (2005; Experiment 3) as well as Duñabeitia et al. (2007) who reported similar findings using both suffixed and prefixed words in Basque and in Spanish. These results also support that orthographic and morphological processes operate very early, being part of the same stages in the visual word recognition.

Similar magnitude of facilitation of TL-within primes and morphological primes point to the flexible degree of letter position coding since both morphological primes (e.g., braveness) and letter-transposed primes (e.g., braevness) facilitated the target word identification (e.g., BRAVE) to the same degree. This finding is consistent with the data reported in Beyersmann et al. (2013) and supports Grainger and Ziegler's (2011) dual-route model of orthographic processing as well as Beyersmann and Grainger's (2021) word and affix model. In the former model, the coarse-grained orthographic route does not require precise information about letter positions, and hence predicts that both morphological primes (braveness) and letter-transposition primes within morpheme boundaries (braevness) would make it easier

to identify the target. But it fails to explain the absence of TL-across priming effects. The word and affix model, however, predicts that TL-across primes (bravneess) will simultaneously activate the embedded word *brave* and the whole word *braveness*. Yet, affix activation mechanism fails to activate the suffix -ment since the precise letter information is distorted through intertranspositions, and this is a prerequisite information for the mechanism to function. The third mechanism, morpho-orthographic full decomposition, will then fail to operate since the sum of letters in the whole word (braveness) and the embedded word (brave) does not match due to the failure in the affix activation mechanism. In turn, since the morpho-orthographic full decomposition is unsuccessful, the competition between the embedded word (brave) and (braveness) could not be reduced, thereby resulting in the inhibition of the embedded word (brave). In contrast, in the case of intratranspositions where the affix is not distorted and therefore could still be activated, the morpho-orthographic full decomposition mechanism successfully detects that the embedded word (brave) and whole-word (braveness) are compatible, resulting the strong activation of the lexical node (brave) and hence TL-within priming effects.

Moreover, the exploratory analyses into modulation of masked morphological and TL-priming by individual variability revealed that morphological priming might interact with spelling and vocabulary proficiency during the L1 processing of complex words, with highly proficient individuals exhibiting more priming than low proficiency individuals. Therefore, despite robust morphological priming effects across the whole reading-proficiency spectrum, these effects did not emerge in low proficiency individuals. This shows that high proficient speakers are more reliant on morpho-orthographic segmentation and more experts in activating morphemic constituents, while low proficient speakers would use full-form processing and thus depend to a lesser degree upon morphological decomposition mechanisms in the processing of complex words. Overall, results showed that variability in the quality of lexical representations when processing complex stimuli in L1 might be a significant determinant of tasks that require word recognition.

CHAPTER 6

GENERAL DISCUSSION AND CONCLUSION

The overall aim of the current study was to reveal the fast-acting processes in the L1 and L2 complex word processing and to compare priming effects across native English and non-native English speaker groups. The current study also investigated whether priming was still robust for morphologically complex primes that contained letter transpositions within their stems and across the morpheme boundaries to closely examine the influences of positional encoding on early morphological processing. Following the seminal work of Andrews and Lo (2013), this study also explored the modulation of the morphological priming and morphological TL priming in different proficiency profiles, indexed by a series of underlying reading skills. In line with those aims, Experiment 1 sought the investigate the early automatic processes used in the recognition of morphologically complex words in L2 English, and Experiment 2 was designed to examine those processes in L1 English while both experiments explored the influences of reading skills on the levels of morphological and TL- priming.

In two masked primed lexical decision tasks, the well-established morphological priming effects were reported both for L1 English and L2 English speakers whereby a brief presentation of a derived prime (e.g., braveness) facilitated the identification of the stem target (BRAVE). In line with previous studies, the general analysis at the group level showed that the morphological segmentation of the stem morpheme is indeed a required process (e.g., Rastle et al., 2000; Taft et al., 2018), suggesting a fast morphological segmentation guided by the morphological structure of the word. This finding adds to the existing ample evidence that has shown the facilitatory effect of the brief presentation of a morphological prime before the target word (e.g., Beyersmann et al., 2015; Feldman et al., 2009; Rastle et al., 2004).

Across the whole L1 sample group, the responses to targets preceded by TL primes with within-morpheme transpositions were significantly faster than those preceded by primes with letter substitutions, while no priming effects were reported in the conditions where TL primes crossed morpheme boundaries. Hence, the results replicated the TL-priming effects reported in L1 speakers and are consistent with those of Christianson et al. (2005) that revealed that the position of the transposition modulated the size of priming as well as Duñabeitia et al. (2007) that extended the morphological boundary effects from suffixed to prefixed words. This inhibition of cross-morphemic transpositions supports pre-lexical morphological decomposition models and shows that orthography and morphology might be part of the same stages (e.g., Duñabeitia et al., 2007). This inhibition might stem from the disturbance of the affix that invalidates the pre-lexical segmentation process, which is required to activate the full-form lexical representation later. A statistically significant difference between the unrelated and the SL-across condition was reported, challenging the results of some studies which used the unrelated condition as the control to get TL-across priming effects (e.g., Experiment 2, Diependaele et al., 2013), and those that used the SL-across condition as the control to obtain morphological priming effects (e.g., Experiments 3-5, Rueckl & Rimzhim, 2011). The general analysis on the TL prime data demonstrated that the difference between the non-transposed morphologically related (braveness) and TL-within (braevness) conditions was not significant in L1 English speakers. This finding converges with previous evidence provided by Rueckl and Rimzhim (2011; Experiment 3) and Beyersmann et al. (2013) who reported equal amounts of morphological and TL-within priming. This finding also lends support for the Word and Affix model (Beyersmann & Grainger, in press) where the coarse-grained and fine-grained mechanisms run simultaneously so that both intact and letter-transposed primes could activate the lexical representation of a word within the orthographic lexicon.

Importantly, in this study, no TL-priming effects were reported for L2 speakers reported earlier for L1 participants (e.g., Duñabeitia et al., 2007; Rueckl & Rimzhim, 2011). It is possible that this finding deviates from the generally observed pattern due to the following reasons: Firstly, in Experiment 1, the size of transposed-letter priming was examined in non-native speakers, which has so far been very

restricted. Therefore, the current results should be assessed together with those of an extremely limited number of attempts to investigate TL effects in L2 speakers and therefore, need further elaboration with other non-native data. Secondly, much of the evidence for TL effects have been obtained from individuals that speak Indo-European languages such as Spanish or English. The bilinguals in this study, on the other hand, had a background of L1 Turkish, which has mainly agglutinative morphology and therefore has a typologically different language structure. Since L2 lexical processing requires the lexical access across languages (e.g., Schwartz & Kroll, 2006), and the typological differences between the two languages of bilinguals could result in differences in orthographic coding for L2 speakers (e.g., Lin et al., 2015), such differences might be manifested in the absence of TL-priming effects.

With regards to the lack of TL-priming (i.e., braevness for intratranspositions; bravneess for intertranspositions for the target word BRAVE) in L2 English (Experiment 1), when considered together with the well-known facilitation arising from a short presentation (50 ms) of a complex prime (e.g., braveness - BRAVE) reported in the current study, the results revealed an initial morphological decomposition mechanism that is sensitive to letter position coding and hence requires more positional certainty in second language processing.

Results of cross-language analysis reported similar masked morphological and (absent) TL-across priming patterns for complex words in L1 and L2. This evidence is in line with a recent study of Diependaele et al. (2011) who revealed that there were not any quantitative differences in the processing of morphologically complex words in L1 and L2 English. Their findings supported the view that complex words are processed within the similar architectural environment and that L2 morphological processing is L1-like, with no L1/L2 differences. Consistent with these, the current results revealed that L2 speakers adopt similar strategies as native speakers in the processing of morphologically complex words.

Lastly, the findings are in line with a body of studies reporting that processing differences could be associated with reading proficiency in L1 speakers (e.g.,

Andrews & Lo, 2013; Ashby et al., 2005; Beyersmann et al., 2016; Duñabeitia et al., 2014; Yap et al., 2009). The current study expanded these findings to L2 speakers and suggested that variability in L2 reading proficiency, in this case reading nonwords and nonword spelling, could moderate the facilitative effect of primes with within-morpheme letter transpositions (e.g., Andrews & Hersch, 2010; Andrews & Lo, 2013; Beyersmann et al., 2015; Hasenäcker et al., 2015; Medeiros & Duñabeitia, 2016). Hence, the findings also suggested that using averaged RT data to characterize the mental architecture of skilled reading only helps founding the basis for the overarching principles of lexical processing.

There was a robust morphological priming effect across the whole reading-proficiency spectrum in L2 speakers; however, the effect moderately declined with growing proficiency in nonword reading and spelling skills. In the L1 English speaker group, the magnitude of morphological priming increased as speakers got more proficiency in vocabulary and spelling skills. This finding implies that higher-proficiency individuals might show more sensitivity to morpho-orthographic information. Distinct profiles of morphological priming reported in readers low versus high vocabulary knowledge provided evidence in favor of dual route models that propose whole-word processing and morphological segmentation processes co-occur via two distinct routes (e.g., Baayen, Dijkstra, et al., 1997; Beyersmann & Grainger, in press; Grainger & Ziegler, 2011; Schreuder & Baayen, 1995). Dual route frameworks that hypothesize distinct mechanisms and strategies for word recognition and processing that function simultaneously easily accommodate the systematic individual differences. In native speakers of English, in the processing of derived words, the lack of priming in the group with low proficiency vocabulary knowledge pointed to the full-form processing mechanisms, whereas high proficiency group employed fast-acting morpho-orthographic decomposition that shows sensitivity to morphological structure (e.g., Beyersmann et al., 2011; Longtin & Meunier, 2005; Rastle & Davis, 2008). Therefore, these observations support the view that the morphological decomposition process is only one of the pathways (e.g., Baayen, Dijkstra, et al., 1997; Beyersmann & Grainger, in press; Diependaele et al., 2009, 2013). Such an approach also supports the lexical quality hypothesis (Perfetti, 1992, 2007) in which the high-quality lexical representations assist with

retrieving the exact word rather than only some parts of it during tasks that require reading such as the lexical decision task. Furthermore, following the findings of Andrews and Lo (2013), high proficient readers might be following a more contextually driven reading profile which reinforces a more segmentational lexicon characterized by firm links for morphological derivatives, whereas the lower proficiency readers could be employing a more bottom-up reading strategy which is associated with precise lexical representations. This strategy could facilitate the retrieval of whole-word representations of morphologically complex words, explaining the reduced sensitivity to morphological structure.

With regard to the modulation of TL-priming effects by reading skills in L2 speakers of English, the results suggest that TL-within priming effects were observed only in the case of lower nonword reading and spelling skills. The higher proficiency nonword readers and spellers could have more precise letter decoding proficiency and therefore employ an orthographically driven segmentation mechanism that is more susceptible to letter transpositions. It is important to note that results with regards to the individual differences were exploratory in nature and can, in their present form, not be generalized to the general population. It is suggested that future research follows up on the individual difference measures used in the present study with a larger cohort to investigate mechanisms that might modulate the size of L2 priming effects.

Current findings also have implications for the time-course of morphological segmentation and letter position assignment. It was demonstrated that the place of letter manipulations might impact the processes of letter position coding and that L2 speakers were particularly sensitive to those manipulations. These results therefore require models of visual word recognition in L2 to consider the inhibitory effects of primes with within-morpheme transpositions and the individual variability in reading skills.

In conclusion, the findings of the current study showed that morphologically complex words are decomposed into morphemic subunits in the very early stages of L1 and L2 processing and that TL priming is obtained only with within-morpheme

transpositions and only in L1 speaker cohorts. Nevertheless, the exploratory analyses into individual variation in reading revealed that individual differences might indeed impact the size and direction of masked morphological priming effects reported for L1 and L2 speakers and TL-within priming effects reported for L2 speakers. These results, therefore, point to a methodological stance that requires a shift from group-level design towards individual-level analyses.

6.1. Limitations of the Study

The current results need to be considered along with a limitation. The number of observations in L2 group was below what Brysbaert & Stevens (2018) suggests for a repeated measures design study. However, the current study added to very limited evidence and shed light on the potential influences of individual differences on L2 morphological processing specifically through a broad testing of reading skills that extended well beyond the relatively restricted and more receptive tests used in the literature to assess individual variability.

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APPENDICES

A. READING SKILLS BATTERY

ANSWER SHEET

First Name	
Last Name	
Date	
Age	
Year (Grade)	

SUBTESTS	Spelling		Reading Comp.	Listen. Compre.	Vocabul. Knowled.		Nonword Spelling	Word Ident.	Reading Fluency	Read. Nonwords	Read. Span Test
	a	b			a	b					
Raw Score											

For tester only:

Test I: Spelling

A. Spelling Dictation Test

Directions: For this test, you will be listening to 44 individual words on the recording, and you are asked to **spell** the words you hear. You will hear 44 words, and a sentence with the word in it. You will then hear the word again for the last time. Then write down your answer. Your response sheet is numbered from 1 to 44.

Please try to do your best and **write as neatly as you can**. If you are not sure what the correct answer is, I still want you to try your best.

A sample item: *(You hear):* **SCENARIO.** A possible scenario is that he was attacked after opening the door. **SCENARIO**

B. Spelling Recognition Test

Directions: You will see 44 words that are written in three ways—1 correct and 2 misspelled. You are asked to circle the correct spelling.

You have **10 minutes**.

No	Option 1	Option 2	Option 3
1.	a. recessive	b. recesive	c. reccesive
2.	a. doctrinare	b. doctrinaire	c. doctriner
3.	a. assymetry	b. asymetry	c. asymmetry
4.	a. pasifiere	b. pasifier	c. pacifier
5.	a. playwrite	b. playwright	c. playright
6.	a. obzervant	b. observant	c. observent
7.	a. glyserin	b. glycerine	c. glycerin
8.	a. larvea	b. larvae	c. larveae
9.	a. ecstasy	b. ecstacy	c. ecstecy
10.	a. coalescense	b. coalesence	c. coalescence
11.	a. precurser	b. precursor	c. precurcer
12.	a. sysmograph	b. saismograph	c. seismograph
13.	a. idiosyncracy	b. idiosyncrasy	c. idiosyncrasie
14.	a. guillotine	b. guilottine	c. guilotin
15.	a. megalomaenia	b. megalomania	c. megolamania
16.	a. rhapsody	b. rapsody	c. rhapsode
17.	a. metalic	b. metalique	c. metallic
18.	a. psydonime	b. psydonym	c. pseudonym
19.	a. penicillin	b. penicilin	c. penisilin
20.	a. affluense	b. affluence	c. affluance
21.	a. salm	b. psam	c. psalm
22.	a. occurrance	b. occurrence	c. occurence
23.	a. nausea	b. nousea	c. neuasea
24.	a. millennium	b. milennium	c. millenium
25.	a. groteske	b. grotesque	c. grotesk
26.	a. hydraulic	b. hydrolic	c. hydroulic
27.	a. homogenity	b. homogeneity	c. homoginity
28.	a. hypocret	b. hipocrite	c. hypocrite
29.	a. lodgers	b. logers	c. loudgers
30.	a. seige	b. siege	c. siedge
31.	a. repertoire	b. repertior	c. repertuare
32.	a. refrigerateur	b. refrigerator	c. refrigerater
33.	a. vernaculaire	b. vernecular	c. vernacular
34.	a. mayonnaise	b. mayonaisse	c. mayonneise
35.	a. phenomennal	b. phenamenal	c. phenomenal
36.	a. champaign	b. champagne	c. champain
37.	a. receipt	b. receite	c. recceit
38.	a. rendevous	b. rendezvous	c. randevous
39.	a. pistashio	b. pistacio	c. pistachio
40.	a. nonchalant	b. nonshalant	c. nonchalent
41.	a. ullcerous	b. ulcerous	c. ulserous
42.	a. rythmical	b. rhythmical	c. rhythmmical
43.	a. digestible	b. digestable	c. digesteble
44.	a. zepplin	b. zeplline	c. zeppelin

Test II: Reading Comprehension

Directions: In this test, you will read **2 passages** and answer **20 questions.**

You need to read **the first passage** and answer comprehension questions. **Second passage** has missing words for you to complete. Fill in the blanks with an appropriate word.

You have 20 minutes to complete **BOTH TESTS**.

A Neuroscientist Reveals How to Think Differently

In the last decade, a revolution has occurred in the way that scientists think about the brain. We now know that the decisions humans make can be traced to the firing patterns of neurones in specific parts of the brain. These discoveries have led to the field known as neuroeconomics, which studies the brain's secrets to success in an economic environment that demands innovation and being able to do things differently from competitors. A brain that can do this is an iconoclastic one. Briefly, an iconociost is a person who does something that others say can't be done.

This definition implies that iconoclasts are different from other people, but more precisely, it is their brains that are different in three distinct ways: perception, fear response, and social intelligence. Each of these three functions utilizes a different circuit in the brain. Naysayers might suggest that the brain is irrelevant, that thinking in an original, even revolutionary way is more a matter of personality than brain function. But the held of neuroeconomics was born out of the realization that the physical workings of the brain place limitations on the way we make decisions. By understanding these constraints, we begin to understand why some people march to a different drumbeat.

