THE EFFECTS OF CROSS-MORPHEMIC LETTER TRANSPOSITIONS ON MORPHOLOGICAL PROCESSING IN TURKISH: A PSYCHOLINGUISTIC INVESTIGATION

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OZAN CAN ÇAĞLAR

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Prof. Dr. Yaşar Kondakçı
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Arts.

Prof. Dr. Çiğdem Sağın Şimşek
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Arts.

Assoc. Prof. Dr. Bilal Kırkıcı
Supervisor

Examining Committee Members

Prof. Dr. Martina Gračanin Yüksek (METU, FLE)
Assoc. Prof. Dr. Bilal Kırkıcı (METU, FLE)
Asst. Prof. Dr. Gülin Dağdeviren Kırmızı (Başkent Uni., ELT)

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name : Ozan Can Çağlar

Signature :

ABSTRACT

THE EFFECTS OF CROSS-MORPHEMIC LETTER TRANSPOSITIONS ON MORPHOLOGICAL PROCESSING IN TURKISH: A PSYCHOLINGUISTIC INVESTIGATION

Çağlar, Ozan Can

M.A., English Language Teaching

Supervisor : Assoc. Prof. Dr. Bilal Kırkıcı

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This study investigates whether Turkish native speakers have access to semantic information in the course of morphological decomposition at the early stages of visual word recognition. Two masked priming experiments were conducted to test the effects of semantic transparency on the recognition of target words. The main prime conditions of the study were the following: (a) semantically transparent (e.g., çizim-ÇİZ, Eng. *drawing-DRAW*), (b) semantically opaque (e.g., tuzak-TUZ; Eng. *trap-SALT)*, and (c) form overlap (e.g., kasap-KAS; Eng. *butcher-MUSCLE*). Transparent pairs were both semantically and morphologically related whereas opaque pairs shared no semantic but a pseudo-morphological relation. Form overlap pairs displayed overlapping orthographic features only. The letter order/identity of the primes were also manipulated at the morpheme boundary for each condition (e.g., transposed-letter primes: çiizm-ÇİZ, replaced-letter primes: çiurm-ÇİZ) to see how cross-morphemic transpositions would inform the debates on the role of semantic information in the early processing. The results showed significant priming effects of both semantically transparent and opaque forms. However, it turned out that opaque forms revealed no priming effect when they included letter transpositions at the morpheme boundary. The significant priming effects obtained from transparent forms, on the other hand, were not decreased by cross-morphemic transpositions as dramatically as that obtained from opaque forms. The findings contest the form-first account which supports the view that the early processing of morphologically complex forms is blind to semantic information. The observed priming effect patterns were consistent with the predictions of dual-route models of morphological processing, which assume parallel activation of morpho-orthographic and morpho-semantic information.

Keywords: morphological processing, semantics, letter transpositions, Turkish, masked priming

ÖZ

TÜRKÇE SÖZCÜKLERDE BİÇİMBİRİM SINIRINDAKİ HARF YER DEĞİŞİKLİKLERİNİN BİÇİMBİLİMSEL İŞLEMLEMEYE ETKİSİ: RUHDİLBİLİMSEL BİR İNCELEME

Çağlar, Ozan Can

Yüksek Lisans, İngiliz Dili Öğretimi

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Mevcut çalışma Türkçe anadil konuşucularının, görsel sözcük tanımanın ilk aşamalarında, biçimbilimsel ayrıştırma esnasında anlamsal bilgiye ulaşıp ulaşamadıklarını incelemiştir. Anlamsal geçirimliliğin hedef sözcüklerin tanınması üzerindeki etkilerini test etmek amacıyla iki maskelenmiş hazırlama deneyi uygulanmıştır. Çalışmanın temel hazırlayıcı sözcük koşulları şu şekildedir: (a) anlamsal olarak geçirimli (Örn. çizim-ÇİZ), (b) anlamsal olarak geçirimsiz (Örn. tuzak-TUZ) ve (c) yalnızca yazımsal örtüşme gösteren (Örn. kasap-KAS). Geçirimli hazırlayıcı-hedef sözcük çiftleri hem anlamsal hem de biçimbilimsel olarak ilintili iken geçirimsiz hazırlayıcı sözcük grubu, ilgili hedef sözcüklerle anlamsal olarak bağıntlı olmayan, yalnızca sahte bir biçimbilimsel ilişki ortaya koyan sözcüklerden oluşmuştur. Örtüşük yazımlı sözcük çiftleri ise yalnızca yazımsal özellikler açısından bir bağıntı ortaya koymaktadır. Buna ek olarak, biçimbirim sınırında gerçekleştirilen harf yer değişikliklerinin anlamsal bilginin erken işlemleme esnasındaki rolü üzerine olan tartışmalara katkısını görmek adına, her bir deneysel durum için, hazırlayıcı sözcüklerin biçimbirim sınırlarında harf sırası ve harf kimliği değişikliği eyletimleri uygulanmıştır (Örn. harf yer değişikliğine uğramış hazırlayıcı sözcükler: çiizm-ÇİZ, harf kimliği değişimine uğramış hazırlayıcı sözcükler: çiurm-ÇİZ). Sonuç olarak, hem geçirimli hem de geçirimsiz hazırlayıcı sözcüklerin istatistiksel olarak anlamlı hazırlama etkileri ortaya koydukları saptanmıştır. Fakat, biçimbirim sınırında uygulanan harf yer değişikliği sonucunda, geçirimsiz yapılarda elde edilden anlamlı hazırlama etkisinin kaybolduğu gözlemlenmiştir. Diğer yandan, geçirimli yapılarda gözlemlenen hazırlama etkisinin, biçimbirim sınırlarındaki harf yer değişikliklerinden geçirimsiz yapılardaki kadar ciddi şekilde etkilenmediği görülmüştür. Bulgular, anlamsal bilginin biçimbilimsel olarak karmaşık yapılardaki sözcüklerin erken işlemlenmesi sürecine dahil olmadığını savunan önce-biçim görüşüyle çelişmektedir. Gözlemlenen hazırlama etkisi örüntüleri, biçim-anlambilimsel ve biçim-yazımsal bilgilerin erken işlemleme sürecinde eş zamanlı etkinleştiğini ileri süren ikil-yollu işlemleme modellerinin öngörüleriyle örtüşmektedir.

Anahtar Kelimeler: biçimbilimsel işlemleme, anlambilim, harf yer değişiklikleri, Türkçe, maskelenmiş hazırlama

To Every Character Uniquely Contributing to the Plot of my Story

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
CC	Consonant-Consonant
DRC	Dual-route Cascaded Model
e.g.	Exempli Gratia
IA	Interactive Activation Model
i.e.	Id Est
ms	Millisecond
RL	Replaced-letter
RT	Reaction Time
SD	Standard Deviation
SERIOL	Sequential Encoding Regulated by Inputs to Oscillations Within Letter Units
SOA	Stimulus Onset Asynchrony
SOLAR	Self-organising Lexical Acquisition and Recognition Model
TL	Transposed-letter
TNC	Turkish National Corpus
VC	Vowel-Consonant
viz.	Videlicet
vs.	Versus

CHAPTER 1

INTRODUCTION

1.1. Background to the Study

1.1.1. The Role of Semantics at Early Stages of Complex Word Processing

One of the most significant functions of language is to communicate our ideas to interlocutors so that we can maintain social interactions. To achieve this, we productively combine certain linguistic units (e.g., combining letters to form words and words to form sentences) to generate meaningful utterances such that it is even possible to come up with completely original configurations, which seems to be a unique property of human communication system (Hockett, 1960). It is therefore essential to understand the nature of the process of forming and comprehending complex linguistic units to be able to have an insight into how language is processed in the human brain. As part of this grand endeavor, psycholinguistic research has been focusing on how morphologically complex words such as *enjoyed* are analyzed in the human brain. Some studies have argued for the view that all forms are listed in the mental lexicon as unanalyzed units and that the only way to retrieve these forms from the mental lexicon is through accessing their whole-word representations (e.g., Butterworth, 1983; Bybee, 1995; Manelis & Tharp, 1977; Rumelhart & McClelland, 1986). Against this *full listing* view, researchers now tend to favor the idea that the visual word recognition system evaluates complex structures as decomposable units (Beyersmann, Castles, & Coltheart, 2011; Diependaele, Sandra, & Grainger, 2005; Diependaele, Duñabeitia, Morris, & Keuleers, 2011; Feldman, Kostić, Gvozdenović, O'Connor, & Moscoso del Prado Martín, 2012; Longtin & Meunier, 2005; Rastle, Davis, & New, 2004 among others). More precisely, complex words are assumed to be parsed into their constituent morphemes and accessed through these individual constituents (e.g., enjoyed: *enjoy* + *-ed*). Empirical support for the latter view has mostly come from studies that have made use of the visual masked priming paradigm.

The basic procedure of the masked priming paradigm involves the display of a prime word for a very short time (e.g., 50 ms) before a target word. Primes tend to be unavailable for conscious perception within that brief time period. The masking of the primes is usually carried out via presenting a series of non-alphanumeric characters (e.g., hashtags: #####) immediately before the onset of prime display. The time period between the onset of the prime and the onset of the target display is called the stimulus-onset asynchrony (SOA). Most of the time, the SOA corresponds to the exact time that the prime remained on the screen; however, it is also common that studies use backward masks (i.e., masks presented between the primes and the targets), which increases the overall SOA (e.g., Christianson, Johnson, & Rayner, 2005; Diependaele, Sandra, & Grainger, 2009). Being exposed to the unconsciously perceived primes, the participants are then expected to decide whether the presented target word is an existing word in the language that is tested in the experiment by pushing some buttons predetermined by the experimenter. The response latencies of the participants are measured for each trial and it is investigated whether the prime words speed up the recognition of the targets (for more elaborate description, see Forster, Mohan, & Hector, 2003). The prime-target relatedness is often manipulated in order to see whether different kinds of primes will show different effects on the participants' reaction times.

Through presenting morphologically related and completely unrelated prime words very briefly before the corresponding target words, it has been reported that the prime-target pairs that shared a morphological relation (e.g., teacher-TEACH) revealed significantly shorter reaction times compared to unrelated prime-target pairs (e.g., sheep-TEACH), indicating that the presence of morphological relatedness speeds up the recognition of a certain target word (e.g., Diependaele, Morris, Serota, Bertrand, & Grainger, 2013; Rastle et al., 2004). This was taken as evidence for the pre-activation of the core stem (TEACH) via the prime display (teacher), which is possible if the complex form is parsed into its constituent units prior to performing the lexical decision (Rastle et al., 2004). That is, through decomposing the complex word *teacher*, the reader has access to the core stem *teach* and activate it, which in turn causes the faster recognition of the target *TEACH*.

Although consensus seems to have been reached on the view that complex words undergo some process of segmentation, the accounts on how exactly this segmentation takes place manifest a discrepancy. The form-first (or form-then-meaning) account suggests that readers rely solely on the form-based analysis in the course of parsing a morphologically complex word at the early stages of processing. It is therefore assumed that although the meaning of a form is a significant element of word processing, the word recognition system performs a semantically blind analysis at first and semantic information becomes available only after the form analysis is completed (e.g., Heyer & Kornishova, 2018; Longtin, Segui, & Hallé, 2003; Rastle, Davis, Marslen-Wilson, & Tyler, 2000). More interestingly, the system is so ignorant to the semantic information that even the mere existence of morphological complexity is sufficient for segmentation according to the form-then-meaning account. That is, when readers encounter a seemingly complex word such as *corner*, it is automatically parsed into the stem *corn* and the pseudo-suffix *-er*. Evidence for this claim comes from masked priming studies manipulating the semantic transparency of primes. Several studies found that both semantically transparent (i.e., primes displaying a true morphological and semantic relationship with the target, *walker-WALK*) and semantically opaque primes (i.e., primes displaying a pseudo-morphological but no semantic relationship with the target, *number-NUMB*) significantly facilitated the recognition of their targets and most importantly the facilitatory effects of both prime types were statistically indistinguishable (e.g., Beyersmann, Ziegler, Castles, Coltheart, Kezilas, & Grainger, 2016; Davis & Rastle, 2010; Kazanina, Dukova-Zheleva, Geber, Kharlamov, & Tonciulescu, 2008; Marslen-Wilson, Bozic, & Randall, 2008; Rastle et al., 2004; Rastle & Davis, 2008).

Based on this finding, researchers have argued for the absence of a semantics-based analysis during the early processing since the presence of semantic as well as morphological relatedness failed to lead transparent items to get ahead of opaque items in terms of the magnitude of the prime effect they produced. The studies further made use of a control condition (a form overlap condition), in which the primes and the targets were only orthographically related, to be able to make sure that the facilitation obtained from transparent and opaque primes is not the outcome of orthographic overlap. It was repeatedly shown that form overlap primes failed to reveal any facilitation. Thus, the observed effects were attributed to the shared morphological relationships between primes and targets only. Moreover, even though the form-then-meaning account supports the idea of semantically blind, fast and automatic morpho-orthographic segmentation at the early stages of processing, it is also suggested that semantics comes into play as well, though at a later stage of processing. Accordingly, a number of studies have reported significant effects of semantic transparency with longer SOAs (e.g., 100 ms) since, as proposed, the readers were then exposed to primes long enough to retrieve morpho-semantic information (e.g., Feldman & Soltano, 1999; Rastle et al., 2000).

In sharp contrast to the form-then-meaning account, the form-with-meaning account indicates that semantic information is also available at the early stages of visual word recognition. The studies supporting this claim have shown that the priming effects obtained from transparent items were in fact significantly greater than those of opaque items (e.g., Diependaele et al., 2009; Diependaele et al., 2011; Diependaele et al., 2013; Feldman, O'Connor, & Moscoso del Prado Martín, 2009; Feldman et al., 2012). More precisely, opaque items were either found to show no effect or the magnitude of priming from opaque items was reduced compared to transparent items. Thus, these studies contest the claim that the early processing of morphologically complex forms is semantically blind. Instead, researchers argued for the involvement of morpho-semantic information in the process as early as morpho-orthographic segmentation. On the basis of the findings supporting the availability of semantic information, researchers created models to account for the observed priming effect patterns. The hybrid model proposed by Diependaele, Sandra, & Grainger (2009), for instance, indicates that complex forms undergo two separate processes (i.e., morpho-orthographic and morpho-semantic) simultaneously. That is, both the constituents and the whole-word representation of a complex form become active upon encountering the complex form visually. The reason why no or a smaller amount of priming was obtained from opaque items was attributed to the fact that these pseudo-complex forms receive activation from their constituent morphemes only (i.e., morpho-orthographic channel) unlike the transparent items, which receive activation from both morpho-orthographic and morpho-semantic channels. Considering the claim that morphemes are the most basic units that denote meaning (Raveh & Rueckl, 2000), resolving the discrepancy in the role of semantics at the early stages of processing would potentially reveal significant information about the nature of the processing of complex forms.

1.1.2. Letter Encoding and the Transposed-letter Priming Effect

Although letters mostly do not bear any meaning on their own, they are also a significant component of the language we build in our brain. Following the argument that readers of an alphabetical language process words through their individual letters (Duñabeitia, Perea, & Carreiras, 2009), we need information about the exact positions of the letters in a word in order to be able to distinguish between anagrams such as *expect* and *except* since they comprise exactly the same letters. Slot-coding models of letter encoding (e.g., Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; McClelland & Rumelhart, 1981), for example, assumes that the positions of letters in a word are coded in a position-specific manner. Accordingly, the letter *p* in the word *expect* and the letter *p* in the word *except* are assumed to be entirely different letters although they are orthographically identical (the former is P_3 and the latter is P_5). Slot-coding models, therefore, successfully differentiate between such anagrams; however, they fail to account for a very well-known phenomenon called the transposed-letter (confusability) effect (i.e., TL effect). In the visual word recognition literature, the transposed-letter effect refers to situations where readers confuse non-words created by transposing two letters of an existing word with their original forms (e.g., *jugde*-*judge*) (e.g., Andrews, 1996; Perea & Lupker, 2003a). That is, readers cannot detect the letter position disruption in the non-word *jugde* and analyze it as *judge*. Interestingly, when presented as primes, transposed-letter non-words significantly facilitate the recognition of their base forms. This significant facilitation was found to be greater than the facilitation obtained from non-word primes created by replacing the two transposed-letters with entirely different letter pairs (i.e., replaced-letter or substituted-letter primes: *jupbe-judge*) in masked priming experiments (e.g., Perea & Lupker, 2003a; 2003b; Perea & Lupker, 2004; Schoonbaert & Grainger, 2004). The difference between the facilitatory effects of TL non-words and RL non-words cannot be captured by slot-coding models since *jugde* and *jupbe* are equally similar to their base form *judge* according to these models. To be more precise, *jugde* and *jupbe* differ from the base form *judge* with two letters at exactly the same position.

The open bigram (Grainger & van Heuven, 2003; Whitney, 2001; 2008) and the SOLAR (Davis, 1999; 2010b) models, however, successfully account for the presence of a TL effect. The former shows that TL non-words share more overlapping bigrams with their base forms compared to the RL non-words. To demonstrate, there seem to be nine shared bigrams between *jugde* and *judge* (i.e., *JU, UD, GE, JD, JG, JE, UG, UE, DE*), but it appears that the shared bigrams between *jupbe* and *judge* are only three in number (i.e., *JU, JE, UE*). Therefore, it can be concluded that TL non-words are in fact more similar to the base forms and this results in the confusability and the facilitatory effects of TL non-words but not RL non-words. The SOLAR model can also explain the TL effect since it postulates that letters are coded in a position-independent way. Accordingly, the TL non-words are thought to be more similar to the base forms in terms of their orthographies as they share the same letters. The existence of the TL effect has been well documented and widely accepted; however, it has also been shown that this effect has some limits and does not manifest itself all the time. For instance, it was found that the facilitatory effects of TL non-word primes disappeared when the transposed-letters were two vowels (e.g., Perea & Lupker, 2004) and when the transpositions contained the external letters (i.e., the first or the last letter) of a word (e.g., Rayner, White, Johnson, & Liversedge, 2006; Perea & Lupker, 2007).