The first thing to realize is that the brain suffers from limited resources. It has a fixed energy budget, about the same as a 40 watt light bulb, so it has evolved to work as efficiently as possible. This is where most people are impeded from being an iconoclast. For example, when confronted with information streaming from the

eyes, the brain will interpret this information in the quickest way possible. Thus, it will draw on both past experience and any other source of information, such as what other people say, to make sense of what it is seeing. This happens all the time. The brain takes shortcuts that work so well we are hardly ever aware of them. We think our perceptions of the world are real, but they are only biological and electrical rumblings. Perception is not simply a product of what your eyes or ears transmit to your brain. More than the physical reality of photons or sound waves, perception is a product of the brain.

Perception is central to iconoclasm. Iconoclasts see things differently to other people. Their brains do not fall into efficiency pitfalls as much as the average person's brain. Iconoclasts, either because they were born that way or through learning, have found ways to work around the perceptual shortcuts that plague most people. Perception is not something that is hardwired into the brain. It is a learned process, which is both a curse and an opportunity for change. The brain faces the fundamental problem of interpreting physical stimuli from the senses.

Everything the brain sees, hears, or touches has multiple interpretations. The one that is ultimately chosen is simply the brain's best theory. ln technical terms, these conjectures have their basis in the statistical likelihood of one interpretation over another and are heavily influenced by past experience and, importantly for potential iconoclasts what other people say.

The best way to see things differently to other people is to bombard the brain with things it has never encountered before. Novelty releases the perceptual process from the chains of past experience and forces the brain to make new judgments. Successful iconoclasts have an extraordinary willingness to be exposed to what is fresh and different. Observation of iconoclasts shows that they embrace novelty while most people avoid things that are different. The problem with novelty, however, is that it tends to trigger the brain's fear system. Fear is a major impediment to thinking like an iconoclast and stops the average person in his tracks. There are many types of fear, but the two that inhibit iconoclastic thinking and people generally find difficult to deal with are fear of uncertainty and fear of public ridicule. These may seem like trivial phobias. But fear of public speaking, which everyone must do from time to time, afflicts one-third of the population. This makes it too

common to be considered a mental disorder. It is simply a common variant of human nature, one which iconoclasts do not let inhibit their reactions

Finally, to be successful iconoclasts, individuals must sell their ideas to other people. This is where social intelligence comes in. Social intelligence is the ability to understand and manage people in a business setting. ln the last decade, there has been an explosion of knowledge about the social brain and how the brain works when groups coordinate decision making. Neuroscience has revealed which brain circuits are responsible for functions like understanding what other people think, empathy, fairness, and social identity. These brain regions play key roles in whether people convince others of their ideas. Perception is important in social cognition too. The perception of someone's enthusiasm, or reputation, can make or break a deal. Understanding how perception becomes intertwined with social decision making shows why successful iconoclasts are so rare.

Iconoclasts create new opportunities in every area from artistic expression to technology to business. They supply creativity and innovation not easily accomplished by committees. Rules aren't important to them. Iconoclasts face alienation and failure, but can also be a major asset to any organization. It is crucial for success in any field to understand how the iconoclastic mind works.

Questions 1-5

Choose the correct letter **A. B. C** or **D**.

1. Neuroeconomics is a field of study which seeks to
   A. cause a change in how scientists understand brain chemistry.
   B. understand how good decisions are made in the brain.
   C . understand how the brain is linked to achievement in competitive fields.
   D. trace the specific firing patterns of neurons in different areas of the brain.

2. According to the writer, iconoclasts are distinctive because
   A. they create unusual brain circuits.
   B. their brains function differently.
   C. their personalities are distinctive.

D. they make decisions easily.

3. According to the writer, the brain works efficiently because

A. it uses the eyes quickly.

B. it interprets data logically.

C. it generates its own energy.

D. it relies on previous events.

4. The writer says that perception is

A. a combination of photons and sound waves.

B. a reliable product of what your senses transmit.

C. a result of brain processes.

D. a process we are usually conscious of.

5. According to the writer an iconoclastic thinker

A. centralizes perceptual thinking in one part of the brain.

B. avoids cognitive traps.

C. has a brain that is hardwired for learning.

D. has more opportunities than the average person.

Questions 6-11

Do the following statements agree with the claims of the writer in Reading Passage 1?

Choose:

YES it the statement agrees with the claims of the writer

NO it the statement contradicts the claims of the writer

NOT GIVEN it is impossible to say what the writer thinks about this

6. Exposure to different events forces the brain to think differently. **Y/ N / NG**

7. Iconoclasts are unusually receptive to new experiences. **Y/ N / NG**

8. Most people are too shy to try different things. **Y/ N / NG**

9. If you think in an iconoclastic way, you can easily overcome fear. **Y/ N / NG**

10. When concern about embarrassment matters less, other fears become

irrelevant.

Y/ N / NG

11. Fear of public speaking is a psychological illness. **Y/ N / NG**

Questions 12-14

Complete each sentence with the correct ending, A-E, below

Write the correct letter **A-E**, at the end of the sentence.

12. Thinking like a successful iconoclast is demanding because it

13. The concept of the social brain is useful to iconoclasts because it

14. Iconoclasts are generally an asset because their way of thinking

A. requires both perceptual and social intelligence skills.

B. focuses on how groups decide on an action.

C. works in many fields, both artistic and scientific.

D. leaves one open to criticism and rejection.

E. involves understanding how organizations manage people.

Now, turn the page for the Passage 2

Passage 2: Complete this passage with only **ONE** appropriate word.

The (15) ---- "emotional intelligence" was probably first used in an unpublished dissertation in 1986. In 1990 it was (16) ---- into the field of scientific psychology, defined as "the ability to monitor one's (17) ---- and others" feelings, to (18) ---- among them and to use this information to guide one's thinking and action." The concept developed (19) ---- a growing emphasis on research into the (20) ---- of emotion and thought.

Answers:

1	
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Subtest III: Listening Comprehension

Directions: In this test you will hear 17 **unrelated** sentences that have a missing word at the end of each sentence. You will supply **one appropriate word** to that fits to the end of the sentence.

You will listen only **once**!

Sample item: (You will hear)

It has been discovered that dolphins are able to understand not only individual words but words clustered together in _____.

Correct: sentences, phrases

Please get ready to listen and write the appropriate word for each sentence below:

Sentence 1:	
Sentence 2:	
Sentence 3:	
Sentence 4:	
Sentence 5:	
Sentence 6:	
Sentence 7:	
Sentence 8:	

Sentence 9:	
Sentence 10:	
Sentence 11:	
Sentence 12:	
Sentence 13:	
Sentence 14:	
Sentence 15:	
Sentence 16:	
Sentence 17:	

Test IV: Vocabulary Knowledge

A. Similar and opposite meanings

Directions: Look at the words and expressions in **bold** in the sample question below.

For the test of ***similar meanings***, there are 16 questions, and you will write **ONE** word that has the same or a similar meaning in the same context.

For the test of ***opposite meanings***, there are 16 questions, and you will write **ONE** word which has an opposite meaning in the same context without the addition of such prefixes as –dis, -im, -ir, -un.

You have 15 minutes.

Sample item for the Test of Similar Meanings:

The story seemed **believable** at first, but a bit of research revealed some startling irregularities.

Answer: **credible**

Sample item for the Test of Opposite Meanings:

We need **exact** figures before we embark on a new venture.

Answer: **approximate**

Test of Similar meanings:

1. Here's an **imaginary** situation: you are in the desert, and you run out of water.

2. Many people believe that exercising makes you more hungry: this is in fact a **misconception**.

3. His inability to act quickly enough will probably **accelerate** their decision to dismiss him.

4. Latin is considered by many to be an **outdated** language, despite the fact that many words from the language are still in use today.

5. The conference was really **disorganized** and a complete waste of time.

6. Trends come and go, but there are a few that will always **stay.**

7. Uncontrolled corruption and abuse of power by officials eventually prompted new anti-corruption laws.

8. If you have any **questions**, please ask a member of staff.

9. The U.S.A. and Iran have often tried to **resolve** their differences, but with little effect.

10. He gained a reputation as an **honest and fair** dealer, and therefore won the respect of his customers.

11. Safety in the workplace is very important and should take **priority** over everything else.

12. His instructions were very **brief and clear**.

13. Some plants, such as beans, **benefit** the soil in which they are planted.

14. He was a **determined** man who believed in fighting for his principles at any cost.

15. Under his reign peace and mutual understanding **flourished.**

16. The results **exceeded** everyone's expectations.

Test of Opposite meanings:

1. The spices used in the production of some international dishes have a very **strong** flavor.
2. He **deposited** $10,000 – half his college fees for the forthcoming year.
3. I don't want to **underestimate** his role in the club.
4. Fuel supplies have been **exhausted**.
5. Many students believe that doing voluntary work for charities is a **pointless** cause.
6. The country displayed all the features of a **stagnant** economy.
7. Scientific laws assume that a specific set of conditions will **unerringly** lead to predetermined outcome.
8. The ultimate freedom of humanity may possibly lead to **unforeseen** choices.
9. She **gathered** and compiled information from military records and published it in newspapers.
10. Henry Louis **pursued** the dream of publishing a collection of his paintings.
11. The bristlecone pine of California, **venerable** pine, predates wonders of the ancient world such as the pyramids of Egypt.
12. In 1930 A. P. Giannini **consolidated** all the branches of Bank of Italy and the Bank of America in New York City into the Bank of America National Trust.
13. Support for technology as the panacea for our environmental **woes** is not without detractors.
14. The demographics of the country have changed **dramatically** in recent years.
15. Rather than have another **argument**, I told them that I would go along with any decision they made.
16. There is no way he is going to **waste** money on flowers that would wither and die within a week.

B. Word Associations

Directions: Complete each of the following 16 sentences with one adjective, noun or a verb. The missing word should be one that is often used (i.e., it *collocates*) with the nouns and / or adjectives and /or adverbs in *italics*.

To help you, the first and last letters of each word have been given to you, and there is a sample sentence to show you how that adjective could work with one of the nouns, adjectives or adverbs.

You have **15 minutes**.

Write your answers in the table given below.

Sample item:

C_____L is often followed by the nouns *analysis*, *assessment*, *consideration*, *deliberation*, *examination*, *observation*, or *planning*.

Answer: CAREFUL

Answers:

No	Words	No	Words
1.		**9.**	
2.		**10.**	
3.		**11.**	
4.		**12.**	
5.		**13.**	
6.		**14.**	
7.		**15.**	
8.		**16.**	

1. I_____T is often followed by the nouns *aspect, element, factor, feature, issue, part, or point*. It is often preceded by the adverbs crucially, extremely, particularly, terribly, or vitally.

(Sample sentence: *It is vitally _____ to disconnect the appliance from the power supply before dismantling it*).

2. You can U_____R *a conspiracy, evidence, a fact, a fraud, a mystery, a plot, a scandal, a secret*, or *the truth*.

(Sample sentence: *The investigation _____ a scandal that would bring down the government*).

3. E_____L is often followed by the nouns *characteristic, component, element, feature, ingredient, part*, or *requirement*.

(Sample sentence: *A working knowledge of Spanish is an _____ requirement if you want the job*).

4. You can C_____T *a crime, a murder, arson, or sin.*

(Sample sentence: *Shockingly, it was a volunteer firefighter who _____ the arson*).

5. B_____d is often preceded by the words *cultural, disadvantaged, educational, ethnic, middle-class, privileged, religious, social*, or *working class*.

(Sample sentence: *There is considerable debate on the relevance of ethnic _____ in clinical genetics*).

6. F_____E is often followed by the nouns *accusation, allegation, assumption, belief, claim, description, impression*, or *statement*. It is often preceded by the adverbs *blatantly, completely, entirely, patently, totally*, or *utterly*.

(Sample sentence: *She made several _____ assumptions about her new professor*).

7. H_____Y is often followed by the nouns *rain, snow, discussion, workload,* or *smoker*.

(Sample sentence: *After a _____ rain, the country roads were souped*).

8. You can K_____P *a promise, secret*, an appointment, a copy of something *the peace or the change*.

(Sample sentence: *Jack did not _____ a promise to attend the session*).

9. D_____c is often followed by the nouns *action, change, cut, decline*, or *decrease*.

(Sample sentence: *There has been a _____ decrease in the number of students who could graduate from a university over the last three years*).

10. You can C_____T *an analysis, an assessment, an investigation, a program, a project, research, a study,* or *a survey*.

(Sample sentence: *The board promised to _____ a study on current working practices*).

11. O_____E is often followed by the nouns *analysis, assessment, description, evaluation,* or *measurement*. It is often preceded by the adverbs *completely, entirely, purely, totally, truly,* or *wholly*.

(Sample sentence: *We tried to capture a purely _____ record of what we heard and saw*).

12. When you are trying to guess or calculate something, you can make a / an *accurate, conservative, realistic,* or *reliable* e_____e.

(Sample sentence: *With an accurate _____ most construction companies and businesses can avoid delays and financial issues*).

13. C_____N is often followed by the nouns *belief, misconception, myth, opinion,* or *view*.

(Sample sentence: *It is a _____ misconception that men are better drivers than women*).

14. Someone can M_____S *the meeting, the chance, the shot, the ball or the opportunity.*

(Sample sentence: *She _____ the chance of promotion when she turned down the job of assistant manager*).

15. E_____S is often followed by the nouns *bus, train, service, mail, or package.*

(Sample sentence: *We need to send the package by _____ service if we want it to arrive tomorrow*).

16. You can C_____E *an agreement, a contract, a deal, a pact,* or *a treaty*.

(Sample sentence: *At the end of the summit, an agreement was _____ under which trade sanctions between both countries would be lifted*).

Subtest V: Nonword Spelling

Directions: Your response sheet is numbered from 1 to 23. You will listen to 23 non-words and write them these in the space provided. Nonwords are made up words that don"t exist. But you can spell them anyway. Sometimes more than one answer is correct. Write down only one answer.

Sample item: (You hear) **/** Θæm/

(You write) **tham**

Spellings:

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Test VI: Word Identification

Directions: In this test, you will be shown 16 words, and I ask you to read them out loud. Your answers will be tape-recorded, and no feedback will be given during the testing process.

For the experimenter:

Scoring Sheet

No	*Response*	*Score*
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
	TOTAL SCORE	

Test VII: Reading Fluency

Directions: In this test, you will read only **1 passage** and answer comprehension questions you will find at the end of each paragraph in the passage. In these questions you are required to select among three words the one that is coherent with the paragraph and/or indicate if the given statement is true or false.

The aim of this test is to measure your reading fluency. You have 1 minute to read the text; however, you might not finish reading in 1 minute. In that case, put an **X** next to the word you could last read.

Every question is worth one point, and the score is calculated based on the number of both **correct** and **incorrect responses**.

Sample Item:

Throughout history, the collection and appreciation of art has mainly been the realm of the intellectual elite and the very rich. The average person quite often finds the art world a mysterious and daunting place. However, art can actually be found and appreciated on a daily basis. You simply need to know where to look and what to look for.

a) cars **b)availability** c) wonderful

Most people are so caught up in the details of their daily grind, that they fail to stop and appreciate the things around them. Taking a little time each day to appreciate art and learn the history of the art around us can be a relaxing and rewarding part of everyone's life.

Many people can easily recognize the details in the nature. True **False**

Now, tell the tester you are ready and let her set the timer.

Go to the next page to start the test.

Times are tough. The nightly news is filled with stories of people who have lost their jobs due to the economic crisis, or lost their homes in a fire or natural disaster. Have you ever seen people who have just endured an awful situation? Some focus on what they have lost, and this is easy to understand. But other people focus on what they did not lose, and they start thinking about a better future. a) water b) trouble c) coat

One good piece of advice to remember is that you cannot always control situations or other people. The only thing you can control is your own personal reaction to bad situations. Sometimes a situation may really be overwhelming. However, in many cases, you really can influence our own moods by the way you think about negative situations. a) feelings b) family c) political

Imagine two families: Both have lost their homes and all their belongings in a devastating storm. One family cannot mask their grief. They feel that everything they hold dear has been destroyed. They cannot imagine how they will ever be able to replace things and start over again. Their normal life seems to have been completely lost. a) negative b) trees c)weather

In contrast, a second family is crying with joy. All of the people in their family are unharmed and safe. This family is just happy that everyone has survived. This family is already trying to figure out how they can recover.

The second family is more focused on what they have lost. True False

You can't really blame the first family for experiencing a very normal reaction to a terrible situation. However, the second family certainly seems to be better off. They are thinking about making progress rather than focusing on the tragic events. Though this storyline is extreme, everyone experiences setbacks that seem just awful at the time. This could be a job loss, illness, or problems with family members. Nobody gets through life without having some bad things happen. a) contain b) smile c) difficulties

In these situations, try to focus on the measures you can take to remedy the situation, instead of how awful the setback is. By doing this, you will be laying the foundation for a better tomorrow. And you will not suffer as much pain today. Actually, controlling how you feel and trying to maintain a positive attitude can help you through many tough situations.