One of the most salient cases in which the transposed-letter effect was shown to disappear, however, is possibly the case of cross-morphemic transpositions since it displays divergent findings as in the case of the form-first versus form-then-meaning debate. A substantial number of studies, for instance, showed that when the letter transpositions cross a morpheme boundary (i.e., TL-across primes: ediotr-editor), significant facilitatory effects of TL non-words were still observed (e.g., Beyersmann, McCormick, & Rastle, 2013; Perea & Carreiras, 2006; Rueckl & Rimzhim, 2011; Sánchez-Gutiérrez & Rastle, 2013; Zargar & Witzel, 2016). TL-across primes were found to be as effective facilitators as TL-within primes (edtior-editor) and both these TL non-words revealed greater facilitation than the replaced-letter control condition (i.e., RL-across: ediabr-editor). Contrary to this finding, some studies found that TL-across primes did not produce significantly stronger facilitation than the RL-across primes as these transpositions were assumed to spoil the morphemic structure of the complex forms, which ended up blocking the priming effect (e.g., Christianson et al., 2005; Duñabeitia, Perea, & Carreiras, 2007; Duñabeitia, Perea, & Carreiras, 2014). The observed inconsistencies in terms of the effects of cross-morphemic transpositions are of great importance as they inform us about the time course of morpho-orthographic segmentation and about whether morpho-semantic information is available at the early stages of processing. For example, the absence of a transposed-letter priming effect for TL-across primes was taken to show that the processing of letter encoding and the morpho-orthographic segmentation takes place concurrently. Accordingly, the disrupted letter positions crossing a morpheme boundary turned out to be much more detrimental than within-morpheme transpositions due to the interfering effects of transpositions on the already established morpheme boundaries. The presence of a significant priming effect despite the across-morpheme transpositions, however, was interpreted in two different ways. One the one hand, it was suggested that letter position coding was carried out before morpho-orthographic decomposition and, therefore, the morpheme boundaries were not affected by the possible detrimental effects of cross-morphemic transpositions. On the other hand, the observed facilitatory effects of cross-morphemic transpositions were attributed to the claim that the early processing of complex forms involves both morpho-orthographic and morpho-semantic processes. Based on this claim, cross-morphemic transpositions were in fact considered to be detrimental since they disrupt the morpho-orthographic segmentation; however, the access to the whole-word representations along with the constituent morphemes provides support for the activation of target word. It is this alternative support that yields priming effect although the morpho-orthographic route is incapacitated by cross-morphemic transpositions (see Figure 2). However, to be able to safely assume that the presence of priming effect from TL-across primes stems from the activated whole-word representations, the findings of truly-affixed forms as well as pseudo-affixed forms should be examined by applying the same TL-across and RL-across manipulations.

The case of pseudo-affixed forms, however, is relatively understudied. One of the most prominent studies testing both truly-affixed and pseudo-affixed forms by implementing cross-morphemic transpositions was conducted by Diependaele et al. (2013). The authors in fact integrated the TL-across and RL-across manipulations into the classical transparent-opaque-form design. Relying on the dual-route model (see Figure 2, Diependaele et al., 2013) and in line with studies attributing the existence of priming from TL-across non-words to the availability of activating whole-word representation, the authors expected to find facilitatory effects for TL-across primes in transparent words (walker: *walekr-WALK*) but not in opaque words (corner: *corenr-CORN*). Their findings unambiguously supported these predictions. On the basis of the observed pattern, Diependaele et al. (2013) claimed that the early processing of complex forms involves not only morpho-orthographic information but also morpho-semantic processing as the TL-across primes yielded facilitation only in the transparent condition. Although the morpho-orthographic route was blocked by cross-morphemic transpositions, these items could receive activation from the morpho-semantic route (through the activation of whole-word representations). The opaque primes, on the other hand, failed to show facilitation when exposed to cross-morphemic transposition since the only source of activation for these items (i.e., morpho-orthographic route) were then incapacitated. It must be recalled that the opaque primes do not share a semantic relationship with their targets. The lack of semantic relatedness therefore ruled out the possibility of receiving support from the morpho-semantic route for opaque pairs unlike transparent pairs. Overall, the study conducted by Diependaele et al. (2013) influentially provided an alternative way to contribute to the form-first versus form-then-meaning debate by applying the evidence from the literature to the well-known transposed-letter effect. Considering the inconsistencies both in the role of morpho-semantic information and in the effects of cross-morphemic transpositions, however, it may well be argued that more studies are needed in order to resolve these inconsistencies and to account for the observed discrepancies. It is the aim of this thesis to inform the current discussion and contribute to the existent body of knowledge on the subject.

1.2. Significance of the Study

As referred to earlier, whether semantic information plays a role at the early stages of visual word recognition and whether across-morpheme transpositions have detrimental effects on morpho-orthographic decomposition are still ongoing debates. Taking a look at the relevant literature, however, it can be seen that the tested languages have predominantly been Indo-Eurpean languages such as English, French and Spanish (in most cases English). It is therefore necessary to investigate to whether languages with different structural properties might yield different results. That is, as suspected by several studies (e.g., Duñabeitia et al., 2007; Sánchez-Gutiérrez & Rastle, 2013; Zargar & Witzel, 2016), it should be taken into account that cross-language differences might be one of the reasons why studies failed to arrive at a consensus on the aforementioned debates. For instance, considering the fact that the transposed-letter effect was found to be absent in Semitic languages (e.g., Perea, Mallouh, & Carreiras, 2010; Velan & Frost, 2009) and in Korean (Rastle, Lally, & Lee, 2019), it is not implausible to entertain the possiblity that cross-language variations might show modulating effects on the observed priming effects. Accordingly, to the best of my knowledge, no study has ever tested the relationship between morpho-orthographic and morpho-semantic processes through cross-morphemic transpositions in Turkish. To this end, the present study is expected to be treated as the baseline for further studies testing the role of semantic information at the early stages of processing and the transposed-letter effect in Turkish.

Turkish is classified as an agglutinative language with rich and productive morphology (Gürel, 1999; Özgür, Güngör, & Gürgen, 2004). That is, as other agglutinative languages, forming complex forms in Turkish is carried out through repeatedly adding affixes (mostly suffixes) to the stems and each affix refers to certain grammatical relations (Aikhenvald, 2007; Özgür et al., 2004). Similarly, Basque is also considered as an agglutinative language that involves high degree of suffixation (Trask, 1998). Taking these properties of Basque into account, Zargar & Witzel (2016) cited the possibility that languages displaying a rich and productive morphology like Basque might lead the speakers of such languages to spend more cognitive resources in the course of processing complex forms compared to the speakers of non-agglutinative languages like English and French. Accordingly, the present study has the potential to significantly inform the ongoing debates as it provides data from native speakers of Turkish. Further, considering the limited number of studies that tested the role of semantics at the early stages of word recognition making use of TL-across and RL-across manipulations, this study might also provide a significant contribution to the robustness of this alternative design to address the form-first versus form-then-meaning debate.

1.3. Research Questions & Predictions

This study investigates how morphologically complex Turkish words are decomposed into their constituent units. That is, the question is addressed whether the segmentation is morpho-orthographic per se or whether it also depends on semantic information at the early stages of visual word recognition. Like the great majority of studies in the relevant literature, the main prime conditions of the present study were transparent, opaque and form overlap conditions. To test the role of semantic information, however, this study also includes TL-across and RL-across manipulations. Therefore, the scope of this study also includes the question of how across-morpheme boundary transpositions affect the processing of truly complex and pseudo-complex Turkish words. Accordingly, the study aims at answering the following research questions: (a) Is morpho-semantic information available along with morpho-orthographic information at the early stages of visual word recognition? (b)

How do cross-morphemic transpositions inform the early processing of morphologically complex forms?

Based on the dual-route model of morphological processing proposed by Diependaele et al., (2013), both transparent and opaque primes are expected to facilitate the recognition of their targets whereas it is predicted that there will be no significant facilitation of form overlap primes. The magnitude of the priming effect obtained from transparent items, however, is predicted to be slightly greater than that of opaque items since the targets in the transparent condition receive an activation boost from both morpho-orthographic and morpho-semantic routes while the ones in the opaque condition receive the boost only from the morpho-orthographic route. Following the claim that cross-morphemic transpositions are more detrimental than within-morpheme transpositions, the facilitation obtained from opaque primes is expected to disappear as a result of the TL-across manipulation because of the fact that the only source of activation boost, which is the morpho-orthographic route, is blocked for these items. On the other hand, it is predicted that the transparent items will reveal significant facilitation anyway since one of the activation sources for these items, the morpho-semantic route, would still be intact. However, the magnitude of the facilitation could decrease with the lack of activation boost from the morpho-orthographic route. According to the claim that the early processing of morphologically complex forms is semantically blind, the results might show that the TL-across primes would yield no facilitation either in the case of transparent or opaque items since there would be no alternative route activation route for transparent items in this scenario. The magnitude of the priming effects for transparent and opaque items is then expected to be statistically indistinguishable. Alternatively, opaque as well as transparent pairs would show priming when the transpositions cross morpheme boundaries depending on the claim that morpho-orthographic information is processed only after letter encoding (e.g., Perea & Carreiras, 2006; Rueckl & Rimzhim, 2011; Zargar & Witzel, 2016).

CHAPTER 2

LITERATURE REVIEW

2.1. Early Processing of Morphologically Complex Words

2.1.1. The Form-then-meaning Account

As referred to earlier, the form-then-meaning account proposes that the early processing of morphologically complex forms is independent of a semantic-based analysis and that the decomposition of such forms into their subunits depends solely on morpho-orthographic information, which is suggested to be indifferent to whether these forms are in fact complex or *appear* to be complex (e.g., Beyersmann et al., 2016; Rastle et al., 2004; Rastle & Davis, 2008; Davis & Rastle, 2010). Despite suggesting a semantically blind early morpho-orthographic segmentation, this account also suggest the eventual involvement of semantic information in this process (i.e., after around 80 ms upon encountering the complex form). Several studies have so far revealed supporting evidence for this account by comparing the magnitude of facilitatory priming effects obtained by prime-target pairs sharing semantic and morphological features (i.e., transparent condition, worker-WORK: + Semantics, + Morphology, + Orthography) and by semantically unrelated pairs that *appear* to be decomposable (i.e., opaque condition, brother-BROTH: - Semantics, + (Pseudo) Morphology, + Orthography). Most studies adopting this design also included a control condition in which the prime-target pairs were semantically and morphologically unrelated, but displayed orthographic overlap (i.e., form overlap condition, scandal-SCAN, - Semantics, - Morphology, + Orthography; cf. Feldman et al., 2009). The form overlap condition provides the opportunity to evaluate the effect of orthographic overlap on the observed priming effects in isolation. More precisely, the lack of a priming effect for form overlap items could lead us to safely assume that the facilitations obtained in the transparent and opaque conditions cannot be attributed to shared orthography, which was indeed reported consistently.

Ruling out the effect of orthography with the form condition, arriving at equally robust facilitation for transparent and opaque items has been regarded as a supportive evidence for the form-then-meaning account. A substantial number of studies has shown that pseudo-affixed primes (e.g., *corner*) appeared to speed up the recognition of target items as strongly as items with real suffixes (e.g., *walker*). This result indicated that even pseudo-complex words were decomposed and that it was possible to access their core stems at the early stages of word recognition. More interestingly, semantic transparency did not seem to make any significant contribution to the obtained facilitation effects.

Evidence for the form-then-meaning account was initially reported for French (Longtin et al., 2003) and English (Rastle et al., 2004). Both these studies tested the complex word processing of native speakers of the specified languages. Using the masked priming paradigm together with a lexical decision task, Longtin et al. compared priming effects of four different prime condition in Experiment 1: (a) a transparent condition in which primes and targets were both semantically and morphologically related (gaufrette-GAUFRE, *wafer-WAFFLE*), (b) an opaque condition in which prime-target pairs were not related semantically, but displayed an etymological relation (fauvette-FAUVE, *warbler-WILDCAT*), (c) a pseudo-derived condition in which the prime-target pairs were semantically and etymologically unrelated but contained an existing French stem with a pseudo-suffix (baguette-BAGUE, *little stick-RING*), and (d) an orthographic overlap condition in which the prime-target pairs were semantically unrelated and displayed no apparent morphological relation (abricot-ABRI; -cot is not a suffix in French, *apricot-SHELTER*). It should be noted that the items in the opaque and pseudo-derived conditions were actually quite similar in terms of semantic transparency and could be parsed into a legal French root and a suffix although the morphological relation between the target and the prime in such words existed only at the surface level. The results of Experiment 1 showed that transparent, opaque and pseudo-derived primes significantly facilitated the recognition of their targets compared to unrelated primes while orthographic control words displayed no facilitation at all (the items in orthographic condition even showed a marginal inhibition effect). Based on this result, it was suggested that the priming effects observed in the transparent, opaque and pseudo-derived conditions were independent of orthographic overlap and semantic transparency, and therefore purely morphological.

Similarly, Rastle et al. (2004) conducted a masked priming lexical decision experiment with a group of native British English speakers. Manipulating semantic and morphological properties of the prime words, three prime conditions were formed; (a) a transparent condition (e.g., cleaner-CLEAN), (b) an opaque condition in which the prime-target pairs were semantically unrelated but could be analyzed as the combination of a root and a suffix in English (e.g., corner-CORN), and (c) a form condition in which the prime-target pairs shared no semantic or morphological relationship, but displayed only orthographic overlap (e.g., brothel-BROTH). Unlike Longtin et al. (2003), Rastle et al. did not present opaque and pseudo-derived words in different conditions, but treated both these items types as opaque. The primes were displayed for only 42 milliseconds. The results revealed that the facilitation obtained from transparent and opaque items were statistically indistinguishable and were significantly greater than that of form items. This pattern was further supported by an item-based analysis. Taken together, Rastle et al. interpreted this result as evidence for the claim that the mere appearance of morphological complexity by itself is sufficient for morpho-orthographic segmentation and that semantics played no role in this process.

Testing the same prime type conditions (i.e., transparent: condition 5, opaque: condition 2 and form: condition 1), Marslen-Wilson, Bozic, & Randall (2008) replicated the results of Rastle et al. (2004) with native speakers of British English. One novel contribution of the study was that Marslen-Wilson et al. used three different prime display durations to investigate whether semantic information would incrementally show itself with longer exposure to the primes. However, with all three SOAs (i.e., 36 ms in Experiment 1a, 48 ms in Experiment 1b and 72 ms in Experiment

1c), the overall pattern turned out to be the same: items in the transparent and opaque conditions showed statistically similar amounts of facilitation while the form condition did not lead to facilitation. It is important to note that the primes were (pseudo) complex forms and the targets were core stems in the first experiment set (e.g., transparent: bravely-BRAVE, opaque: archer-ARCH, and form: scandal-SCAN). Additionally, it was reported that the results of the first experiment set remained unchanged when the primes and the targets were switched in Experiment 2 (i.e., transparent: brave-BRAVELY, opaque: arch-ARCHER, and form: scan-SCANDAL). The results, therefore, favored the form-then-meaning account and indicated that semantic information was unavailable even at a 72 ms SOA. It is also crucial to dwell on the fact that the magnitude of the facilitation obtained in the opaque condition was not reduced at 72 ms SOA contrary to Rastle, Davis, Marslen-Wilson, & Tyler (2000). Marslen-Wilson et al. (2008) attributed this evident discrepancy to the possibility that the degree of the masking of the primes could have shown some variation between the two studies since it was argued that the priming effects observed in the opaque condition tended to decrease as primes became more susceptible to conscious perception (e.g., Longtin et al., 2003).

In their meta-analysis, Rastle & Davis (2008) documented all masked priming studies that had applied stimulus onset asynchronies between 30 ms and 59 ms. Calculating the average priming effects obtained with transparent, opaque and form items across all the listed studies, they arrived at 30 ms facilitation for the transparent condition, 23 ms facilitation for the opaque condition and only 2 ms facilitation for the form condition. It was argued that the transparent and opaque conditions, overall, yielded statistically indistinguishable priming effects and that these effects were significantly greater than the facilitation in the form condition. Based on this meta-analysis, Rastle & Davis concluded that semantics had no effect on the decomposition process, but this process involved form-based (i.e., morpho-orthographic) analysis only at the early stages of word recognition. Also, morpho-orthographic segmentation was claimed to be fast and automatic, which applies to real and pseudo derivations alike. Rastle & Davis, therefore, suggested that these results provided counter-evidence against semantically based theories that would predict facilitation only when the prime-target pairs were semantically related such as in distributed-connectionist theories (e.g., Rueckl & Raveh, 1999) and the supralexical theory of Giraudo & Grainger (2000).

As a response to the meta-analysis of Rastle & Davis (2008), Feldman et al. (2009) argued against the view that early morphological segmentation is semantically blind by claiming that the studies documented in Rastle & Davis (2008) in fact showed reduced priming effects for opaque items and that the facilitation obtained in the transparent condition was numerically greater than that of the opaque condition. With an additional experiment, Feldman et al. (2009) also showed that opaque items failed to reveal significant facilitation with 50 ms SOA (revisited in section 2.2.). Davis & Rastle (2010), however, challenged Feldman et al.'s arguments against the form-then-meaning account by presenting another meta-analysis with the results of earlier studies (including Feldman et al., 2009) via funnel plots (see Goldacre, 2008). Using funnel plots enabled Davis & Rastle to see the dispersion of the effect sizes of the studies (in this case the magnitude of priming effects or the difference between the priming effects) relative to the accuracy of effect size estimate (in this case, the magnitude of the sample size). It was argued that the studies with smaller sample sizes would typically show wide ranges of effect sizes (e.g., -17 ms, 10 ms, 18 ms, 25 ms, 36 ms) whereas studies with larger sample sizes would tend to be accumulated around the most accurate estimate of the effect size (i.e., the mean priming effect across the studies).