Managing your feelings is a way of overcoming bad situations. True False

The bottom line is, no matter what the problem is, you are more likely to fix it if you can stay positive and work out a plan. Also, never be afraid to seek help when you need it. The advice of a friend, family member, or even a professional may be all it takes to get back on track. It may sound like a cliché. While a positive attitude may

not be the answer to every problem, it can certainly give you an advantage in surviving most of life's minor setbacks. a) definite b) optimism c) observation

Test VIII: Reading Nonwords

Directions: You will be shown 20 made-up words. They are not real words but you can still read them. In this test, you are required to read these words out loud, and your answers will be tape-recorded.

Sample Item:

(You will see)**: pheitrex** (You will read): **/feitreks/**

For the experimenter:

Scoring Sheet

no	**Response**	**Accuracy (whole item)**

<u>Subtest IX: Reading Span Test</u>

Instructions: Wait for the experimenter for the directions please.

B. STIMULI

Table 1. Stimuli

TARGET	Morphological Prime	TL-within Prime	SL-within Prime	TL-across Prime	SL-across Prime	Unrelated Prime
dispute	disputable	disptuable	dispkaable	dispuatble	dispuokble	absorbable
lament	lamentable	lametnable	lamedrable	lamenatble	lamenelble	bridgeable
spend	spendable	spednable	spetmable	spenadble	spenolble	assessable
laugh	laughable	lauhgable	lautyable	laugahble	laugidble	refutable
sharp	sharpness	shaprness	shagcness	sharnpess	sharcqess	crossness
fleet	fleetness	fleteness	flelaness	fleentess	fleeskess	uniqueness
short	shortness	shotrness	sholmness	shorntess	shorvless	cleverness
prompt	promptness	promtpness	promlgness	prompntess	promptsless	stiffness
noble	nobleness	nobelness	nobidness	noblneess	noblruess	bleakness
allow	allowable	allwoable	allveable	alloawble	alloimble	believable
imagine	imaginable	imagniable	imagzeable	imagianble	imagierble	driveable
search	searchable	searhcable	searkrable	searcahble	searcetble	manageable
trust	trustable	trutsable	trufcable	trusatble	trusidble	drinkable
spread	spreadable	spredaable	sprekiable	spreaadble	spreaifble	licensable
brave	braveness	braevness	braocness	bravneess	bravruess	directness
acute	acuteness	acuetness	acuohness	acutneess	acutsiess	grossness
false	falseness	falesness	falirness	falsneess	falszaess	politeness
cheap	cheapness	chepaness	chejeness	cheanpess	cheamgess	toughness
broad	broadness	brodaness	brotuness	broandess	broartess	whiteness
amend	amendable	amednable	amekcable	amenadble	amenekble	obtainable
admire	admirable	admriable	admvoable	admiarble	admiosble	electable
paint	paintable	paitnable	paifrable	painatble	painefble	attachable
palate	palatable	paltaable	palhoable	palaatble	palaidble	clickable
advise	advisable	advsiable	advxoable	adviasble	advionble	realisable
eager	eagerness	eagreness	eagnaness	eagenress	eagevcess	crispness
fresh	freshness	frehsness	fredness	fresnhess	fresmtess	briskness
loose	looseness	looesness	looarness	loosneess	loosmiess	steepness
alive	aliveness	alievness	aliocness	alivneess	alivmiess	wholeness
execute	executable	exectuable	execheable	executatble	executefble	touchable
oppose	opposable	oppsoable	oppxaable	oppoasble	oppoecble	learnable
catch	catchable	cathcable	catkrable	catcahble	catcetble	irritable
adopt	adoptable	adotpable	adolyable	adopatble	adopelble	noticeable
mould	mouldable	moudlable	mouhkable	mouladble	mouletble	enjoyable
slack	slackness	slakcness	slahvness	slacnkess	slacmless	bluntness
remote	remoteness	remoetness	remoidness	remotneess	remotziess	brashness
grand	grandness	gradnness	gralrness	grannddess	gransteess	otherness
alone	aloneness	aloenness	aloorness	alonneess	alonzuess	roughness
wrong	wrongness	wrognness	wroprness	wronngess	wronmyess	vividness
afford	affordable	affodrable	affokvable	afforadble	afforulble	chargeable
assign	assignable	assingable	assicqable	assiganble	assigemble	pardonable
stack	stackable	stakcable	stalwable	stacakble	stacutble	thinkable
achieve	achievable	achiveable	achinaable	achieavble	achieunble	changeable
black	blackness	blakcness	blahrness	blacnkess	blacrtess	moistness
sweet	sweetness	sweteness	swediness	sweentess	sweerkess	harshness
crude	crudeness	cruedness	cruabness	crudneess	crudraess	stillness
clear	clearness	cleraness	clemeness	cleanress	cleasmess	smartness
break	breakable	brekaable	brefuable	breaakble	breaihble	verifiable
attain	attainable	attaniable	attaseable	attaianble	attaierble	stoppable
teach	teachable	teahcable	teabnable	teacahble	teacidble	breathable
watch	watchable	wathcable	watlzable	watcahble	watcutble	adaptable
coarse	coarseness	coaresness	coararness	coarsneess	coarsvaess	frankness
exact	exactness	exatcness	exakrness	exacntess	exacwless	faintness
close	closeness	cloesness	cloavness	closneess	closcuess	vagueness
alert	alertness	aletrness	alelzness	alerntess	alermless	subtleness

C. DENSITY SCORES: L2 ENGLISH SPEAKERS

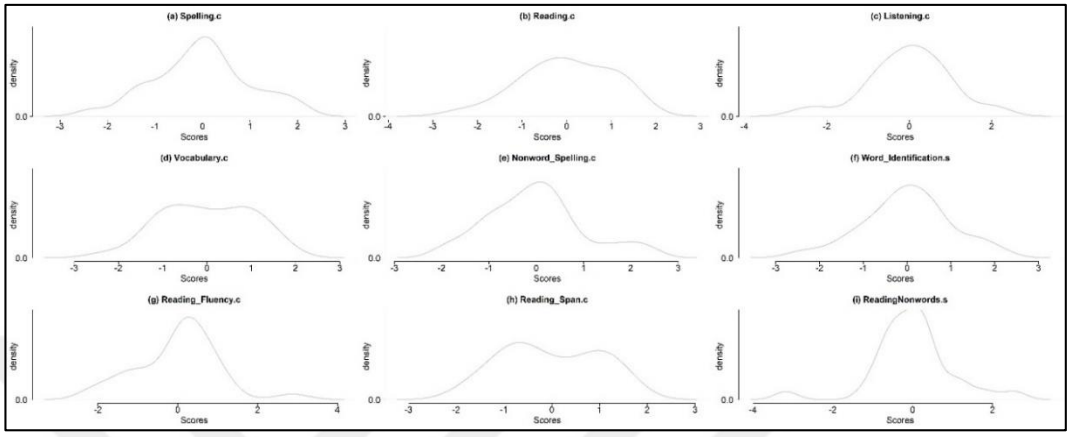


Figure 1. Score Distributions for Each Proficiency Subtest in L2 English

D. DESCRIPTIVE STATISTICS: L2 ENGLISH SPEAKER GROUP

Table 1. Characteristics of L2 English Participants

	L1 Number	L2 Number	Spelling max= 88	Reading max= 62	Listening max= 136	Vocabulary max=144	Nonword Spelling max=92	Word Identification max=64	Reading Fluency max=516	Reading Span max=80	Reading Nonwords max=80
Min	1	1	24	29	54	32	28	27	144	7	31
1st Quarter	-	-	43	40	78	44	37	39	215	20	50
Median	-	-	50	43	87	50	43	42	260	28	53
Mean	-	-	49.76	43.66	85.45	50.86	42.9	41.97	249.1	29.93	53.17
3rd Quarter	-		54	49	93	58	46	46	280	42	56
Max	2	3	72	53	112	65	62	55	397	51	71

E. TOWRE TEST (SIGHT WORD EFFICIENCY): WORD IDENTIFICATION

____ 1. is	____ 23. men	____ 45. space	____ 67. morning	____ 89. understand
____ 2. up	____ 24. baby	____ 46. short	____ 68. resolve	____ 90. emphasis
____ 3. cat	____ 25. new	____ 47. left	____ 69. describe	____ 91. confident
____ 4. red	____ 26. stop	____ 48. people	____ 70. garment	____ 92. intuition
____ 5. me	____ 27. work	____ 49. almost	____ 71. business	____ 93. boisterous
____ 6. to	____ 28. jump	____ 50. waves	____ 72. qualify	____ 94. plausible
____ 7. no	____ 29. part	____ 51. child	____ 73. potent	____ 95. courageous
____ 8. we	____ 30. fast	____ 52. strong	____ 74. collapse	____ 96. alienate
____ 9. he	____ 31. fine	____ 53. crowd	____ 75. elements	____ 97. extinguish
____ 10. the	____ 32. milk	____ 54. better	____ 76. pioneer	____ 98. prairie
____ 11. and	____ 33. back	____ 55. inside	____ 77. remember	____ 99. limousine
____ 12. yes	____ 34. lost	____ 56. plane	____ 78. dangerous	____ 100. valentine
____ 13. of	____ 35. find	____ 57. pretty	____ 79. uniform	____ 101. detective
____ 14. him	____ 36. paper	____ 58. famous	____ 80. necessary	____ 102. recently
____ 15. as	____ 37. open	____ 59. children	____ 81. problems	____ 103. instruction
____ 16. book	____ 38. kind	____ 60. without	____ 82. absentee	____ 104. transient
____ 17. was	____ 39. able	____ 61. finally	____ 83. advertise	____ 105. phenomenon
____ 18. help	____ 40. shoes	____ 62. strange	____ 84. pleasant	____ 106. calculated
____ 19. then	____ 41. money	____ 63. budget	____ 85. property	____ 107. alternative
____ 20. time	____ 42. great	____ 64. repress	____ 86. distress	____ 108. collective
____ 21. wood	____ 43. father	____ 65. contain	____ 87. information	
____ 22. let	____ 44. river	____ 66. justice	____ 88. recession	

F. TOWRE TEST (PHONEMIC DECODING EFFICIENCY): NONWORD READING

ip	barp	cratty
ga	stip	trober
ko	plin	depate
ta	frip	glant
om	poth	sploosh
ig	vasp	drecker
ni	meest	ritlun
pim	shlee	hedfert
wum	guddy	bremick
lat	skree	nifpate
baf	felly	brinbert
din	clirt	clabom
nup	sline	drepnort
fet	dreef	shratted
bave	prain	plofent
pate	zint	smuncrit
herm	bloot	pelnador
dess	trisk	fornalask
chur	kelm	fermabalt
knap	strone	crenidmoke
tive	lunaf	emulbatate

G. DENSITY SCORES: L1 ENGLISH SPEAKERS

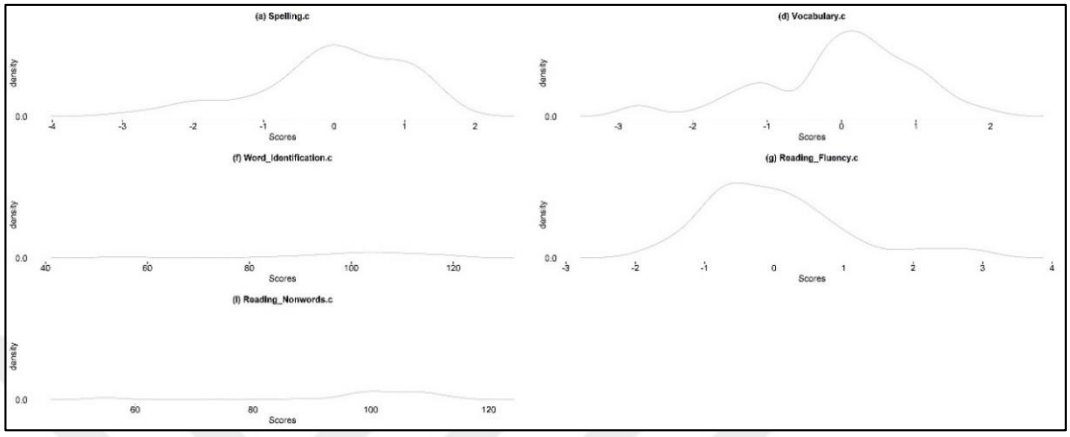


Figure 1. Score Distributions for Each Proficiency Subtest in L1 English

H. DESCRIPTIVE STATISTICS: L1 ENGLISH SPEAKER GROUP

Table 1. Characteristics of L1 English Participants

	L1 Number	**L2 Number**	**Spelling max= 60**	**Vocabulary max=16**	**Reading_Fluency max=516**	**Word Identification**	**Reading Nonwords**
						TOWRE **max=114**	TOWRE **max=120**
Min	1	0	20	5	119	78	89
1st Quarter	-	-	41	11	206	85	90
Median	-	-	45	12	260	97	92
Mean	-	-	44.24	11.41	270.4	96.46	95.77
3rd Quarter	-	-	52	13	305	106	976
Max	2	2	56	16	516	114	115

I. SCORING SHEET

Table 1. Scoring Sheet for the Reading Nonwords Test

No	Response	Accuracy (whole item)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

J. APPROVAL OF THE METU HUMAN SUBJECTS ETHICS COMMITTEE

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
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Sayı: 28620816/ 162

02 ŞUBAT 2018

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Doç .Dr. Bilal KIRKICI ;

Danışmanlığını yaptığınız doktora öğrencisi Hasibe KAHRAMAN'ın ***"Individual Differences in the L1 and L2 Processing of Morphologically Complex Words"*** başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek gerekli onay **2017-EGT-208** protokol numarası ile **02.01.2018 - 30.04.2019** tarihleri arasında geçerli olmak üzere verilmiştir.

Bilgilerinize saygılarımla sunarım.

Prof. Dr. Ş. Halil TURAN
Başkan V

Prof. Dr. Ayhan SOL
Üye

Prof. Dr. Ayhan Gürbüz DEMİR
Üye

Doç. Dr. Yaşar KONDAKÇI
Üye

Doç. Dr. Zana ÇITAK
Üye

Yrd. Doç. Dr. Pınar KAYGAN
Üye

Yrd. Doç. Dr. Emre SELÇUK

K. CURRICULUM VITAE

Personal Details

Name Hasibe Kahraman
Email hasibe.kahraman@hotmail.com

Academic Qualifications

2015-2021 **PhD in English Language Teaching**
Department of English Language Teaching, Middle East Technical University (METU), Turkey
Thesis title: Individual Differences in The L1 And L2 Processing of Morphologically Complex Words.
Supervisors: Prof. Bilal Kirkici & Dr. Elisabeth Beyersmann (overseas director)
Investigation of processes involved in the visual recognition of morphologically complex words in native speakers of English and non-native speakers of English and mechanisms L1 and L2 skilled readers use to acquire cognitive representations of abstract morphological information.

2010-2012 **MSc in Measurement and Evaluation in Education**
Department of Educational Sciences, Hacettepe University, Turkey
Thesis title: The Impact of Smoothed Scores on Equating Error.
Supervisor: Professor Selahattin Gelbal

2006-2010 **Bachelor's Degree in English Language Teaching**
Department of Foreign Language Education, Başkent University

Employment History

July 2021 - August 2021
Research Assistant
Psychology Department, Macquarie University
- Kana Project: The project consists of 2 phases:
- Adapting the DMDX script for online study
- Data collection and Student Interaction

February 2021 - Present
Research Assistant
Psychology Department, Macquarie University
- Taboo Words Project: For each language/locale, the project consis s of 2 phases:
- Collection of taboo words, and creating stimuli,
- Ratings of taboo words on various dimensions (imageability, valence, etc).

October 2020 - Present
Research Officer
Cognitive Science Department, Macquarie University
- Meta-Analysis and Systematic Review Project: The project involves:
- Doing searches to find relevant papers in the literature,
- Abstract screening,
- Full-text screening,

November 2019 - Present
International Research Fellowship
The Scientific and Technological Research Council Of Turkey, Turkey
- 1-year full-time research fellowship awarded by *The Scientific and Technological Research Council of Turkey* (TUBITAK)
- Contributing to the research activities and developing projects in collaboration with overseas universities

October 2015- June 2019
National Scholarship Programme
The Scientific and Technological Research Council of Turkey
- 4-year full-time research fellowship awarded by TUBITAK
- Developing and conducting language processing research

January 2014- July 2016
Izmir University Research Assistant
Department of English Language Teaching, Izmir University, Turkey
- Duties involved lecturing courses and contributing to the intellectual life of the university through conducting academic research
- I was supposed to assist with the departmental duties by arranging coursework, and educational and training workshops

September 2013-March 2014 **English Language Instructor**
Department of Basic English, Hacettepe University, Turkey

- Duties involved teaching basic English skills including reading, writing, and speaking to the graduate students who were admitted to Master's Degree and Doctoral Degree.
- I was expected to instruct students about the structure and content of the English language.