Based on the overall picture represented in the funnel plots, Davis & Rastle (2010) claimed that the effect size indicating the difference between transparent and opaque conditions in Feldman et al. (2009) evidently showed an atypical priming effect difference (Figure 1A, p. 751) favoring the semantically transparent items (i.e., 26 ms). Considering the fact that the mean priming effect difference between transparent and opaque conditions was only 7 ms, it could be argued that the results of Feldman et al. (2009) inconsistently deviated from the most accurate estimate of the effect size although it was considered to be a large sample size study. Further, it must be noted that only two studies displayed a pattern similar to Feldman et al.; however, these studies could be classified as small sample size studies on the plots. When the effect sizes regarding the magnitude of the priming effects for the transparent and the opaque conditions were taken into account separately (Figures 1B and 1C, p. 751), it could be seen that the priming effect for the transparent condition in Feldman et al. (2009) was typical, but they arrived at a reduced priming effect (i.e., 4 ms) for the opaque condition. This reduced priming effect was again supported by only two small sample size studies. Compared to the facilitation obtained for the opaque condition (i.e., 20 ms) in studies with large sample sizes, Feldman et al.'s results seemed to deviate from the norm in this case as well. Lastly, with Figure 1D, Davis & Rastle (2010) showed that the effect size for the priming difference between opaque and orthographic control condition presented around 20 ms facilitation in favor of the opaque condition. This comparison, however, was not tested in Feldman et al. (2009). Overall, the meta-analysis of Davis & Rastle eloquently challenged the argument that sematic transparency also plays a role during the early stages of visual word recognition as reported by Feldman et al. (2009), and argued for purely morpho-orthographic segmentation.

Most importantly, Davis & Rastle (2010) listed three possible reasons to explain the atypical pattern observed in Feldman et al. (2009). First, Davis & Rastle pointed out the fact that there was a marginally significant difference between transparent and opaque items in terms of target family size, which might have led the results in Feldman et al. (2009) into the observed direction. Second, among the opaque items, Davis & Rastle detected some samples that might yield ambiguity in the course of segmentation. For instance, the prime in the pair *earless-EARL* could also be parsed into the stem "ear" and the suffix "-less". Based on this fact, Davis & Rastle argued that such segmentation ambiguities could potentially block the priming effect observed in the opaque condition. Third, Davis & Rastle (2010) noticed that Feldman et al.'s prime-target pairs in the opaque condition display more arbitrary orthographic alterations than the ones in the transparent condition (e.g., *coin-coyness* and *sack-saccade*). It is crucial to note that, as reported by Davis & Rastle (2010), most of the alterations observed in the transparent condition (e.g., *bake-bakery*) did not interfere with the priming effect reported in McCormick, Rastle, & Davis (2008), but the alterations in the opaque condition were found to be detrimental in the same study. The prime-target pairs with these arbitrary alterations in the opaque condition were, in fact, classified as orthographic control words (*bliss-blistery*; *s* does not turn into *t* in English in word-final position) in McCormick et al. (2008). Due to its relevance to the current discussion, it is worth mentioning that both transparent and opaque items in McCormick et al. (2008) revealed robust priming effects even when they were exposed to systematic orthographic alterations (e.g., transparent: adorable-ADORE, lover-LOVE and dropper-DROP; opaque: committee-COMMIT, badger-BADGE and fetish-FETE). It seemed, therefore, that the opaque items were still parsed into a root and an affix despite the orthographic alterations, which indicated that transparent and opaque items were analyzed in the same way. Turning back to Feldman et al. (2009), given the fact that the transparent and the opaque items were not matched on these three important variables, the atypical results on the funnel plots regarding the opaque condition clearly need further inspection.

A relatively recent study conducted by Beyersmann et al. (2016) tested the classic transparent, opaque and form overlap prime-target conditions with native speakers of English and revealed consistent results with the meta-analysis of Davis & Rastle (2010). Considering the criticism by Baayen, Milin, Đurđević, Hendrix, & Marelli (2011) on the opaqueness of the pseudo-suffixed items used in the earlier studies, Beyersmann et al. underscored the fact that they firmly controlled the items in the opaque list by excluding the prime-target pairs that were actually related in terms of their etymology (e.g., archer-ARCH) and the pairs that contained a fully functional suffix conveying its original meaning in the opaque prime word (e.g., gaffer-GAFF; the pseudo-suffix still bears the meaning 'someone who does something'). Applying a 50 ms prime display duration, they found significant priming effects with both truly suffixed and pseudo-suffixed items. As expected, no priming effect was observed for orthographic control items. It is important to point out that the priming effects obtained with truly suffixed and pseudo-suffixed items were numerically almost identical (i.e., 25 ms and 23 ms respectively, cf. Feldman et al., 2009).

Heyer & Kornishova (2018) also investigated the possible role of semantic transparency in the early processing of morphologically complex words using two different SOAs: shorter (i.e., 39 ms) and longer (i.e., 77 ms). Unlike the previously reported studies, the semantic transparency of the items was not considered categorical but gradual. To measure the transparency of the items tested in the study, Heyer & Kornishova (2018) asked a group of participants to rate the meaning overlap between the prime and the target pair words on a 7-point Likert scale (1 corresponding to "no overlap at all" and 7 corresponding to "nearly identical"). Based on this criterion, items were regarded as closer to the transparent end of the scale (e.g., paleness-PALE) or closer to opaque end of the scale (e.g., business-BUSY). Only the suffix "-ness" was tested in the study and the justification for this preference was the possibility of creating a confound with regard to affix variation. The results showed that there was no effect of the degree of semantic transparency when the primes were presented for 39 ms (short SOA) and the items yielded a greater priming effect compared to a set of unrelated words. With a 77 ms prime display duration (long SOA), on the other hand, the priming effect was even greater and this time the data showed a transparency effect. Most importantly, testing the Russian suffix "-ost", which is comparable to "-ness" in English, Heyer & Kornishova (2018) replicated the results of this experiment for Russian as well. Accordingly, it was concluded that semantic information did not inform the initial stages of processing, but it took part in the process at a later stage with increased exposure to the prime word.

The studies lending support for the form-then-meaning account are not limited to Indo-European languages like English and French. For instance, Frost, Forster, & Deutsch (1997) found that both transparent and opaque items significantly speeded up the recognition of their targets in Hebrew and this facilitation effect was greater than that in the orthographic overlap condition. With a 59 ms prime display duration, Kazanina, Dukova-Zheleva, Geber, Kharlamov, & Tonciulescu (2008) replicated this facilitation pattern for Russian. Focusing on prefixed words, Kazanina (2011) showed, yet again, that semantically transparent and pseudo-morphological prime-target pairs showed significant facilitation effects but no facilitation was observed with pairs sharing solely orthographic overlap for Russian (with 60 ms SOA in Experiment 1a and 1b). In Experiment 2a and 2b, Kazanina (2011) arrived at the same conclusion with a 40 ms SOA. Although the results favoring the form-then-meaning account were observed in various languages, the evidence for the absence of semantic influences at the early stages of processing in the relevant literature is not unequivocal. Several other studies have lent support to the claim that the word recognition system might not be so blind to semantic information. Accordingly, the following section focuses on the form-with meaning account which supports the active role of semantics in the early processing of complex forms.

2.1.2. The Form-with-meaning Account

Contrary to the argument of the form-then-meaning account, which rejects the involvement of morpho-semantic information during the early processing of complex forms, the form-with-meaning account suggests that both morpho-orthographic and morpho-semantic processes inform the early segmentation process concurrently and interdependently. On the basis of the classic masked priming experiment design that includes transparent, opaque and form overlap conditions, this account would predict significantly greater priming effects for semantically transparent compared to semantically opaque items. That is, since opaque prime-target pairs bear no semantic but a pseudo-morphological relationship, the facilitation obtained from these items would be reduced relative to the transparent items, or disappear completely depending on the SOA employed.

The earliest evidence for the form-with-meaning account was actually reported by studies that implemented different kinds of priming paradigms such as cross-modal and long-SOA priming rather than masked priming. For example, using cross-modal repetition priming, Marslen-Wilson, Tyler, Waksler, & Older (1994) showed that semantically transparent primes successfully facilitated the recognition of their targets (e.g., punishment-PUNISH), but semantically opaque primes failed to reveal any facilitatory priming effects (e.g., casualty-CASUAL). It should be specified that the primes in this study were presented in the auditory domain while target words were made available to the participants visually immediately after the offset of the auditory primes. Similarly, Longtin et al. (2003) tested the same prime-target conditions utilized in their masked priming experiment (i.e., Experiment 1: transparent, opaque, pseudo-derived and orthographic conditions; see section 2.1.), but this time in the cross modal priming paradigm in Experiment 2. As in Marslen-Wilson et al. (1994), Longtin et al. used auditory primes and visual targets. In sharp contrast to the results of the masked priming experiment, Longtin et al. found that the opaque and pseudo-derived primes no longer facilitated the recognition of their targets while the only significant priming effect was obtained in the transparent condition. It was therefore concluded that semantic information had a fundamental role in morpho-orthographic segmentation. However, it can be clearly seen that the effect of semantic transparency was only visible when the primes were consciously available to the participants, but failed to arise when the primes were masked and unconsciously processed in the masked priming experiment.

Also employing the auditory-visual cross modal priming paradigm, Meunier & Longtin (2007) focused on prime-target conditions in which the semantic interpretability of French pseudowords were manipulated (see Longtin & Meunier, 2005). It should be noted that Longtin & Meunier (2005) formed the following three conditions and tested them with masked priming lexical decision tasks: (a) semantically interpretable pseudowords (e.g., rapidifier, *to quickfy*), (b) semantically non-interpretable pseudowords (e.g., sportation, *sport* + *-ation*), and (c) non-morphological pseudowords with non-suffix ending (e.g., rapiduit, *-uit* being the non-suffix ending). Longtin & Meunier (2005) arrived at significant priming effects with both semantically interpretable and non-interpretable pseudowords. Testing the same conditions using cross modal priming, Meunier & Longtin (2007) found that only semantically interpretable pseudowords yielded significant facilitation. The significant role of semantic transparency was reported in various other studies using masked cross modal priming (e.g., masked visual primes-auditory targets in Dutch: Diependaele et al., 2005), long SOA priming (e.g., Feldman & Soltano, 1999; Rastle et al., 2000), and long-term priming (e.g., Rueckl & Aicher, 2012). These results support the importance of semantic information in morphological processing; however, the findings of these studies cannot be directly compared to the findings of masked priming experiments that found the effect of semantically opaque items as well. The primes in the cross-modal and the long SOA priming studies were fully visible to the participants unlike masked priming studies. Therefore, the conscious perception of the primes apparently modulated how the complex forms were analyzed during the early stages of word recognition. For instance, despite showing the effect of semantics with long SOA primes (e.g., 100 ms), it should be emphasized that Longtin & Meunier (2005), Feldman & Soltano (1999) and Rastle et al. (2000) found that semantic information was not available with short SOA primes (i.e., 47 ms, 48 ms and 43 ms).

Depending on the model proposed by Schreuder & Baayen (1995), Meunier & Longtin (2007) defined three stages for the processing of morphologically complex forms. While the first stage involves purely morpho-orthographic segmentation, in the second stage the decomposed complex forms are subject to a licensing process where they are checked for semantic and syntactic appropriateness. Even more important, the third stage, which is the combining stage, is only viable if the licensing process does not crash. Accordingly, it could be concluded that the segmentation of complex forms are morpho-orthographic in nature and this mechanism automatically decomposes each and every form that has a morphological surface structure (e.g., *corn-er*). With semantic information being available, however, only the semantically transparent forms survive licensing while opaque forms fail to combine and are analyzed as whole-units. Nevertheless, it is particularly important to detect when exactly semantics comes into operation in the process. Although it has been shown that morpho-semantic information is a crucial part of the processing of morphologically complex forms, studies using paradigms such as cross modal and long SOA priming do not seem to provide sufficient information about the time course of the involvement of semantics. Further, a substantial number of studies that applied masked priming lexical decision tasks with short SOAs (e.g., 50 ms) revealed findings that suggest exactly the opposite view (see section 2.1.). It is, therefore, essential to obtain consistent masked priming evidence (with short prime display durations like 50 ms) in support of the argument that semantic information is also available at the early stages of visual word recognition.

One of the best-known piece of evidence for the form-with-meaning account obtained via the masked priming paradigm was reported by Feldman, O'Connor, & Moscoso del Prado Martín (2009). As mentioned in section 2.1., the authors compared the facilitatory effects of transparent and opaque item pairs disregarding the orthographic control condition. Using a 50 ms SOA, Feldman et al. (2009) found that transparent primes facilitated the recognition of their targets significantly better than matched unrelated primes (i.e., a 30 ms difference). Opaque primes, however, could not facilitate the recognition of their targets reliably more than the matched unrelated prime set (i.e., 4 ms difference). Based on this result, Feldman et al. argued for the claim that morpho-semantic information has an influence on the early morpho-orthographic segmentation. Further, Feldman et al. proposed some reasons that might have affected the results of Rastle, Davis, & New (2004). For instance, the choice of adding unrelated fillers in Rastle et al. was criticized since it purportedly decreased the proportion of related prime-target pairs below half of the overall trial set. Depending on the claim that using more related trials (e.g., identity prime-target pairs like artist-ARTIST) increases the possibility of detecting facilitatory effects of semantic relatedness (e.g., Feldman & Basnight-Brown, 2008), Feldman et al. argued that the absence of a semantic transparency effect in Rastle et al. (2004) might have stemmed from the low proportion of related trials.

Going further, Feldman et al. claimed that most of the earlier studies reported in Rastle & Davis (2008) actually displayed small effects of transparency when examined holistically although they revealed equal facilitation for transparent and opaque items individually (e.g., Marslen-Wilson et al., 2008). Feldman et al. also pointed out that unlike Feldman et al. (2009), Rastle & Davis (2008) presented a qualitative analysis of the previous experiments rather than providing quantitative analyses. As discussed in section 2.1., Davis & Rastle (2010), however, documented the results of funnel plots and showed that larger-sample-size studies consistently revealed reliable effects of both transparent and opaque conditions, Feldman et al. (2009) being the only exception. The inconsistencies, on the other hand, stemmed from the small-sample-size studies. Davis & Rastle (2010), therefore, challenged Feldman et al.'s claim that the data they presented were 'nearly prototypical of the published literature' (p. 688). Further, it is essential to emphasize that Davis & Rastle (2010) drew attention to three major problems with Feldman et al.'s opaque item samples: unmatched target family size, more orthographic alterations in opaque items and ambiguously decomposable primes in the opaque condition. It is, therefore, indispensable to avoid such limitations for more credible evidence supporting the form-with-meaning account.

In line with the results of Feldman et al. (2009), Diependaele, Sandra, & Grainger (2009) found reduced priming effects in the opaque condition with Dutch prefixed words. That is, both transparent (e.g., gegil-GIL, *screaming-SCREAM*) and opaque items (e.g., gebed-BED, *prayer-BED*) yielded significant facilitation, but the facilitatory effect of transparent items was significantly greater than that of opaque items in Experiment 3. Items in the orthographic control condition (e.g., barok-ROK, *baroque-SKIRT*), unsurprisingly, revealed no facilitation. It should be noted, however, that this pattern arose only with one of the tested SOAs (i.e., 67 ms) while no priming effects were observed for the conditions tested with a 40 ms prime display duration. Considering the findings of earlier studies, this result appears to be quite unexpected. Therefore, Diependaele et al. (2009) estimated that the use of the backward consonantal masks that were placed between the primes and the targets might have acted as an intervening factor. Removing the backward masks and presenting the targets immediately after the primes, Diependaele et al. (2009) implemented another experiment (Experiment 4) with the same material and design that was used in Experiment 3. Replicating the result obtained with 67 ms in Experiment 3, the findings of Experiment 4 also revealed significant facilitatory effects of transparent and opaque items with both 40 ms and 67 ms SOAs; however, the transparent condition showed greater facilitation yet again. Thus, it was concluded that the failure to detect any priming effects with a 40 ms SOA in Experiment 3 was in fact due to including backward consonantal masks. Based on these facts, the results of Experiment 4 in Diependaele et al. (2009) could be considered more compatible with the studies that applied the masked priming paradigm in the literature.

Taken all together, Diependaele et al. proposed a hybrid model of complex word processing. The model suggested that both morpho-orthographic and morpho-semantic representations of morphologically complex words are activated in parallel upon visually encountering the stimuli. It was, therefore, claimed that the only channel providing activation to opaque prime-target pairs is overlapping morpho-orthographic representations whereas the activation of transparent pairs is boosted by both channels. With increasing exposure to the prime, the activations arising from morpho-orthographic and morpho-semantic channels are expected to remain intact for only transparent items whereas the effect of opaque items is predicted to fade away gradually as it solely depends on the morpho-orthographic channel. Considering the fact that the morphological relationship between opaque prime-target pairs is not real but appears on the surface structure, it is quite plausible to expect that the facilitatory effects of opaque primes would gradually disappear with more salient feedback through semantic information. The hybrid model could indeed account for the semantic transparency effect and the reduced priming effects for the opaque items in Diependaele et al. (2009).

Comparing native speakers of English with L1 Spanish – L2 English and L1 Dutch – L2 English speakers, Diependaele et al. (2011) tested the same prime-target conditions for English in the masked priming paradigm. To form a baseline, the focus of Experiment 1 was the performance of the native speakers of English only and Diependaele et al. arrived at significant facilitatory effects for both transparent and opaque items. However, the priming effect in the opaque condition did not significantly differ from that of the form overlap condition whereas transparent items revealed a statistically greater facilitation compared to the other two conditions. The authors argued that this pattern did not significantly diverge from earlier studies, and that the experiment was therefore feasible to be run with an L2 group. Accordingly, the performance of L1 Spanish high proficiency speakers of L2 English (in Experiment 2) and Dutch speakers of English (in Experiment 3) was tested using the same design. Both L2 groups, interestingly, showed the same priming effect patterns for the transparent, opaque and form overlap conditions. Diependaele et al. therefore claimed that native speakers and L2 speakers similarly process morphologically complex forms in English and that the overall pattern was in accordance with the meta-analyses of L1 data (e.g., Feldman et al., 2009).