September 2010-September 2012 **Project Instructor**
Ankara University, Turkey
Hacettepe University, Turkey,
The Scientific and Technological Research Council of Turkey, Turkey

- 2-year full-time research fellowship
- Investigation of science learning development in children
- Duties involved setting up and conducting experiments
- Data analysis and scientific writing

September 2006-Present **Private IELTS/TOEFL Tutor**
Freelance & Turkish-American Association

- Teaching exam techniques and strategies
- Teaching advanced level English

Additional Research Experiences

January 2017 **Eye-tracking in reading and language research.**
Workshop at Human-Computer Interaction LAB, METU, Turkey.

January 2017 **Reading as a single construct**
Study at Human-Computer Interaction LAB, METU, Turkey.

January 2017 **Tolerance to Variation in English Language Tests: Views from the Turkish EFL context**
Presentation at Faculty of Education, METU, Turkey.

May 2016 **Role of Pronunciation in Identity Formation**
Presentation at Faculty of Education, METU, Turkey.

January 2016 **Facilitative Effect of Visual Cues in Reading, Eye tracking research**
Workshop at Human-Computer Interaction LAB, METU, Turkey.

Publications

Refereed journal articles:

1. **Kahraman, H.** & Beyersmann, E. (in press) Cross-language influences on morphological processing in bilinguals. In I. Elgort, A. Siyanova, & M. Brysbart (Eds.), Cross-language Influences in Second Language Acquisition and Processing: Interdisciplinary Insights and Perspectives (Bilingual Processing and Acquisition). Philadelphia: John Benjamins.
2. **Kahraman, H.,** & Kırkıcı, B. (2021). Letter transpositions and morphemic boundaries in the second language processing of derived words: An exploratory study of individual differences. *Applied Psycholinguistics, 42*(2), 417-446. doi:10.1017/S0142716420000673
3. **Kahraman, H.** (in review). Validating the (In)Equality of Two Alternative Forms of English Proficiency Exams at Turkish Universities through Smoothed Scores. *Language Assessment Quarterly.*
4. **Kahraman, H.,** (2019). Reading as a single construct: A process-oriented study. *Novitas Royal, 13*(2), 207-221.
5. **Kahraman, H.,** & Pipes, A. (2018). Experiences of international language teachers at a Turkish university. *Annual Review of Applied Linguistics, 38,* 209-219.
6. **Kahraman, H.** (2017). Construction of the teaching ability belief scale-extended: a pilot study. *ELT Research Journal, 6*(1), 45-68.

Planned publications:

1. **Kahraman, H.,** & Beyersmann, E. *Masked constituent priming effects from compound words in L1 and L2.*
2. Taft, M., Beyersmann, E., Yunmin, L., & **Kahraman, H**. A bound form and *BOSS experiments.*

Scholarships, Grants and Awards

September 2019	**Research Transparency & Reproducibility Full Scholarship** Berkeley, University of California Training with Competitive full scholarship.
September 2019	**Capturing and Quantifying Individual Differences in Bilingualism** University of Tromsø, Arctic University of Norway Workshop with Competitive full scholarship (NOK 5000).
Nov 2019-Nov 2020	**International Fellowship Program (1 year).** *The Scientific and Technological Research Council of Turkey, Turkey* Competitive full-time research fellowship for conducting research in an overseas university. (USD 21,600/annum). Project Title: Individual Differences in the Processing Morphologically Complex Words. Investigators: Kahraman, H., Beyersmann, E., & Kirkici, B.

Sep 2015-Sep 2020	**National Fellowship Program (4 years).** *The Scientific and Technological Research Council of Turkey, Turkey* Competitive full-time research fellowship for conducting research in a national university. (TL 33,600/annum).
June 2010	**Salutatorian Award** Baskent University
Sep 2006- July 2010	**Higher Education Scholarship** Ministry of Education, Turkey Baskent University, Turkey Competitive tuition fee scholarship (TL 45.000/annum)
2006	**Medal of Outstanding Success** *Ministry of Education*

Conference Presentations

1. **Kahraman, H.** (2019, September). *Individual differences in the processing transposed letters and morphologically complex words*. Poster presented at the Bilingual Literacy and Input Negotiate Knowledge: Tracing Heritage Language Bilingual Development, UiT the Arctic University of Norway, Tromsø, Norway.
2. **Kahraman, H.** (2017, March). *Drops in the Bucket: A Multiple Case Study of Three Native Foreign Language Teachers in Turkey*. Paper presented at the 45th Australasian Experimental Psychology Conference, Hobart, Tasmania.

Seminars and Lectures

July 2020	**Structured Word Inquiry.** *Online Seminar, Macquarie University, Australia.*
June 2020	**A multi-task examination of word- and character-frequency effects in Chinese.** *Online Seminar, Macquarie University, Australia.*
March 2020	**How to collect psycholinguistic data from home: Introduction to crowdsourcing tools** *Online Training, Centre for Advanced Research in Experimental & Applied Linguistics, McMaster University, Canada.*
May 2020	**Types of phonological dyslexias** *Online Seminar, Macquarie University, Australia.*
October 2017	**Eyelink 1000 Hz Eyetrackers and Data Viewer** *Seminar at Cognitive Science Department, METU, Turkey.*
October 2017	**Eyelink 1000 Hz Eyetrackers and Experiment Builder** *Seminar at Cognitive Science Department, METU, Turkey.*

January 2017 **Early Morphological Processing through Morpho-semantic accounts**
Lecture, METU, Turkey

January 2017 **Semantic Influences on Visual Word Recognition**
Lecture, METU, Turkey

January 2017 **Tobii T120 Eyetrackers**
Human- Computer Interaction Lab, METU, Turkey.

January 2017 **Tobii T120 Eyetracker Glasses I**
Human- Computer Interaction Lab, METU, Turkey. Turkey.

December 2016 **Morphological Decomposition based on the Analysis of Orthography**
Online Seminar, Macquarie University, Australia.

December 2016 **Effects of Orthographic Opacity on Morpho-orthographic Segmentation in Visual Word Recognition,**
Lecture, METU, Turkey

November 2016 **Derivation & Inflection in the Second Language**
Lecture, METU, Turkey

November 2016 **The Processing of Morphologically Complex Words in Turkish Heritage Speakers**
Lecture, METU, Turkey

November 2016 **Morphological Processing in Children**
Lecture, METU, Turkey

October 2016 **Inflection & Derivation in Native & Non-native Language Processing**
Lecture, METU, Turkey

October 2016 **Morphological Processing & Decomposition of Inflected Words in a Second Language**
Lecture, METU, Turkey

October 2016 **Memory Systems & Short-term Memory**
Lecture, Cognitive Science Department, METU, Turkey

Teaching Activity

August 2021- December 2021 — **Tutor** (COGS1010: Delusions and Disorders of the Mind and the Brain)
Department of Psychological Sciences, Macquarie University, Sydney
- ~75 students

August 2021- December 2021 — **Tutor** (LING2214: Introduction to Psycholinguistics)
Department of Linguistics, Macquarie University, Sydney
- ~50 students

September 2015- June 2016 — **Lecturer** (Computer Assisted Language Learning)
Department of English Language Teaching, Izmir University, Turkey
- ~80 students
- Planning and coordinating the delivery of the course, including lectures, tutorials and exams
- Teaching and supervision of 3rd year undergraduate students

September 2015- June 2016 — **Lecturer** (Listening and Pronunciation I and II)
Department of English Language Teaching, Izmir University, Turkey
- ~80 students
- Planning and coordinating the delivery of the course, including lectures, tutorials and exams
- Teaching and supervision of 1st year undergraduate students

February 2014- June 2016 — **Research Assistant** (Women in Society)
Rectory, Izmir University, Turkey
- ~150 students
- Coordinating student projects
- Supervision of undergraduate students across many departments

September 2015- June 2016 — **Instructor** (English I, II, III and IV)
Department of Basic English, Hacettepe University, Turkey
- ~30 students
- Planning and coordinating the delivery of the course, including lectures and exams
- Teaching graduate students

September 2006- present — **Private Tutor** (English Proficiency Exams such as IELTS and TOEFL)
- Total ~40 students
- Estimating the proficiency level of a learner
- Planning the delivery of the course based on the individual student
- Planning and coordinating the delivery of the course, and teaching

Skills and Knowledge

- Excellent knowledge of computer programming and editing tools, including Microsoft Office, DMDX, EPrime
- High proficiency with statistics software SPSS and Zoom
- High proficiency in linear mixed-effects model analysis using software R
- Excellent communication skills
- Ability to work with young children and university students

References

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L. TURKISH SUMMARY / TÜRKÇE ÖZET

1. Çalışmanın Arka Planı, Önemi ve Özgün Değeri

Görsel sözcük tanıma çalışmalarının temel amacı, insan beyninde bulunan zihinsel sözlükteki kelime girdilerine hangi mekanizmalar aracılığıyla erişim sağlandığının açıklığa kavuşturulmasıdır. 40 yılı aşkın süredir birçok çalışma görsel sözcük tanımanın doğasını araştırmakta ve evli, akıllı, gitti gibi biçimbilimsel açıdan karmaşık sözcüklerin nasıl işlemlendiğini anlamaya çalışmaktadır. Biçimbilimsel açıdan karmaşık sözcüklerin nasıl tanındığı ve işlemlendiği üzerine görüş birliği olmamasına rağmen, alan yazında 3 farklı teori sınıfı bulunmaktadır: Bütüncül sözcük teorileri, yapıları ne olursa olsun tüm sözcüklerin zihinsel sözlükte bütün-üniteler olarak (akıllı) kayıtlı olduğunu ve bu sebeple bu karmaşık sözcüklere ancak bütün-sözcük simgelemesi aracılığıyla erişilebileceğini göstermektedir (Butterworth, 1983; Manelis ve Tharp, 1977). Ancak, çok biçimbirimli sözcüklerin, zihinsel sözlükte kökler ve ekler (akıl + lı) olarak kayıtlı olduğu için, bileşenlerine ayrıştırıldığını öne süren Biçimbilimsel Ayrıştırma Hipotezi (Taft & Forster, 1975) yakın dönem alan yazınına hakim olmuştur. Üçüncü teori olan –Çift Erişim teorisi- ise çok biçimbirimli sözcüğün, bileşen biçimbirimlerinin simgelemeleri yoluyla veya bütün-sözcük simgelemeleri yoluyla tanınabileceği iki ayrı sürecin varlığını göstermektedir (Baayen, Dijkstra, & Schreuder, 1997; Diependaele, Sandra, & Grainger, 2009; Diependaele vd.., 2011; Grainger & Ziegler, 2011).

Anadildeki (D1) biçimbilimsel yapıların işlemlenmesinde kullanılan mekanizmaları inceleyen çalışmalar, İngilizce, Almanca, İspanyolca ve Macarca gibi çeşitli dillerdeki yapım ve çekim ekleri olguları üzerine odaklanmıştır. Bu çalışmaların büyük çoğunluğu çift erişim teorisini savunurken (Kırkıcı & Clahsen, 2013; Marslen-Wilson & Tyler, 1998; Münte vd., 1999; Silva & Clahsen, 2008; Sonnenstuhl vd., 1999; Stanners vd., 1979), yalnızca biçimbilimsel ayrıştırma teorisini kabul eden diğer çalışmalar da mevcuttur (Amenta & Crepaldi, 2010;

Beyersmann vd., 2016; Gor & Cook, 2010; Morris & Stockall, 2012; Rastle vd., 2004; Rastle vd., 2018).

Son dönemde, biçimbilimsel açıdan karmaşık sözcüklerin işlemlenmesini araştıran çalışmalar kapsamlarını genişletmişlerdir. Bu araştırmalar, anadilin yanı sıra ikinci dildeki yapım ekleri ve çekim ekleri olgularını incelemiş ve aynı zamanda ikinci dildeki biçimbilimsel işlemleme süreçlerinin ana dildeki işlemlemeden farklılaşıp farklılaşmadığını ve varsa, bu değişkenliğin kaynaklarını belirlemeye çalışmışlardır. Ancak, bu kapsamdaki çalışmaların sonuçları büyük ölçüde tutarsızlık göstermektedir; çünkü anadil ve ikinci dildeki işlemlemenin benzer mekanizmalar ile gerçekleştirildiğini gösteren bir çok çalışmanın (Ciaccio & Clahsen, 2020; Chen vd., 2007; Dal Maso & Giraudo, 2014; Diependaele vd., 2011; Jacob vd., 2018; Kirkici & Clahsen, 2013; J. Li vd., 2017; J. Li & Taft, 2020; M. Li vd., 2017b; Silva & Clahsen, 2008; Viviani & Crepaldi, 2019) yanı sıra işlemlemede farklı mekanizmaların kullanıldığını belirten araştırma sonuçları da bulunmaktadır (Babcock vd., 2008; Clahsen vd., 2010; Clahsen & Neubauer, 2010; Neubauer & Clahsen, 2009; Silva & Clahsen, 2008).

D1 ve D2 işlemlemede benzer mekanizma yaklaşımını savunan çalışmalar işlemlemenin aynı prensipler doğrultusunda meydana geldiğini, fakat daha düşük yeterlik seviyelerindeki konuşucularda ve düşük sıklıktaki kelimelerde önemli farklılıkların oluşabileceğini belirtmektedirler (Diependaele, Duñabeitia, Morris, & Keuleers, 2011). Ayrıca, görsel sözcük tanımanın altında yatan genel mekanizmaların varlığına rağmen, D2'deki performansın az da olsa D1 performansından daha yavaş olabileceği ve daha çok zihinsel çaba gerektirebileceği de vurgulanmaktadır. Sözcük ortografik form hazırlayıcı etkilerinin D2 konuşucularında daha çok ortaya çıkması da ikinci dil konuşucularının sözcüklerin morfolojik özelliklerinin yanısıra ortografik özelliklerini de işlemlediğini göstermektedir (Ciaccio & Jacob, 2019; Diependaele vd., 2011; Feldman vd., 2010; Heyer & Clahsen, 2015b; J. Li vd., 2017; J. Li & Taft, 2020; M. Li vd., 2017; Viviani & Crepaldi, 2019).

Farklı mekanizmaların varlığını savunan çalışmalar ise, D2 konuşucularının yeterlik testlerinden çok yüksek puanlar almalarına rağmen, D2 işlemlemenin dilbilgisinin belirli alanlarındaki işlemlemelerindeki farklılıklarından dolayı hala D1 işlemlemesinden farklılaşacağını belirtmektedir (Clahsen & Felser, 2006b; Ullman, 2005). Cümle işlemlemedeki farklılıklar ile ilgili olarak ise, soyut sözdizimsel yapı gibi daha derinsel ipuçlarını kullanan D1 konuşucularının aksine, D2 konuşucularının cümleleri anlamak için sözcük-anlamsal ve cümlelerin ilişkisel örgüleri gibi yüzeysel ipuçlarını kullandığı belirtilmektedir (Clahsen & Felser, 2006a). Benzer şekilde, Ullman (2005), bildirimsel bellek ve işlemsel bellek olmak üzere iki beyin alt yapısının bulunduğunu öne sürmektedir. Bildirimsel belleğin kelimelerin depolanması, işlemsel belleğin ise dilin kurallarını işleme görevi ile yükümlü olduğunu ve bu iki hafıza sisteminin, olgunlaşma etkilerine hassaslığı nedeniyle ergenlik sonrası görev etkilerinde azalmaların olduğunu vurgulamaktadır. Bu durum ise işlemsel beyin sistemine daha çok bağımlı olan D1 işlemlemenin aksine, D2 işlemlemenin daha çok ezberlemeye dayalı sistemi kullanmasına sebep olmaktadır.

Biçimbirimsel işlemlemenin D1 ve D2'de farklılaşıp farklılaşmaması birçok farklı etkilere dayanmaktadır (Jacob vd., 2017; Kırkıcı & Clahsen, 2013). Örneğin, yapım ekleri ve çekim ekleri eklenmiş sözcüklerin işlemlenmesini araştıran çalışmalar arasında büyük farklılıklar bulunmaktadır. Düzensiz çekim eki almış karmaşık sözcükleri (go - went) araştıran çalışmalar hem anadil hem de ikinci dil konuşucuların bu sözcükleri ayrıştırdığını göstermektedir (Basnight-Brown vd., 2007; Feldman vd., 2010; Gor & Jackson, 2013; Neubauer & Clahsen, 2009; Pliatsikas & Marinis, 2013), ancak düzenli çekim almış karmaşık sözcükler (play - played) ikinci dilde daha çok bütüncül sözcükler olarak işlemlenebilmektedir (Jacob vd., 2018; Kırkıcı & Clahsen, 2013; Pliatsikas & Marinis, 2013; Silva & Clahsen, 2008; Neubauer & Clahsen, 2009). Ancak, birçok çalışma ikinci dil konuşucularının düzenli çekim eki almış bu sözcükleri ayrıştırdığını da göstermektedir (Basnight-Brown vd., 2007; Coughlin & Tremblay, 2015; Gor & Jackson, 2013; Jacob vd., 2013; Feldman vd., 2010; Foote, 2017; Lehtonen vd., 2006). Sonuç olarak, büyük çoğunluğu ayrıştırma teorisini destekleyen daha benzer sonuçlar ortaya koysa da ikinci dildeki türemiş kelime çalışma bulguları birkaç çalışma ile sınırlıdır ve hala

büyük ölçüde birbiriyle çelişkilidir. Özellikle biçimbilimsel açıdan zengin bir dil olan Türkçe yetişkin konuşucularının biçimbilimsel açıdan fakir olan İngilizce dilindeki yapım eklerinin işlemlenmesinde kullandıkları mekanizmaları araştıran araştırmalar neredeyse yoktur.