Taking the facilitatory effects of opaque items into account, the results of Diependaele et al. (2011) could argue for the fast and automatic morpho-orthographic segmentation following earlier evidence (e.g., Davis & Rastle, 2010; Longtin & Meunier, 2005; Rastle et al., 2004). However, the form-then-meaning account fails to explain the transparency effect and the null result regarding the comparison of opaque and form overlap items found in Diependaele et al.'s data. It is crucial to mention that the primes were displayed for 53 ms in this study. Thus, Diependaele et al. considered the possibility that the effect of semantic information could have emerged within the provided prime display duration. Depending on the previously mentioned models that entertain the idea of having two separate routes (i.e., morpho-orthographic and morpho-semantic) concurrently informing the decomposition of complex words at the early stages, Diependaele et al. also discussed their results within the scope of these models. Referring to the latest version (i.e., the parallel dual-route model, see Figure 1), Diependaele et al. argued that both morpho-orthographic and morpho-semantic routes might have informed the decomposition simultaneously, which caused greater facilitation for transparent items since these items receive activation from both routes. The model also accounts for the relatively reduced effects of opaque items as the morpho-orthographic route is assumed to be only source of activation for these items. Although they considered the plausibility of both form-first (i.e., form-then-meaning) and parallel activation (i.e., form-with-meaning) accounts, Diependaele et al. regarded the form-first account as 'parsimonious' (p. 355) in explaining their data.

Focusing on morphologically complex Serbian forms, Feldman, Kostić, Gvozdenović, O’Connor, & Moscoso del Prado Martín (2012), nevertheless, replicated the results of Feldman et al. (2009), which received criticism in terms of the construction of opaque item samples and the variable matchings between the transparent and opaque item lists. Feldman et al. (2012) compared the facilitatory effects of semantically similar (e.g., transparent condition: ratovi-RAT, *wars-WAR*) and semantically dissimilar (e.g., opaque condition: ratar-RAT, -ar being an existing suffix in Serbian but not in this case, *peasant-WAR*) prime-target pairs with a 50 ms SOA. It was emphasized that the stems of the primes were exposed to no orthographic or phonemic alterations. Even more importantly, the same stems were used for both semantically similar and dissimilar items (e.g., semantically similar: gladan-GLAD, *hungry-HUNGER*; semantically dissimilar: gladak-GLAD, *smooth-HUNGER*). Further, Feldman et al. varied the scripts in which the primes were displayed. Both primes and targets were presented in the Roman alphabet in Experiment 1a whereas targets remained in Roman but primes were presented in the Cyrillic alphabet in Experiment 1b. The results showed that the facilitatory effects of semantically similar primes were significantly greater than those of semantically dissimilar primes. It was argued that these results could not be attributed to the differences in orthographic similarity as the same stems were utilized in the process of forming the semantically similar and dissimilar primes. Crucially, manipulating the scripts that the primes were presented in did not yield any significant influence on the overall pattern. This supported the claim that the observed priming effects could not be due to overlapping orthographic representations between primes and the targets since we would otherwise observe reduced effects in the case of cross-alphabet comparisons. Feldman et al. (2012) provide evidence for the claim that morpho-orthographic and morpho-semantic information are concurrently and interdependently activated during the early stages of morphological processing (cf. Davis & Rastle, 2010).

Creating semantically similar (i.e., transparent) and semantically dissimilar (i.e., opaque) prime-target pairs as in Feldman et al. (2012), Feldman, Milin, Cho, Moscoso del Prado Martín, & O’Connor (2015) also tested these conditions in English (e.g., transparent: sneaky-SNEAK, opaque: sneaker-SNEAK). It should be noted that the opaque item list contained both etymologically related prime-target pairs (e.g., archer-ARCH) and pairs bearing a pseudo-morphological relation (e.g., ratify-RAT). To be able to see the time course of the emergence of semantic information during the early stages of processing, priming effects of semantically similar and dissimilar primes were scrutinized using five different SOAs (i.e., 34 ms, 67 ms, 84 ms in Experiment 1a and 48 ms, 100 ms in Experiment 1b). As a result of these experiments, Feldman et al. reported that the semantic transparency effect turned out to be available across all the tested SOAs, but the difference between the two prime types was only 6 ms at 34 ms SOA. Keeping in mind that testing multiple SOAs within a single experiment might have influenced the priming effects of semantically similar and dissimilar primes (both visible and invisible primes embedded in a single experiment), Feldman et al. (2015) decided to test 48 ms SOA alone in a separate experiment (i.e., Experiment 2). The underlying reason for the choice of this specific SOA was explained by the fact that SOAs around this period causes the discrepancy between form-then-meaning and form-with-meaning accounts most (e.g., Amenta & Crepaldi, 2012). The effect of semantic transparency was again statistically significant with a 48 ms SOA. As pointed out earlier, the difference between semantically similar and dissimilar conditions were quite small numerically at 34 ms SOA although the comparison turned out to be significant (i.e., greater facilitation from transparent items). To examine this in detail, Feldman et al. (2015) conducted another experiment focusing solely on 34 ms SOA. In line with the results of the previous experiments in the study, Feldman et al. (2015) arrived at significantly more facilitatory effects from transparent items compared to opaque items even with an SOA as short as 34 ms. Overall, these results, especially the effect of semantic transparency at shorter SOAs, clearly contested the claims established in studies lending supportive evidence to the form-then-meaning account.

As in Diependaele et al. (2011), Zhang, Liang, Yao, Hu, & Chen (2017) aimed to test the performance of L1 Chinese learners of L2 English as earlier studies predominantly focused on typologically similar languages (e.g., Dutch-English). Rather than forming an orthographic control condition, Zhang et al. opted for a control condition in which the prime-target pairs were only semantically related. Two experimental conditions were formed with semantically transparent and semantically opaque items as in several other studies. The primes were displayed for 40 ms in their first experiment and the results unambiguously supported the form-with-meaning account as the only significant facilitation was observed with semantically transparent items. To further investigate this finding, Zhang et al. tested the same conditions with a 80 ms SOA in their second experiment. Interestingly, this time, both semantically transparent and semantically opaque conditions yielded significant priming effects. Referring to Diependaele et al. (2011), Zhang et al. concluded that their findings supported the parallel dual-route model of complex word processing. However, the reason behind the discrepant results between the first and the second experiments remain unexplained.

The availability of semantic information at the early stages was also reported with designs that tested conditions different from the classic transparent-opaque-form trio. Tsang & Chen (2013), for instance, focused on Chinese compounds that contained ambiguous morphemes. Presenting derivations that contained either dominant (e.g., 月蝕, *lunar eclipse*) or subordinate (e.g., 月薪, *monthly salary*) meanings of these morphemes (e.g., 月, *moon*) as primes, they tested how meaning frequency would affect the reaction times to the corresponding targets using a masked priming lexical decision task. One other notable detail was the fact that the target type was also manipulated by presenting the ambiguous roots bearing either the dominant (*moon*) or subordinate (*month*) meaning. It is important to note that the primes were presented for only 40 ms, which was shown to be too early for the involvement of semantic information in several studies. Against the form-then-meaning account, the results indicated that meaning frequency manipulation indeed modulated the magnitude of priming effects. That is, it was found that targets bearing the dominant meaning were significantly speeded up both by dominant and subordinate primes. The targets with subordinate meaning, on the other hand, revealed significant facilitation only with subordinate primes. In light of these findings, the form-then-meaning account would have difficulty in explaining the meaning frequency effect observed in Tsang & Chen (2013) since it would not be possible for the parser to access the semantic information within 40 ms and, therefore, manipulating the meaning frequency of the words would make no difference based on this account (for further evidence with a similar design in Chinese, see Tsang, Wong, Huang, & Chen, 2014).

Andrews & Lo (2013), introduced a novel perspective to the debate. The authors also made use of the classic transparent (e.g., dreamer-DREAM), opaque (e.g., number-NUMB) and form overlap conditions (e.g., freeze-FREE), but the main focus of the study was to see whether individual differences would modulate the priming effects obtained in the tested conditions. The participants were classified as 'semantic profile' participants and 'orthographic profile' participants based on three tests that were applied before the masked priming experiment (50 ms SOA). A vocabulary test was used to determine the participants that depend more on semantic information. The participants relying more on orthographic information, on the other hand, were determined using a dictation task and a spelling recognition task. Based on the characteristics of these two groups, it was predicted that the facilitation from opaque pairs would be more robust in the orthographic group. The semantic group, on the other hand, was expected to display transparency effects.