Biçimbirim ünitelerinin ayrıştırılması ile ilgili iki yeni teori, bu ayrıştırmanın ne zaman gerçekleştiğini belirlemeyi amaçlamaktadır. Bu bağlamda ilk görüş olan sözcük-öncesi teorisi, biçimbilimsel açıdan karmaşık olan sözcüklerin biçim-ortografik alt birimlerine otomatik olarak ayrıştırıldığını ve hemen ardından bütün-sözcük simgelemesinin etkinleştirildiğini iddia etmektedir (Rastle vd., 2000; Rastle vd., 2004; Taft, 2003, 2004). Sözcük-sonrası teorisi ise, biçimbilimsel açıdan karmaşık olan sözcüklerin her zaman ilk olarak bütün-sözcük simgelemesine eşleştirildiği ve ancak zihinsel sözlüğe erişim sağlandıktan sonra ayrıştırmanın yapıldığını belirtmektedir (Giraudo & Grainger, 2000, 2001).

Son zaman alan yazını, ayrıca, anlambilimsel bilginin biçimbilimsel ayrıştırma sürecine olan etkilerini de ele almaktadır. Biçimbilimsel açıdan karmaşık olan sözcüklerin işlemlenmesi sırasında biçim-anlambilim bilgisinin etkisinin bulunup bulunmadığı, varsa, bu etkilerin nasıl ve ne zaman erişilebildiği son zaman alan yazınında çok tartışılmaktadır. Bu süregelen tartışmalar sonucunda, iki ana teori olan biçim-ortografik ve biçim-anlambilim teorileri ortaya konmuştur. İlk teori, ayrıştırmanın anlambilim etkilerine kapalı olan ve sözcüğün tamamıyla ortografik formuna bağlı olduğu görüşünü savunurken, diğer teori ise biçimbilimsel ayrıştırmanın ilk aşamalarındaki anlambilimsel etkilerinin varlığını kabul etmektedir. Rastle vd. (2004) anlambilimsel açıdan geçirimli biçimbilimsel hazırlayıcı ve hedef sözcük çiftlerinin (cleaner - CLEAN), anlambilimsel açıdan geçirimsiz çiftlerinin (corner - CORN) ve biçimbilimsel olmayan çiftlerinin (brothel - BROTH) hazırlama etkilerini araştırmışlardır. Bu çiftlerde, katılımcılar sözcüğün anlamını biçimbirimsel alt birimler aracılığıyla çıkarabilmekte (cleaner - CLEAN) veya çıkaramamaktadır (corner -CORN ve brothel - BROTH). Eğer sözcük simgelemeleri anlambilimsel ilişki temel alınarak ayrıştırılıyorsa, hazırlama etkilerinin biçimbilimsel geçirimli koşulda daha fazla olması gerekmektedir. Ancak, bu simgelemelerin belirleyici etkeni ortografi ise, biçimbilimsel açıdan ilişkili

koşullardaki (cleaner - CLEAN; corner - CORN) hazırlama etkilerinin, hazırlayıcı ve hedef sözcüklerin biçimbilimsel açıdan ilişkili olmayan koşullarda (brothel - BROTH) elde edilen hazırlayıcı etkilerden daha yüksek olması beklenmektedir. Çalışmanın sonuçları, hazırlayıcı ve hedef sözcüğün biçimbilimsel açıdan ilişkili olduğu koşulda daha fazla hazırlayıcı etkilerin elde edildiğini göstermektedir. Bu durum, biçimbilimsel ayrıştırmanın anlambilim etkilerinden bağımsız ve hızlı bir ayrıştırmaya uğradığına işaret etmektedir. Ancak, Feldman vd. (2009), anlambilimsel açıdan geçirimli (coolant - COOL) ve geçirimsiz (rampant - RAMP) hazırlayıcı-hedef kelime gruplarındaki kolaylaştırma örüntülerini karşılaştırmış ve araştırmanın sonucunda biçimbilimsel kolaylaştırmanın, anlambilimsel açıdan geçirgen sözcük çiftlerinde anlambilimsel açıdan geçirgen olmayan çiftlere kıyasla daha fazla olduğunu belirtmiştir. Ayrıca, bir ERP çalışmasında Morris, Frank, Grainger ve Holcomb (2007) ne yalnızca biçim-ortografik ne de biçim-anlambilim teorileri ile örtüşen kanıt sunmuştur. Bu çalışmanın verileri karmaşık dil işlemleme üzerinde hem biçim-ortografik hem de anlambilim etkilerinin bulunduğu etkileşimli bir işlemleme sürecini göstermiştir. Karmaşık sözcük işlemleme üzerine sunulan çok yeni bir model, sözcük ve ek modeli (Beyersmann & Grainger, 2011), bu çalışmaların sonuçlarını açıklayabilmektedir. Bu modele göre, kelimenin zihinsel sözlükteki ortografik temsilleri anlambilimsel temsillerine hem yukarıdan aşağıya hem de aşağıdan yukarıya bilgi transferi sağlayan çift yönlü bağlantılar aracılığıyla eşlenmektedir.

Ruhdilbilim çalışmalarında kullanılan temel deneysel yöntem, maskelenmiş ve maskelenmemiş biçimbilimsel hazırlama paradigmasıdır ve yukarıda bahsedilen çalışmaların çoğunluğu araştırmalarını maskelenmiş biçimbilimsel hazırlama paradigmasını kullanarak gerçekleştirmişlerdir. Maskelenmiş hazırlama paradigması, görsel sözcük tanıma çalışmalarında çok yaygın şekilde kullanılan bir yöntemdir ve üç aşamadan oluşmaktadır: İlk olarak, hazırlayıcı sözcükle (örn. keyifle) aynı sayıda kare işaretinden oluşan ön bir maske (###) 500 milisaniye (ms) boyunca gösterilir, daha sonra hazırlayıcı (keyifle) çok kısa süreyle gösterilir (genellikle 50 ms). Hazırlayıcı tipik olarak biçimbilimsel açıdan karmaşık hazırlayıcı (keyifle), anlambilimsel hazırlayıcı (istekle), ilişkisiz hazırlayıcı (kokusuz) hazırlayıcıyı içermektedir. Bu işlemin hemen ardından ekranda hedef

sözcük belirir (KEYİF) ve deney, katılımcının hedef kelimenin gerçek bir kelime olup olmadığına ilişkin kararını bir düğmeye basarak bildirmesiyle bitirilir. Maskelenmiş hazırlama, görsel sözcük tanımanın erken süreçlerine erişen bir paradigmadır; çünkü hazırlayıcı çok kısa bir süre boyunca sunulur, bu yüzden katılımcıların hazırlayıcı-hedef sözcük ilişkisi ile ilgili neredeyse hiçbir olgusal farkındalığı yoktur, fakat katılımcı cevaplarının, hazırlayıcının hedef sözcük ile ilişkisine dayalı olarak etkilendiği bilinmektedir. Örneğin, keyifle gibi biçimbilimsel açıdan karmaşık hazırlayıcı, katılımcıların keyif hedef sözcüğüne vereceği gerçek cevap kararlarını hızlandırmaktadır. Ekli sözcük (keyifle - KEYİF) ve ekli gerçek olmayan sözcük (keyiflik -KEYİF) gibi deneysel koşullardan elde edilen hazırlama etkileri ilişkisiz koşul ile (kablosuz -KEYİF) karşılaştırılabilir ve hangi faktörlerin cevap sürelerine ve hata oranlarına etkide bulunduğu araştırılabilir.

Biçimbilimsel işlemleme çalışmalarında son zamanlarda önem kazanmaya başlayan yenilikçi yöntemlerden biri de maskelenmiş harflerin yeri değiştirilerek (HYD) hazırlama tekniğidir. Bu teknikte hazırlayıcılar, hedef sözcüğün harflerinin yerlerinin değiştirilmiş bir ünitesini içermektedir. Bu teknik, biçimbilimsel ayrıştırmanın harf konumu kodlaması ile aynı anda gerçekleşip gerçekleşmediğini ve biçimbilimsel açıdan karmaşık sözcüğün tanınmasının biçimbirim sınırındaki harflerin yerinin değiştirilmesiyle engellenip engellenmediğini belirlemede kullanılır. Bu sebeple, hazırlayıcıdaki yerleri değiştirilmiş olan harfler hem biçimbirim sınırında hem de biçimbirim sınırının dışında olabilir. Örneğin, sabırlı sözcüğünün işlemlenmesini araştıran bir HYD deneyinde sabır hedef sözcüğü için sabrılı, biçimbirim sınırı içerisinde HYD hazırlayıcıyı içermekteyken, sabılrı biçimbirim sınırı dışındaki HYD hazırlayıcıyı kullanmaktadır. HYD deneylerinde, genellikle ikame-harf koşulu temel dayanak olarak kullanılır. Bu koşulda, harflerin yeri değiştirilen ünitelerin yerine (örneğin, sabrılı hazırlayıcısındaki rı) iki yeni harf konulur (örneğin, sabmolı hazırlayıcındaki mo).

Biçimbirim sınırında ve dışındaki hazırlayıcı etkileri araştıran HYD deneylerindeki hedef sözcüğün kök (sabrılı - SABIR) veya bütün-sözcük (sabrılı - SABIRLI) olup olmaması gerektiği ile ilgili olarak, bazı çalışmalar hedef sözcükler olarak bütün-sözcükleri kullanırken (Christianson vd., 2005; Duñabeitia vd., 2007; Duñabeitia

vd., 2014; Perea & Carreiras, 2006; Rueckl & Rimzhim, 2011; Sanchez-Gutierrez & Rastle, 2013), diğer çalışmalar ise sözcüklerin köklerini hedef sözcük olarak göstermişlerdir (Beyersmann vd., 2013; Diependaele vd., 2013; Rueckl & Rimzhim, 2011). Ancak, Rueckl ve Rimzhim (2011), etki büyüklüğünün biçimbirim içi ve dışı değiştirmelerde hedef sözcüklerin kök veya bütün-sözcük olup olmamasına bağlı olarak değişiklik göstermediğini bulmuşlardır.

Harflerin yeri değiştirilerek hazırlama etkileri, HYD koşulundaki hazırlayıcının, ikame-harf koşulundaki hazırlayıcıdan daha az yıkıcı olduğu durumda elde edilir. HYD hazırlama etkisinin elde edilmesi araştırmacıya genellikle iki sonuç çıkarılmasını mümkün kılar: İlk olarak, ayrıştırma otomatik bir işlemdir ve bu işlem, HYD hazırlayıcısı gerçek bir kelime olmadığı ve zihinsel sözlükte var olmadığı için, kelimenin ortografik sözlükte etkinleştirilmesinden bağımsızdır. İkinci olarak, HYD deneylerindeki harflerin kesin olmayan konum kodlamalarının (sabrılı) sonucu olarak, ayrıştırmanın sözcük tanıma sürecinde harf pozisyonu kodlama süreciyle aynı erken süreçte işlediği çıkarımı yapılabilir. Çünkü, biçimbilimsel açıdan karmaşık bir sözcüğü bağlamdan bağımsız şekilde tanımak öncelikle harf konumunun kodlamasını gerektirir. Bu özellikle sadece HYD deneylerinde bulunabilecek çok önemli bir bulgudur; çünkü harflerin yerlerinin değiştirilmesini inceleyen bir çalışma, bazı konumsal değişikliklere rağmen biçimbilimsel hazırlama etkisi bulabilir ve bu durum da biçimbilimsel ayrıştırmanın konumsal belirsizliğinin kanıtını sunmaktadır.

Diğer çalışmalar, HYD etkilerini katılımcıların biçimbirimsel sınır içinde ve biçimbirimsel sınır dışındaki harf değişikliklerini içeren karmaşık sözcüklere verdiği cevaplama sürelerini kullanarak incelemişlerdir (Christianson vd., 2005; Duñabeitia vd., 2007; Rueckl & Rimzhim, 2011; Sanchez-Gutierrez & Rastle, 2013). Bu çalışmalarda ayrıştırma teorisi, biçimbirimsel sınır içerisindeki harf değişiklikleri, biçimbirimsel sınır dışındaki harf değişikliklerinden daha fazla yıkıcı olduğu durumlarda kabul edilmiştir. Örneğin, sabırlı sözcüğü sabır kökünden –lı eki çıkarıldıktan sonra tanınıyorsa, o zaman kök ve ekin bozumu kelime karar deneyinde ret cevabını daha hızlı vermede kolaylık sağlayacağı için biçimbilimsel işlemlemeyi engellemelidir; çünkü sabılrı hazırlayıcısı SABIR hedef sözcüğünü

sabrılı hazırlayıcısı kadar hazırlayamayabilir. Bunun sebebi olarak da ilk koşuldaki ekin bozulmuş olduğu ve bu yüzden kökten ayrıştırılamayacağı belirtilebilir.

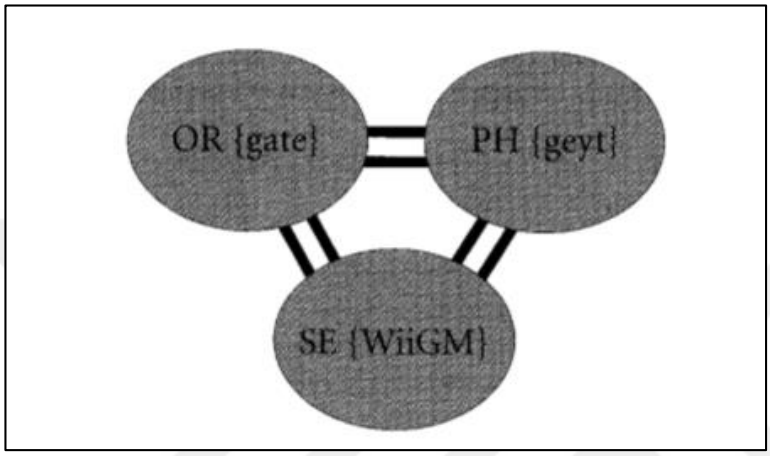
Ancak, HYD hazırlama deneylerinin biçimbilimsel işlemleme ve belirsiz harf konumu kodlama çalışmalarında sunacağı sağlam ve birleşik kanıtlara rağmen, biçimbilimsel açıdan karmaşık sözcüklerin görsel tanınması araştırmalarında bu yenilikçi tekniği kullanan çok az çalışma vardır. Bu az sayıdaki çalışmalardan elde edilen sonuçlar da biçimbilimsel işlemlemede farklı örüntülerin kullanıldığını gösterdiği için kesin sonuç niteliğinde değildir. Bazı çalışmalar HYD hazırlama etkilerini sadece biçimbirimsel sınır içerisindeki harf değişikliklerinde bulunduğunu gösterirken (Christianson vd., 2005; Duñabeitia, vd., 2007), diğer çalışmalar hazırlama etkisi büyüklüğünün biçimbirimsel sınır içinde ve dışında olması ile ilgili olmadığı sonucuna varmıştır (Beyersmann vd., 2013; Diependaele vd., 2013; Perea & Carreiras, 2006; Rueckl & Rimzhim, 2011; Sanchez-Gutierrez & Rastle, 2013). Ayrıca, hiçbir çalışma HYD etkilerini D2 konuşucularında araştırmamıştır. Bu nedenle bu çalışma, yeni bir deneysel paradigma olan hem biçimbirim sınırında hem de biçimbirim sınırı dışında maskelenmiş harflerin yeri değiştirilerek (HYD) hazırlamayı ve daha geleneksel olan maskelenmiş biçimbilimsel hazırlamayı birlikte hem anadilde hem de ikinci dilde kullanan daha sağlam ve yenilikçi bir çalışmadır.

2. Teorik Çerçeve: Sözcüksel Nitelik Hipotezi

Bu çalışma, alan yazında bulunan teorik ve deneysel çelişkili bulguları açıklığa kavuşturmak amacıyla katılımcıların bireysel farklılıklarını kullanan yeni bir yaklaşım benimsemektedir. Bu farklılıklar en iyi şekilde Perfetti'nin (1992, 2007) ortaya koyduğu sözcüksel nitelik hipoteziyle yansıtılmaktadır. Bu hipotez, sözcük simgelemelerinin kalitesinde değişkenliğin bulunduğunu ve bu değişkenliğin okuma anlama, heceleme, okuma hızı ve kelime bilgisi kullanmayı içeren sözcük tanıma görevlerindeki başarının temel belirleyicisi olduğunu göstermektedir.

Dahası, sözcüksel kalite hipotezi, güvenilir, tutarlı ve yüksek kaliteli bir sözcük simgelemenin kolaylıkla ve tutarlı biçimde çağrılabilmesi için "başarılı okuma

anlama becerisinin, sözcük simgelemelerindeki kaliteye ve ortografik ünitelerden çağrılan sesbilimsel ve anlambilimsel bilgiye bağlı olduğunu belirtmektedir" (Perfetti, 1992). Aşağıda belirtilen Şekil 1, "gate [kapı]" kelimesinin ortografik (OR), sesbilimsel (PH) ve anlambilimsel (SE) tanınmasında, sözcük bileşenleri seti arasındaki sıkça bağlanmış ve yüksek kalitedeki simgelemeyi göstermektedir (Perfetti & Hart, 2002).



Şekil 1. "gate [kapı]" sözcük girdisinin iyi bütünleşmiş ortografik (OR), sesbilimsel (PH) ve anlambilimsel (SE) bileşenleri

Şekilde de görüleceği üzere, sözcük bileşenleri arasında iyi bütünleşme sağlandığında, sözcüksel kalite de iyi olmakta ve sözcük tanıma becerini gerektiren okuma anlama, heceleme, yüksek sesle ve hızlı okuma gibi görevlerde karşılaşılabilecek olası problemler de engellenebilmektedir. Bu sebeple, bir metni anlamak, kelime dağarcığının büyüklüğü ve depolanmış sözcük simgelemeleri arttıkça gelişir; çünkü bu sözcüklerin sesbilimsel, ortografik ve anlambilimsel bilgileri arasındaki bağlantıların gücü deneyim aracılığıyla gelişir. Bireyler zamanla deneyim kazandıkça bu bağlantılar güçlenir ve otomatik hale gelir. Bu nedenle, okuyucunun okuduğu sözcüğe ait bilgisi, bu üç bileşene ait özellikleri temsil edebildiğinde, bu sözcüğün zihinsel sözlükteki kalite girdisi sağlanabilir ve bu durum okuma anlamanın da temelini oluşturur. Sözcüğe ilişkin yüksek kalitenin belirleyici özellikleri, okuyucuya diğer kelimelerin de parçaları olabilecek kelimelerin parçalarını değil de tam olarak o belirli kelimeye ulaşmasını sağlar ve bu durum da hem anlam hem de yapıdaki kafa karışıklığını en aza indirgemektedir.

“Kesin simgelemeler kısmen değil, tam belirli bir durumdadır, böylece girdi özellikleri, etkinleştirilecek simgelemeyi kesin olarak belirleyebilir ve diğer adayların minimum etkinleştirilmesiyle tek bir doğru simgelemenin getirimi mümkün olur” (aktaran Andrews & Hersch, 2010, s. 299). Okuyucunun sözcük simgelemelerindeki netliği, oldukça başarılı yazılı dil işlemlenmesinin temel belirleyicisidir. Sözcük bileşenlerinin kalitesi ve bunlar arasındaki sıkı bağ, sözcük girdisinin otomatik şekilde çağrılmasını ve bu sözcüğün parçanın zihinsel modeliyle bütünleşmesini sağlar.

Bireysel farklılıkların rolünü belirlemeyi amaçlayan önemli bir çalışma (Andrews & Lo, 2013) katılımcıların heceleme ve kelime test puanlarını kullanarak hazırlama etkilerinin büyüklüğünü araştırmıştır. Andrews ve Lo, çalışmalarında, katılımcıların heceleme puanlarına oranla kelime testi puanlarında daha yüksek puanlar aldığı kelime ölçütünü “anlambilimsel profil” ile ilişkilendirmek için kullanmıştır. Kelime puanlarına kıyasla heceleme puanlarından daha yüksek puan alan bireyler ise “ortografik profil” ile ilişkilendirilmiştir. Andrews ve Lo, bireyleri “anlambilimsel profil” olarak sınıflamada, katılımcıların kelime testindeki farklı puanlarını karşılaştıran ve yüksek kelime grubundakilerin daha fazla anlambilimsel hazırlama etkisi gösterdiğini bulan Yap vd. (2009)’ nin çalışma sonuçlarını kullanmışlardır. Ayrıca, Andrews ve Lo (2013) bireyleri heceleme becerilerindeki seviyelere göre gruplamada, Hargreaves vd. (2012)’nin uzman Scrabble oyuncuları üzerine yaptığı ve ortografik bilgi kodlamada daha gelişmiş becerileri olan bireylerin kelime anlamına olan bağımlılığının en aza indirildiğinin gösterildiği çalışmaları referans olarak belirtmişlerdir.

Bu çalışmalar, hazırlayıcı etki gücünün bireysel farklılıklar tarafından anlamlı ölçüde değişikliğe uğratılabildiğini göstermiştir. Diğer çalışmalar da okuma ve heceleme testi puanlarını (Andrews & Hersch, 2010), okuma hızını (Duñabeitia vd., 2014; Medeiros & Duñabeitia, 2016) ve dil yeterlilik puanlarını (Beyersmann vd., 2014) kullanarak bireysel farklılıkların bu çalışmalarda önemli olduğunu bulmuşlardır.

Sonuç olarak, son dönem çalışma bulguları, hazırlayıcı etkilerin okuma, heceleme ve dil yeterliliğindeki bireysel farklılıklar tarafından değişikliğe uğratılabileceğini göstermiştir. Fakat bu çalışmalarda kullanılan bireysel farklılıklar testleri ya yöntemsel anlamda sınırlı ya yeterince kapsamlı değil ya da psikometrik açıdan sağlam ölçümlerden oluşmamaktadır. Bu sebeple, bu çalışma, alan yazında tartışmalı olan D1 İngilizce ve D2 İngilizce'yi aynı anda kullanması açısından ve yeni bir deneysel paradigma olan harflerin yeri değiştirilerek hazırlama etkilerini hem biçimbirim sınırları içinde hem de dışında kullanarak elde edilen hazırlayıcı etkilerinin bireysel farklılıklar tarafından değişikliğe uğratılıp uğratılmadığını araştırması bakımından önemli, özgün ve yenilikçi bir çalışmadır. Daha önce ayrıca, bu çalışmalardan hiçbiri HYD etkilerini D2 konuşucularında araştırmamıştır. Ayrıca, bu çalışma, bireysel farklılıklar puanlarını elde etmede, alan yazında hem sayıca daha fazla hem de okuma becerilerini açıkladığı belirtilen fakat hiç kullanılmamış olan becerilerin geçerli ve güvenilir şekilde ölçmesi bakımından da değerli ve yenilikçi bir çalışmadır.

3. Çalışmanın Amacı, Araştırma Soruları ve Öngörüler

Son 40 yıldır, birçok çalışma, görsel sözcük tanımanın doğasını araştırmakta ve (government [hükümet], touched [dokundu]) gibi biçimbilimsel açıdan karmaşık sözcüklerin nasıl işlemlendiğini anlamaya çalışmaktadır. Ancak, bu sözcüklerin tanımasında hangi mekanizma(lar)ın kullanıldığı ile ilgili bir görüş birliği kurulamamıştır. Ayrıca, alan yazında bulunan sözcük tanıma çalışmaların bulguları değerlendirildiğinde, bu sözcüklerin tanınması ve işlemlenmesiyle ilgili çelişkili bulgular bulunmaktadır. Yeni yapılmakta olan çalışmalar, hazırlayıcı etkilerin okuma, heceleme ve dil yeterliliğindeki bireysel farklılıklar tarafından değişikliğe uğratılabileceğini göstermiştir. Fakat bu çalışmalarda kullanılan bireysel farklılıklar testleri ya yöntemsel anlamda sınırlı ya psikometrik açıdan yetersiz ya da yeterince kapsamlı değildir. Bu sebeple, bu çalışmanın amacı, D1 İngilizce ve D2 İngilizce' deki türetilmiş kelime formlarının tanınmasında kullanılan erken otomatik işlemleri karşılaştırmak ve yeni deneysel paradigma olan hem biçimbilimsel hazırlayıcı etkilerinin hem de biçimbirim sınırları içinde ve dışındaki hazırlayıcı etkilerin işlemsel bellek testi, heceleme testi, dinleme anlama testi gibi 9 farklı ölçümle elde

edilecek olan bireysel farklılıklar tarafından değişikliğe uğratılıp uğratılmadığını araştırmaktır. Çalışma ayrıca, ortografinin biçimbilimsel hazırlamaya olan katkısını açıklığa kavuşturmayı ve biçimbilimsel ayrıştırma sürecinin harf konumu kodlaması ile aynı anda gerçekleşip gerçekleşmediğini araştırmayı amaçlar.

Bu çalışma, alan yazındaki çelişkili bulguları Perfetti'nin (1992) başarılı dil işlemlenmesinin sözcük imgelemelerindeki kesinlik olduğunu belirten sözcüksel nitelik hipotezini kullanarak açıklığa kavuşturmayı ve aşağıda belirtilen araştırma sorularını cevaplamayı amaçlamaktadır:

1. D1 ve D2 İngilizce' de biçimbilimsel açıdan karmaşık kelime formlarının tanınmasında kullanılan erken otomatik işlemler nelerdir?
2. D1 ve D2 İngilizce' de bu kelimelerin işlemlenmesinde kullanılan genel mekanizma(lar)a ilişkin nicel ve nitel farklılıklar var mıdır?
3. Biçimbilimsel hazırlama etkileri bireysel farklılıklar tarafından değişikliğe uğramakta mıdır?
4. Harflerin yerleri değiştirilerek hazırlama etkileri bireysel farklılıklar tarafından değişikliğe uğramakta mıdır?
5. Biçimbilimsel ayrıştırma süreci harf konumu kodlama ile aynı anda gerçekleşmekte midir?

Biçimbilimsel hazırlama etkileri ile ilgili olarak, araştırmacı, kısa süreli sunulan biçimbilimsel açıdan ilişkili kelimenin (braveness- BRAVE) kelime tanımlama süreci esnasında biçimbilimsel yapısı doğrultusunda ([brave] + [-ness]) ayrıştırılacağını öngörmektedir. Eğer bu ayrıştırma süreci hazırlayıcının ortografik ve sesbilimsel etkileri tarafından destekleniyorsa, o zaman ne biçimbirim sınırları içinde ne de biçimbirim sınırları dışında HYD etkileri beklenmemektedir. Çünkü HYD hazırlayıcıları, hazırlayıcının hedef kelime ile ortografik ve sesbilimsel benzerliğini gidermektedir.

Ayrıca, biçimbilimsel hazırlama etkileri ve HYD hazırlama etkilerinin okuma becerilerindeki bireysel farklılıklar tarafından değişikliğe uğrayacağı öngörülmektedir. Ancak, bu etkilerin yönü ve şiddeti bu araştırmada

soruşturulacaktır. Çünkü daha önce hiçbir çalışma HYD etkilerinin D2 konuşucularında araştırmamıştır. Son olarak, eğer D2 konuşucuları D1 konuşucuları ile benzer biçimbilimsel işlemleme mekanizmalarını kullanıyorsa bu iki grup açısından deney koşulları arasında benzer biçimbilimsel ve HYD etkileri beklenmektedir.

4. Çalışmanın Yöntemi

Bu çalışmada altı hazırlayıcı koşulu bulunan iki maskelenmiş hazırlayıcılı kelime karar deneyi uygulanmıştır. Bu altı hazırlayıcı koşul, (i) biçimbilimsel hazırlama, (ii) biçimbirim sınırında harflerin yeri değiştirilerek (HYD) hazırlama, (iii) biçimbirim sınırında ikame-harfler ile yerine koyma (iv) biçimbirim sınırı dışında HYD hazırlama (v) biçimbirim sınırı dışında ikame-harfler ile yerine koyma (vi) ilişkisiz hazırlamadan oluşmuştur. İlk deney, D2 İngilizce'deki türetilmiş kelimelerin tanınmasını, ikinci deney ise D1 İngilizce'deki kelime formlarının tanınmasını araştırmıştır. Ancak, her iki deney de harf pozisyonu kodlamanın çok biçimbirimli işlemlenmesindeki rolünü değerlendirmiştir. Her iki deneyde ayrıca bireysel farklılıklar testleri uygulanmıştır. İlk deneyde aşağıda detaylı bir şekilde sunulan, katılımcıların okuma becerilerindeki farklılıklarını değerlendiren ve 9 alttesten oluşan Okuma Becerileri bataryasını kullanılmış, ikinci deneyde ise Kelime Becerileri, Heceleme, Sözcük Tanıma, Gerçek olmayan Kelimeleri Okuma testlerini kullanılmıştır. Bu çalışmada bağımlı değişkenler, sözcük karar cevaplama süreleri; bağımsız değişkenler ise hazırlama etkileri koşullarıdır.

4.1. Bireysel Farklılıklar Ölçekleri: Okuma Becerisi Bataryası

D1 ve D2 İngilizce' deki türetilmiş kelime formlarının tanınmasında kullanılan erken otomatik işlemleri araştırmak ve hazırlama etkilerinin katılımcıların okumadaki ve dil yeterliliğindeki bireysel farklılıkları tarafından değişikliğe uğrayıp uğramadığını belirlemek için, araştırmacı tarafından öğrencilerin okuma ve dil becerilerini ölçen okuma becerileri bataryası geliştirilmiştir. Bu çalışmada kullanılan bireysel farklılıklar ölçekleri iki amaç doğrultusunda seçilmiş ve uyarlanmıştır: İlk amaç, sözcük tanıma çalışmalarında farklı becerilerin hazırlama

etkilerine yaptığı anlamlı katkıyı değerlendirebilmek amacıyla hem D1 hem de D2'de mümkün olduğunca farklı testleri kullanmaktır. İkinci amaç ise, dil işlemleme alanında daha önceki çalışmalarda elde edilen farklı ve uyumsuz sonuçları açıklığa kavuşturacak olan faktörleri belirleyip alan yazına fazla veri ile katkıda bulunmaktır.

Bu bataryayı oluşturmadaki temel varsayım, bireylerin okuma ve dil becerilerinde farklılık gösterdiği ve bu farklılıkların bu becerileri kestirebileceği ve kelime tanıma çalışmalarındaki farklı hazırlayıcı etkilerini açıklığa kavuşturabileceğidir. Grabe ve Jiang (2014) okuma becerilerini derinden etkileyen faktörleri vurgulamış ve D1 ve D2 bağlamlarını araştıran çalışmaları kullanarak okuma performansındaki bireysel farklılıkların, (i) etkili sözcük tanıma işlemleri; (ii) kelime bilgisi; (iii) zaman sınırları altında dilbilgisi bilgisi; (iv) bir parçanın ana fikirlerini sunma becerisi; (v) daha zor parçaları okurken stratejik işlemleri kullanma becerisi; (vi) arka plan bilgisini uygun şekilde kullanabilme becerisi; (vii) okuma amacına ilişkin şekilde parçadan kritik anlamı çıkarabilme becerisi; (viii) işlemsel belleğin etkili kullanımı; (ix) okuma hızı becerilerinin etkili kullanımı; (x) okumaya katılabilme, çaba harcama, dikkat dağınıklığı olmaksızın okumaya devam etme ve okumada başarıyı yakalayabilme işlemlerinden oluştuklarını belirtmiştir.

4.1.1. Testlerin Literatür Taraması

Bu bataryada kullanılan testler, literatürde bireylerin okuma ağının çeşitli alanlarını kullandığı kanıtlanan testlerden seçilmiştir. Ayrıca, bu testlerin okuma ile ilişkili olduğu tutarlı bir şekilde gösterilmiştir. Oluşturulan alt testler ve okumadaki varsayımsal rolleri aşağıda taranmıştır. Bu testler, literatürde farklı amaçlar ve değişik test formatları ile kullanıldığı için, bu bataryadaki birçok alt test Woodcook-Johnson III Başarı Testleri (Woodcock vd., 2001, 2007) ve Kaufman Eğitsel Başarı Testi- İkinci Versiyon'da (Kaufman & Kaufman, 2004) kullanıldığı gibi oluşturulmuştur. Çünkü bu testler okuma ve yazma dilindeki ve sözel dildeki akademik başarıyı ölçmek için kullanılmakta ve hem geçerli ve güvenilir hem de standartlaştırılmış olan testlerdir.

Test 1: Sözcük Tanıma.

Sözcük tanıma, okumada en yaygın olarak tekrarlanan bilişsel beceridir (Perfetti, 2007, s. 357) ve araştırmacılar sözcük tanımanın okumada merkez bir beceri olduğunu kabul etmektedirler. Çalışmalar, sözcük tanımanın, okuma anlama becerisinin en güçlü kestiricisi ve en önemli belirleyici etkeni olduğunu desteklemektedir (Joshi & Aaran, 2000; Zinar, 2000). Ayrıca, Landi (2005), sözcük tanıma becerilerinin okuma parçasını iyi anlamada yetersiz fakat gerekli olduğunu belirtilen çarpıcı bir kanıt sunmuştur ve bulgu bu çalışmada kullanılan bataryada temsil edilmesi gerektiği kadar önemli bulunmuştur. Bu çalışmada kullanılan bataryadaki sözcük tanıma alt testinde birey, gerçek kelimeleri bağlam olmadan yüksek sesle okumuştur. Maddeler giderek artan zorluktadır ve SUBTLEX-UK bütüncesinden seçilmiştir (van Heuven vd., 2014). Bu bütünce, 2010 Ocak ve 2012 Aralık ayları arasında dokuz İngiliz televizyon yayınındaki 201.7 milyonluk altyazı bütüncesinden hesaplanan 160.022 kelime formlarını sıklık değerleri ile vermektedir.

Test 2: Okuma Hızı.

Rasinski (2006) ve Ulusal Okuma Paneli (2000) okuma hızını, okuyucuyu parçadaki bireysel sözcükleri çözümlemeden ziyade içeriğe odaklayan ve okumadaki hız, doğruluk ve yüzdeki uygun ifadedeki yetenek olarak tanımlamışlardır. Okuma hızı ve okuma anlamanın ilişkisi ile ilgili olarak Saebra vd. (2017) ve Neddenriep vd. (2010) iki yapının benzerliğine ilişkin kanıtlar sunmuş ve okuma hızı testinin, okuma anlama modellerinin bir öğesi olarak kullanımını önermiştir. Diğer çalışmalar da okuma hızının okuma anlamanın kestiriminde çok önemli katkıda bulunduğunu göstermişlerdir (Hudson vd., 2005; Johnson & Kirby, 2006; Klauda & Guthrie, 2008; LaBerge & Samuels, 1974). Türkyılmaz vd. (2014) okuma hızını, iyi okuyucuların ayırt edici özelliklerinden biri olarak tanımlamakta ve hız eksikliğini zayıf okuyucuların bir özelliği olarak görmektedir. Ayrıca Stanovich (1991) okuma hızı eksikliğinin okuma anlama problemlerinin güvenilir bir kestiricisi olarak kabul etmektedir.

Test 3: Heceleme.

Rapp ve Lipka (2011), okuma ve hecelemenin nöral olarak incelendiği Fonksiyonel Manyetik Rezonans Görüntüleme (fMRI) çalışmasında, bu iki bilişsel fonksiyonun ortak elementlere sahip olduğunun kanıtını göstermiş ve hem okumanın hem de hecelemenin, beynin sol yarım küresinin belirli alt tabakasını paylaştığını açığa çıkarmışlardır. Bu sonuçlar Holmes ve Carruthers (1998)' ın bulguları ile ve katılımcılara içerisinde doğru şekilde heceleyemediği sözcükler bulunan kelime karar deneyi verildiğinde daha yavaş ve daha az doğru olduklarını gösteren Burt ve Tate (2002)'in çalışma sonuçları ile aynı doğrultudadır.

Heceleme ve okuma arasındaki ilişki, bu iki alanın aynı işlemleri paylaştığına ilişkin kesin bulgular sunan diğer bilişsel nöro-psikolojik araştırmalarla da raporlanmıştır (Caramazza vd., 1996; Rapp & Caramazza, 1989; Tainturier & Rapp, 2003). Lezyon eksikliği çalışmaları (Philipose vd., 2007; Rapcsak & Beeson, 2004) ve fonksiyonel beyin görüntüleme çalışmaları da (Menon & Desmond, 2001; Norton vd., 2007) okuma ve hecelemenin ortak bağlantısına ilişkin kanıt sunmuştur. Bu çalışmalarda heceleme becerisi göstergesi, katılımcıların duydukları kelimeleri yazmalarının istendiği heceleme üretim testleri (Beyersmann vd., 2014; Burt, 2006; Burt & Fury, 2000; Hasenäcker vd., 2015) ve katılımcıların doğru olmayan seçenekler arasında doğru şekilde hecelenmiş kelimeyi seçmelerinin istendiği heceleme tanıma testlerinden (Andrews & Hersch, 2010; Andrews & Lo, 2013; Sawi, 2016; Tan & Yap, 2016) elde edilmiştir. Şu anki batarya, alan yazında heceleme becerilerini ölçmek için kullanılan bu iki heceleme testini (heceleme üretim testi ve heceleme tanıma testi) kullanmıştır.

Test 4: Okuma Anlama.

Hangi faktörlerin iyi okuyucu olmada yardımcı olduğuna ilişkin cevapta Kintsch ve van Dijk (1978) okuma performansındaki farklılıkların hem mikro hem de makro seviyedeki faktörler tarafından belirlendiğini belirtmiştir. Mikro seviyedeki faktörler, metinsel elementlerin sözdizimi işlemlemesini kapsarken, makro faktörler de parçanın bir bütün olarak anlamını kavramasını içermektedir. Bir okuyucu ancak mikro seviyedeki bireysel kelimeleri ve cümleleri ayrıştırdıktan sonra daha bütüncül

çıkarım ve önermelere ulaşabilir. Daha az başarılı okuyucular ve başarılı okuyucular arasındaki okuma anlamadaki farklılıklar, bu makro seviyedeki doğru çıkarım yapmadaki başarıdan kaynaklanmaktadır (Palmer vd., 1985).

Alanyazında kullanılan testlere bakıldığında (Aaronson & Ferres, 1986; Alptekin & Erçetin, 2010; Alptekin vd., 2014; Baddeley vd., 1985; Burton & Daneman, 2007; Palmer vd., 1985) okuma anlama testlerini oluşturmada birçok test formatı bulunmaktadır. Ancak, şu anki bataryada kullanılan okuma anlama testleri iki önemli standartlaştırılmış dil yeterlilik testlerinden uyarlanmıştır: IELTS' de (Uluslararası İngilizce Dil Testi Sistemi) parçanın söylem yapısının tanınması, ana fikirlerin belirlenmesi, dikkatli okuma becerileri, çeşitli parça türlerinin okunmasında beceri ve daha uzun parçaları okuyabilme becerileri gerekirken, YDS'de (Yabancı Dil Sınavı) kelime, dilbilgisi, bağlamsal ipuçlarının tanınması ve dikkatli okuma becerilerinin ortak şekilde test edildiği cloze test tekniği de kullanmaktadır. Çalışmada kullanılan bataryanın okuma anlama alt testinde farklı test maddeleri olan iki farklı testin kullanımının sebebi, çoklu ölçüm testlerinin araştırmacıya okuma anlama becerisindeki bireysel farklılıklara ilişkin varyansın çoğunu açıklayabilmesinde sunduğu olanaktır.

Test 5: Gerçek Olmayan Kelimeleri Okuma.

Gerçek olmayan kelimeleri okuma becerisi, sesbilimsel yeniden kodlama olarak bilinen harf-ses ilişkileri bilgisini, yazılı olan kelimeleri sesletme becerisini kullanarak okuyabilme becerisidir. Sesbilimsel yeniden kodlama becerisine sahip olan öğrenciler, ketup, heruk gibi konvansiyonel heceleme örgülerine sahip, yapay olarak oluşturulan ve gerçek olmayan kelimeleri başarılı bir şekilde okuyabilirler. Birçok teorik okuma modeli, gerçek olmayan kelimeleri okumadaki doğrulukla ölçülen sesbilimsel yeniden kodlama becerisinin önemini vurgulamaktadır. Örneğin, çift yönlü okuma modeli, harflerin seslere yazıbirim-sesbirim mutabakatı aracılığı ile dönüştürüldüğü, sözcüksel-olmayan (nonlexical) yolun da var olduğunu belirtmektedir (Coltheart vd., 2001). Şimdiki bataryadaki gerçek olmayan kelimeleri heceleme testinin ilk 14 maddesi, tanısal gerçek olmayan kelimeleri tanıma testinden (DiRT) (Colenbrander vd., 2018) uyarlanmış ve son 6 maddesi ise araştırmacı tarafından daha zor maddelerin bataryaya eklenmesi amacıyla Wuggy yazılımı tarafından oluşturulmuştur. Bu testi başarıyla

tamamlamak için gerekli olan beceri, biçimsel-sesbirim harf örgülerini temelde yatan sesbilimsel simgelemelerine eşlemeyi gerektirmiştir.

Test 6: Dinleme Anlama.

Dinleme anlama, bireyin, yazılı parçayı yeniden kodlamayı gerektiren bilişsel gereklilikler olmadan duyduğunu anlamadaki becerisi olarak kavramsallaştırılabilir. Hogan vd. (2014), tarama çalışmalarında, dinleme anlamanın okuma anlamadaki baskın etkisine dair kanıt sunmuş ve bu sebeple okuma testlerinde dinleme testinin bulunması gerektiğini vurgulamıştır. Bu çalışmada kullanılan bataryadaki dinleme anlama alt testi, Woodcock-Johnson Başarı Testi Sözel Anlama Alt Testinde kullanılan formatı benimsemektedir; fakat test araştırmacı tarafından oluşturulmuştur. Testte katılımcılardan 17 adet konusu bakımından birbirinden ilişkisiz cümleleri dinlemeleri ve her bir cümlenin sonundaki eksik cümleyi yazarak belirtmeleri istenir.

Test VII: Kelime Bilgisi. Bir parçayı anlamak için okuyucunun parça içerisinde kullanılan kelimeleri anlaması gerekmektedir. Bu sebeple, birçok çalışma kelime bilgisi ve okuma anlama arasındaki önemli korelasyonu açığa çıkarmış (Anderson & Freebody, 1983a; Cameron, 2002; Read, 2000) ve kelime bilgisinin tüm okuma becerisinin önemli bir kestiricisi olduğunu göstermiştir (Braze vd., 2007; Hargrave vd., 2002) ve bir çok bilinmeyen kelime varlığının anlamayı engelleyeceğini belirtmiştir (Curtis 1987; Landi & Perfetti, 2007; Nation, 2001).

Heaton (1988) kelime testlerinin kelime oluşturma, kelime ilişkileri, eş anlamlar, zıt anlamlar, yeniden düzenleme, tanımlama ve tamamlama şeklinde olması gerektiğini önermiştir. Bu tür testler, katılımcıdan sadece şıklar arasında bir seçim yapması beklenen alıcı testlerin yerine daha üretken olan testlerdir. Şu anki bataryada kullanılan kelime alt testi de üretken olan test formunu kullanmış ve katılımcılardan belli bir bağlamda verilen kelimelerin eşanlamlısını, zıt anlamlısını ve daha derin bilgiyi gerektiren kelime ilişkilerini belirtmelerini istemiştir.

Test 7: İşlemsel Bellek Testi.

İşlemsel bellek testi, yaygın olarak kullanılan hafıza genişlik testidir ve bağlama-dayalı kelime öğrenimi (Daneman & Green, 1986), hipotez üretme (Dougherty & Hunter, 2003), hem dinleme hem de okuma anlama (Daneman & Merikle, 1996) ve bilişsel işlemleme araştırmalarında kullanılmaktadır. Bu testler, cümlelerin doğruluğunu yargılama gibi işlemleme öğesi ile ileriki hatırlamalar için bir seri kelime veya harfleri ezberleme gibi depolama öğesini birleştirmektedir. O yüzden bu testlerde, katılımcılardan genellikle tematik olarak birbirinden bağımsız cümleleri yüksek sesle okumaları, cümlelerin doğruluğunu yargılamaları ve her bir cümle kaybolduktan sonra gördükleri harfleri doğru sırada hatırlamaları beklenmektedir. Bu setlerdeki harf ve cümle sayıları ikiden altıya yükselmektedir. Şu anki bataryada kullanılan işlemsel bellek testi, Randall Engle'nin laboratuvarının sunduğu ve E-Prime yazılımında programlanmış olan testten oluşmuş (http://englelab.gatech.edu/tasks.html) ve anlambilimsel test yöntemini kullanmıştır.

Test 8: Gerçek Olmayan Kelimeleri Heceleme.

Gerçek olmayan kelimeleri heceleme alt testi, okuyucunun ses-harf mutabakat bilgisini ve sözcükaltı veya birleştirici ses-heceleme çevirimi sürecini kullanan (Leask & Hinchliffe, 2007; Martin & Barry, 2012) ve sesbirimsel farkındalığına bağlı olan sesbilimsel temelli veya üretici stratejilerini kullanma becerilerini ölçmektedir (Pogorzelski & Wheldall, 2005).

Heceleme ve ses bilimsel farkındalığının arasındaki ilişki, bireylerin kelimeleri, onları oluşturan sesbirimlere bölmeleri ve bunları harf dizileri ile temsil etmeleri gereken ses-harf çeviriminde gösterilmektedir (Oerlemans & Dodd, 1993). Neilson, (2003b) hecelemede gerçek kelimelerin yerine yeni üretilmiş kelimelerin kullanımının daha avantajlı olduğu vurgulanmıştır, çünkü bu şekilde bir birey, daha önceki öğrenilmiş harf sıralarını veya görsel stratejileri kullanamayacak, yalnızca sesbilimsel stratejileri kullanmak durumunda kalacaktır. Bu çalışmalarda, katılımcıların gerçek olmayan kelimeleri heceleme becerileri, tipik olarak hundup gibi yeni üretilmiş kelimeleri hecelemelerini gerektirmektedir.

Shankweiler, okumayı öğrenmek için, başlangıç okuyucularının "bütün kelimelerin sesbilimsel sekmelere ayrılabileceğine ilişkin farkındalık" a sahip olmaları gerektiğini belirtmektedir (1999, s. 114). Birçok çalışma, okumada kelimeleri seslerden oluştuğunu anlama becerisi olan sesbilimsel farkındalığın hayati önemini vurgulamıştır (Adams, 1990; Byrne & Fielding-Barnsley, 1990; Stanovich, 2000). Çarpıcı şekilde, Bishop (2001, s. 189) "dil öğrenme güçlüğü" nü, okuma güçlüğünün daha büyük çerçevedeki sesbilimsel dil bozukluğunun bir parçası olarak görmekte ve zayıf okuma becerisinin temelde dil-temelli bir problem, daha özelde ise sesbilimsel işlemleme problemi (Shankweiler, vd., 1996; Share, 1995; Torgesen & Wagner, 1998) olarak görmektedir. Şu anki bataryada kullanılan gerçek olmayan kelimeler ise Kohnen ve Nickels (2010) çalışmasından alınmıştır ve testte katılımcılardan duydukları gerçek olmayan kelimeleri cevap kağıdına yazmaları istenmiştir.

4.1.2. Okuma Becerileri Bataryası- Zihinsel Süreçlerin Tanımları

Tablo 1.
Okuma Becerileri Bataryasındaki Her Bir Alt Test Performansı için Gerekli Olan Zihinsel İşlemlerin Tanımları

TEST	ALT BECERİLER	ZİHİNSEL SÜREÇLER
Test I: Sözcük Tanıma	Yeniden kodlayarak okuma	Görsel sözcük formlarının tanınması ve bu görsel formlara ilişkili sesletimlere olan sesbilimsel erişim
Test II: Okuma Hızı	Hızlı okuma Anlamsal işlemleme hızı	Okuma becerisi ve jenerik bilgi gerektiren otomatik anlamsal karar verme
Test III: Heceleme	Heceleme becerisi	Bütün-sözcük sesdizimini bütün-sözcük ortografiye eşleyerek, sesdizimsel parçaları yazıbirim ünitelerine çevirerek veya anlamsal kelime haznesinden kelimelerin heceleme formlarını aktifleştirerek kelime formlarının ortografi bilgisine erişim ve bu bilgiyi kullanma
Test IV: Okuma Anlama	Okuma anlama	Önermesel simgelemeler oluşturma; yazılı kelimelerin ve cümlelerin sözdizimsel ve anlambilimsel özelliklerinin tüm parçaya entegrasyonu
Test V: Gerçek olmayan Kelimeleri Okuma	Yeniden kodlayarak okuma Sesbilgisel kodlama	Yazıbirimi-sesbirime çeviri ve zihinsel sözlükte var olmayan görsel kelime formlarının sesletimlerine ulaşma
Test VI: Dinleme anlama	Dinleme becerisi İşlemsel Bellek	Sözel olarak belirtilen parçaların sözdizimsel ve anlambilimsel entegresyonu aracılığı ile önermesel simgelemeler oluşturma
Test VII: Kelime Bilgisi	Sözcük bilgisi Okuma anlama	Sözcüksel aktivasyon ve anlamsal erişim; anlamsal eşleştirme
Test VIII: İşlemsel Bellek Testi	Yeniden kodlayarak okuma İşlemsel Bellek	İşlemsel belleğin okumadaki, depolama ve işlemleme elementleri
Test IX: Gerçek olmayan Kelimeleri Heceleme	Heceleme becerisi Sesbilgisel kodlama	Sesbirimi-yazıbirime çeviri Var olmayan kelimelerin sözel elementlerini yazıbirim ünitelerine çevirme; ortografinin sesbilim yardımıyla eşlenmesi

5. Deney 1: D2 İngilizce'de Maskelendirilmiş Hazırlama

5.1. Katılımcılar

Deney 1, hazırlama etkilerini D2 İngilizce konuşucularında araştırılmasına odaklanmıştır. Anadili Türkçe, yabancı dili ise İngilizce olan ve Orta Doğu Teknik Üniversitesi İngiliz Dili Eğitimi bölümünde okuyan 29 konuşucu (22 kadın, yaş ortalaması=26.14, Standart Sapma=3.16, min=20, max=32) deneye katılmıştır.

5.2. Materyaller

58 adet İngilizce kelime seti hedef sözcük olarak kullanılmıştır. Hedef sözcükler, türetilmiş kelimelerin tek biçimbirimli kökleridir (Örn: WATCH [İZLEMEK]). Her bir hedef sözcük, altı adet hazırlayıcının ardından gösterilmiştir:

(i) biçimbilimsel hazırlayıcı (watchable [izlenebilir]),
(ii) biçimbirim sınırında HYD hazırlayıcı (wathcable [izelnebilir])
(iii) biçimbirim sınırında ikame-harf koşulundaki hazırlayıcı (watksable [izatnebilir])
(iv) biçimbirim sınırı dışında HYD hazırlayıcı (watcahble [izlneebilir]),
(v) biçimbirim sınırı dışında ikame-harfler ile yerine koyma (watcekble [izlmuebilir]),
(vi) İlişkisiz hazırlayıcı (drinkable, [içilebilir]).

İlişkili ve ilişkisiz hazırlayıcı kelimeler, kök uzunluğu, kök sıklığı, kök biyagram sıklığı, kök ortografik komşu sayısı, kelime uzunluğu, sıklığı, biyagram sıklığı ve uyarıcı kelimedeki bir harfin değiştirilerek oluşabilecek gerçek kelime sayısı olarak tanımlanan ortografik komşu sayısı (Örn: horse kelimesinin ortografik komşu sayısı: house ve worse olmak üzere 2 tanedir) bakımından eşlenmiştir. Bu değerlerin alınmasında ve eşitleme çalışması için internetten ücretsiz olarak temin edilebilen N-Watch yazılımı kullanılmıştır. Ekin olası etkisini kontrol altına almak için, her ilişkili kelime hazırlayıcısı için seçilen ilişkisiz hazırlayıcı aynı eki kullanmıştır (Örn: watchable [izlenebilir]; drinkable, [içilebilir]). Harflerin yerini değiştirmeler

her zaman bir sesli ve bir sessiz kelimeyi içermiştir (Lupker vd., 2008) ve bu değiştirmelerin hiçbiri gerçek bir kelimenin oluşumuna sebep olmamıştır (Duñabeitia vd., 2009). Dahası, ikame-harfler kontrol koşulu iki yeri değiştirilen harfin yerine aynı uzunluğa ve benzerliğe sahip yeni iki harfler konarak oluşturulmuştur (Örn: watksable [izatnebilir]). HYD harfleri ve ikame harfler de uzunluk, biyagram sıklığı ve ortografik koşulu sayısı bakımından eşitlenmiştir.

Kelime karar deneyi için, 42 filler ve 100 ortografik olarak yasal ve sesletilebilir gerçek olmayan kelimeler kullanılmıştır. Bu gerçek olmayan kelimeler, gerçek bir kelimenin ilk ve son harfi değiştirilerek oluşturulmuştur. (Örn: frinp, bring; [jetirmef, getirmek]). Her bir gerçek olmayan kelime, ilişkisiz bir kelimeden sonra gelmekte ve tüm gerçek olmayan kelimeler, hedef kelimeler ile uzunluk, pozisyon-belirli biyagram sıklığı, pozisyon-belirli triyagram sıklığı ve ortografik komşu sayısı ile eşitlenmiştir. Eşitleme için N-Watch programı kullanılmıştır. Her bir hedef sözcüğün her bir listede farklı hazırlayıcı koşulunda yalnızca bir kere ve Latin kare yöntemiyle farklı sırada görünmesi için toplam 12 liste oluşturulmuştur. Katılımcılar her bir listeye rastgele atanmıştır.

Bireysel farklılıkları çeşitli alanlarda ölçmeyi amaçlayan Okuma Becerileri bataryası 9 alt testten oluşmuştur: Kelime Tanıma Testi, Okuma Hızı Testi, Heceleme Testi, Okuma Anlama Testi, Gerçek Olmayan Kelimeleri Okuma Testi, İşlemsel Bellek Testi, Dinleme Anlama Testi, Kelime Bilgisi Testi ve Gerçek Olmayan Kelimeleri Heceleme Testi.

5.3. Uygulama

Uyarıcılar, DELL marka bilgisayar ekranının merkezinde ücretli E-prime yazılımı kullanılarak rastgele sırada gösterilmiştir. Her bir katılımcı, sessiz bir odada bireysel olarak test edilmiştir. İleri maskelendirilmiş hazırlama yöntemi kullanılarak her denemede, önce # sembolü 500 milisaniye (ms) gösterilmiştir, ardından küçük harfler ile yazılmış hazırlayıcı ekranda 50 ms kaldıktan sonra hemen ardından büyük harfler ile yazılmış hedef uyarıcı gösterilmiştir. Hedef uyarıcı, katılımcılar bir cevap verene kadar veya maksimum 3000 ms boyunca ekranda kalmıştır. Katılımcılardan

olabildiğince hızlı ve doğru bir şekilde ekranda gördükleri kelimelerin gerçek İngilizce kelimeler mi yoksa gerçek olmayan kelimeler mi olduğuna ilişkin karar vermeleri istenmiştir. Tüm kelime karar deneyi yaklaşık olarak 8 dakika sürmüştür.

Karar deneylerinin yanısıra bireysel farklılıklar bataryası kullanılmıştır. Bataryada bulunan tüm alt testler, İşlemsel Bellek, Kelime Tanıma ve Gerçek Olmayan Kelimeleri Okuma alt testleri dışında kalem kağıt testinden oluşmaktadır; İşlemsel Bellek testi E-prime yazılımı aracılığıyla, Kelime Tanıma testi DELL marka bilgisayar üzerinde MS PowerPoint üzerinde ve Gerçek Olmayan Kelimeleri Okuma alt testi ise sunu programı üzerinde ses kaydı ile uygulanmıştır. Her bir katılımcı sessiz bir odada bireysel şekilde test edilmiş ve toplam uygulama saati testi alan katılımcının kişiliğine, moduna ve uygulayıcıyla ilişkisine bağlı olarak toplam 1 saat ve 25 dakika sürmüştür. Yorgunluk ve sıra etkisini kontrol altına almak için batarya, sıralı bir düzen takip edilerek ya kelime karar deneyinden önce ya da sonra 10 dakikalık ara sonrasında verilmiştir.

6. Deney II: D1 İngilizce'de Maskelendirilmiş Hazırlama

6.1. Katılımcılar

Anadili İngilizce olan ve Sidney, Australya'da Macquarie Üniversitesi'nde okuyan 50 konuşucu (14 erkek, yaş ortalaması=20.73, Standart Sapma=5.99, min=17, max=53) deney II'ye katılmıştır.

6.2. Materyaller

Deney I' de kullanılan uyaranlar deney II' de de kullanılmıştır. Ancak, sahte ek oldukları tespit edilen dört hedef sözcük veri toplama öncesinde listeden çıkarılmıştır. Kelime karar deneyi için 54 adet hedef sözcük 54 adet ortografik açıdan düzgün ve sesletilebilir gerçek olmayan sözcüklerle karıştırılmıştır. Gerçek olmayan sözcükler deney I' deki yöntem kullanılarak oluşturulmuştur. Bireysel farklılıklar testlerini, Kelime Bilgisi, Heceleme, Sözcük tanıma ve Gerçek olmayan kelimeleri okuma becerileri testleri oluşturmuştur.

6.3. Uygulama

Uyarıcılar, DMDX yazılımı kullanılarak rastgele sırada gösterilmiştir. Her bir katılımcı, sessiz bir odada bireysel olarak test edilmiştir. İleri maskelendirilmiş hazırlama yöntemi kullanılarak her denemede önce # sembolü 500 milisaniye (ms) gösterilmiştir, ardından küçük harfler ile yazılmış hazırlayıcı ekranda 50 ms kaldıktan sonra hemen ardından büyük harfler ile yazılmış hedef uyarıcı gösterilmiştir. Hedef uyarıcı, katılımcılar bir cevap verene kadar veya maksimum 3000 ms boyunca ekranda kalmıştır. Karar deneyi yaklaşık 8 dakika sürmüştür.

7. Genel Sonuçlar

Katılımcı cevap hızları üzerinde uygulanan genelleştirilmiş doğrusal karışık-etkili model analiz sonuçlarına göre, D1 ve D2 İngilizce'de biçimbilimsel açıdan karmaşık kelime formlarının tanınmasında kısa süreli sunulan biçimbilimsel açıdan ilişkili kelimenin (braveness- BRAVE) kelime tanımlama sürecini kolaylaştırdığı ve bu formların biçimbilimsel yapısı doğrultusunda ([brave]+[-ness]) ayrıştırıldığı gözlemlenmiştir. Önceki çalışmalar doğrultusunda, ortalama cevap süreleri sonuçları biçimbilimsel ayrıştırmanın zorunlu bir işlem olduğunu göstermiştir (Rastle vd., 2000; Taft vd., 2018). Bu bulgu, alanyazında var olan sonuçları pekiştirmekte ve erken biçimbilimsel ayrıştırmanın hazırlayıcının biçimbilimsel yapısı tarafından tetiklendiğini göstermektedir (Beyersmann vd., 2015; Feldman, vd., 2009; Rastle vd., 2004).

D1 ve D2 İngilizce gruplarında, HYD hazırlama etkilerinde farklılıklar gözlenmiştir. D1'de biçimbirim sınırında HYD koşulunun harflerin yeri değiştirilerek hazırlama koşulunun ikame harf koşulundan istatiksel olarak daha hızlı cevaplandığı bulunmuştur. Biçimbirim sınırı dışında ise HYD hazırlayıcı etkileri kaybolmuştur. Bu sonuçlar, HYD etkilerinin biçimbirim değişikliklerinin gerçekleştiği pozisyona göre değişikliğe uğradığını belirten Christianson vd. (2005), Duñabeitia vd. (2007) ve Perea ve Carreiras (2008) bulguları ile aynı yöndedir. HYD hazırlama etkilerinin biçimbirim sınırı dışında kaybolması, biçimbilimsel açıdan karmaşık olan sözcüklerin biçim-ortografik alt birimlerine otomatik olarak ayrıştırıldığını ve hemen ardından bütün-sözcük simgelemesinin etkinleştirildiğini iddia eden sözcük-öncesi teorisini desteklemektedir.

Sonuçlar ayrıca, ortografinin ve biçimbilimin aynı süreçlerden geçtiğini göstermekte (Duñabeitia vd., 2007) ve Beyersmann ve Grainger'ın (2021) çift yönlü Kelime ve Ek Modeli'ni desteklemektedir.

D1 İngilizce konuşucularında rapor edilen HYD etkileri, D2 İngilizce konuşucularında bulunmamıştır. Bu sonuçlar olası iki sebepten kaynaklanmaktadır. İlk olarak, HYD hazırlama etkileri bu zamana kadar yalnızca D1'den elde edildiği için bu etkilerin D2'de nasıl sonuçlar verdiğine ilişkin önceki araştırmalar mevcut değildir. Bu sebeple, bu çalışmanın sonuçları diğer D2 konuşucuları kullanarak yeniden değerlendirilmedir. İkinci olarak, D1 konuşucularında rapor edilen bulguların çoğu İngilizce ve İspanyolca gibi Hint-Avrupa dil ailesine mensup dillerden elde edilmiştir. Mevcut çalışmada ise tüm katılımcılar anadilleri Türkçe olan D2 konuşucularıdır. Türkçe tipolojik olarak farklı, Hint-Avrupa dil ailesine ait olmayan ve çekimli morfolojiye sahip bir dildir. Çalışmanın başında belirtildiği gibi, D2'deki sözcük erişimi diller arası sözcük temsillerinin aktive edilmesini gerektirmektedir (Schwartz & Kroll, 2006) ve D1-D2 arasındaki farklılıklar D2 konuşucularında ortografik kodlamada farklılıklara sebep olabilmektedir (Lin vd., 2005) ve bu farklılıklar HYD hazırlama etkilerinin bulunamamasının bir göstergesi olabilir. Ek olarak, HYD hazırlayıcı etkilerinin eksikliği, biçimbilimsel hazırlayıcı etkilerinin varlığı ile birlikte değerlendirildiğinde, D2'de biçimbilimsel ayrıştırmanın harf kodlamaya karşı hassas olduğu ve daha fazla pozisyonel kesinlik gerektirdiğini göstermektedir.

Diller arası analiz sonuçlarına göre, D1 ve D2 İngilizce' deki türetilmiş kelime formları için benzer biçimbilimsel hazırlayıcı etkileri bulunmuştur. Bu kanıt, Diependaele vd.'nin (2011) bulguları ile tutarlıdır ve D1 ve D2 biçimbilimsel işlemlemenin benzer mekanizmalar tarafından yönetildiğini göstermektedir. Ayrıca, bu bulgu dilden bağımsız ortografik ve sesbilimsel kodlama mekanizmalarını gösteren çalışmalarla benzerdir ve erken sözcük tanıma sürecindeki seçkisiz otomatik dil aktivasyonu göstermektedir (Van Heuven vd., 2008; Dimitropoulou vd., 2011).

Son olarak, çalışma bulguları işlemleme farklılıklarının D1 konuşucularındaki okuma becerileri ile ilişkili olabileceğini gösteren çalışmalarla tutarlılık göstermektedir (Andrews & Lo, 2013; Ashby vd., 2005; Beyersmann vd., 2016; Yap vd., 2009). Bu

çalışma, bu bulguları D2 konuşucularına genişletmiş ve D2 okuma becerilerindeki bireysel farklılıkların biçimbirim sınırları içinde HYD hazırlama etkilerini belirleyebileceğini önermiştir (Andrews & Lo, 2013; Beyersmann vd., vd., 2015, Duñabeitia vd., 2014). D1 İngilizce'de biçimbilimsel hazırlama etkileri tüm okuma becerileri spektrumunda sabit olmasına rağmen, kelime ve heceleme bilgisi daha yüksek olan D1 konuşucularında bu etki giderek artmıştır. Bu bulgu, bütüncül sözcük işlemleme ve biçimbilimsel işlemlemenin aynı anda farklı yollar olarak kullanıldığını gösteren teorileri desteklemektedir (Beyersmann vd., 2013; Schreuder & Baayen, 1995). Bu fark ayrıca, kelimelerin yüksek kaliteli sözcük simgelemeleri, başarılı okuma anlamada çok önemli bir önkoşulu olduğunu ve başarılı ve zayıf okuyucular arasındaki farklılıkların bu simgelemelerdeki farklılıktan kaynaklandığını belirten sözcüksel nitelik hipotezini desteklemektedir (Perfetti, 1992, 2007). D2 konuşucularında gerçek olmayan sözcükleri okuma ve heceleme becerileri, biçimbirim sınırları içinde HYD hazırlayıcı etkileri değiştirebileceği bulunmuştur. HYD etkileri yalnızca gerçek olmayan kelimeleri okuma ve hecelemede düşük yeterliğe sahip konuşucularda gözlemlenmiştir. Yüksek yeterlikteki katılımcılar daha kesin harf kodlama yeterliğine de sahip olabileceği için bu grupların kullandığı ortografik temelli ayrıştırma mekanizmaları harf değişikliklerine daha hassas olabileceği bulunmuştur.

Sonuç olarak, mevcut çalışma sonuçları, D1 ve D2 dil işlemlemede biçimbilimsel açıdan karmaşık sözcüklerin erken dönemde eklere ve köklere bölündüğünü göstermiştir. Yalnızca D1'de biçimbirim sınırında HYD hazırlayıcı etkileri bulunmuştur. Sonuçlar, biçimbilimsel ayrıştırma ve harf pozisyon kodlamanın zamanlamasına ilişkin bulgular da sunmaktadır. Bu çalışma D1'de harf pozisyon kodlama sürecinin manipülasyonların gerçekleştiği bağlama tabi olduğunu göstermektedir. D2 konuşuculardaki HYD hazırlama etkileri yokluğu harf pozisyonu tayini ve biçimbilimsel ayrıştırmanın bu grup için aynı anda gerekiyor olabileceğini göstermektedir (Taft vd., 2018). Bu sonuçlar hem D1 hem de D2 görsel sözcük tanıma modellerinin bu farklılıkları ve okuma becerilerindeki bireysel farklılıklarının rolünü açıklayabilmesi gerektiğini göstermektedir.

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