Consistent with these predictions, Andrews & Lo (2013) found that the transparent items revealed facilitatory priming effects but the effects of the opaque items were reduced for the semantic profile group. As expected, opaque items yielded a robust priming effect in the orthographic profile group, which turned out to be at least as strong as the transparent ones. Considering the accounts suggesting two separate activation channels operating in parallel for the processing of morphologically complex forms such as the hybrid model proposed by Diependaele et al. (2009), Andrews & Lo (2013) concluded that the participants with different profiles might be relying on the two channels to various degrees. That is, participants in the semantic profile group might dominantly use the resources of morpho-semantic information whereas the orthographic profile group might depend more on morpho-orthographic information.

Altogether, the relevant literature shows that both form-then meaning and form-with-meaning accounts have received empirical support from several studies. The underlying reasons behind the inconsistent results have been attributed to the varying designs and materials adopted in the studies. For instance, some studies included etymologically related but semantically unrelated prime-target pairs in the opaque condition while others avoided using such pairs. Moreover, the decomposability of primes, especially the pseudo-complex primes, was disputable in some studies (e.g., *blistery-BLISS* in Feldman et al., 2009). It was also argued that the productivity of the affixes might have affected the observed priming effect patterns. It should be recalled that, for example, Heyer & Kornishova (2018) addressed this problem by focusing solely on the suffix *-ness*. Depending on these arguable preferences for the design and the materials, it is evident that more tightly controlled studies are needed. The debate, therefore, is far from being resolved and needs further investigations to explore the nature of complex word processing through providing evidence from various sources (through testing the unattempted). Accordingly, the performance of Turkish native speakers was examined in the present study. To be able to understand the arguments of the two opposing accounts that were inspected within the scope of this study, the following section summarizes a model of form-then-meaning account (Diependaele et al., 2011) and a parallel dual-route model (Diependaele et al., 2011) in its extended version considering transposed-letter manipulations (Diependaele et al., 2013). The divergent assumptions of the form-first and the form-with-meaning accounts are discussed through the above-mentioned models. Thus, it is of great importance to inspect the arguments supported by these models more closely.

2.1.3. Modelling the Form-first and the Form-with-meaning Accounts

One of the earliest mentions of the idea that segmentation of complex forms is informed by form and meaning concurrently at the early stages of visual word recognition was provided in a model proposed by Schreuder & Baayen (1995). Referring to this model, Meunier & Longtin (2007), for example, suggested that morphologically complex forms could be accessed via two routes operating in parallel.

One route allows access to the complex form through the whole-word representation (morpho-semantic). The access to the complex form in the other route, on the other hand, is carried out through constituent morphemes with parallel activation of the whole-word form and the morphemic representations (morpho-orthographic).

Diependaele et al. (2011), in a similar manner, illustrated the parallel activation of the morpho-orthographic and morpho-semantic routes along with an architecture modelling the form-then-meaning account (see Figure 1). Looking at the first panel (A) in Figure 1, the model shows that initial automatic form-based segmentation is compulsory and morpho-semantic information becomes available only after the outcome of this segmentation maps onto lexical levels. Further, it is seen that the interactions between semantically transparent pairs (worker-work) form more potent links whereas no interaction is available for opaque pairs at later stages of processing. This could explain why transparent and opaque pairs reveal indistinguishably robust priming effects with shorter SOAs while the facilitation for opaque pairs gradually decreases and fades away with longer exposure to primes.

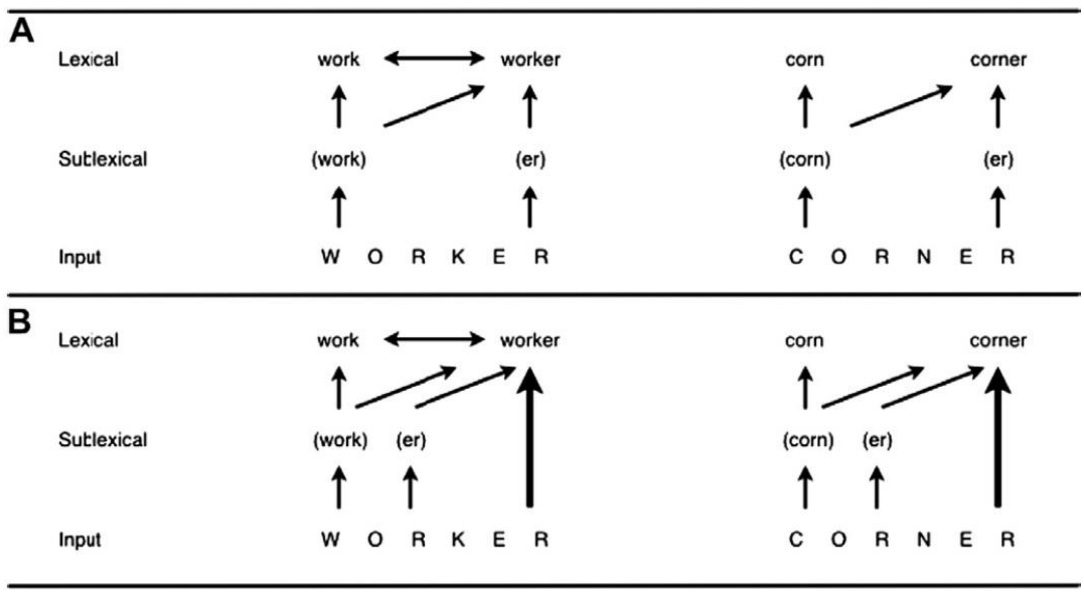

Figure 1. A Model of Form-then-meaning Account and the Parallel Dual-Route Model (Diependaele et al., 2011).

The second panel (B) in Figure 1, on the other hand, diverges from the first panel at the point where it depicts the possibility of whole input to interact with the lexical levels that contains the whole-word representations (i.e., the thickest arrow from the input *worker* to the whole-word representation *worker*). This direct route from the whole input to the lexical levels enables the activation of the target word depending on semantically-based analysis and independently of morpho-orthographic information. More importantly, this purely morpho-semantic route operates concurrently with the morpho-orthographic segmentation route. It must be noted that the morpho-semantic route by itself is claimed to be a sufficient source of facilitatory effects in masked priming studies. In the case of semantically transparent words, the joint effects of the morpho-orthographic and morpho-semantic routes constitute the sources of activation for the corresponding targets since the links are again strong between the pairs at the lexical level (i.e., the interaction between *walk* and *walker*, see the left configuration in Panel B). For opaque words, however, the only reliable source of activation is the morpho-orthographic route. The whole input directly maps onto the whole-word representations for these items as well, but the link between the opaque pairs does not exist at the lexical level (i.e., no interaction between *corn* and *corner*, see the configuration in the right hand side in Panel B), which makes it unlikely for morpho-orthographic and morpho-semantic routes to operate cooperatively to boost the activation to the target simultaneously. Based on this architecture, the model can predict the semantic transparency effect observed in several studies since transparent items receive an activation boost from both routes while opaque items receive activation solely from morpho-orthographic one, which could potentially yield significantly greater facilitation in the case of semantic transparency.

Building on the previously reported models that assume a dual-route for the early processing of complex forms (e.g., Schreuder & Baayen, 1995; Diependaele et al., 2011), Diependaele et al. (2013) introduced a novel version of the parallel dual-route model that makes predictions on the basis of the transposed letter manipulations applied at the (pseudo) morpheme boundaries of transparent and opaque words. This novel version presents two significant components. First, it assumes the existence of two concurrently and cooperatively operating routes in accordance with earlier versions. As presented in the first panel (Panel A) in Figure 2, one of the routes decomposes the complex forms into their morphemic units (worker: work + -er) and these form-based morphemic units becomes the source of activation for the corresponding lexical forms (*worker* and *work*). The second route, on the other hand, enables the whole input to directly map onto the whole-word representations (i.e., the thickest arrow on the left hand side). Second, the lexical forms activated via the two separate routes map this time onto a more abstract level "{work}", where the interactions between lexical forms are encoded in relation to form-based and semantic-based similarities. Such similarities exist between transparent prime-target pairs; however, opaque pairs are devoid of the shared semantic similarities. The first component depicts the morpho-orthographic processing at the sublexical level whereas the second component describes how morpho-semantic processing operates at the supralexical level. Based on this model, Diependaele et al. (2013) suggests that the automatic decomposition of morphologically complex words is influenced by morpho-orthographic and morpho-semantic processes in a cascaded manner.

Within the scope of the dual-route model of morphological processing (see Figure 2), Diependaele et al. (2013) also refers to orthographic processing models to discuss their predictions on how the facilitatory effects of transparent and opaque items would be affected by cross-morphemic letter transpositions. Accordingly, the authors aimed to make a connection between their predictions and the theoretical background behind them. Based on these models, the printed words of alphabetical languages are assumed to be analyzed using two distinct kinds of orthographic code (e.g., Grainger & Ziegler, 2011). The first kind of code, which is called the fine-grained code, is considered to be responsible for identifying adjacent letter sequences that frequently co-occur (e.g., affixes). The coarse-grained code, on the other hand, enables the immediate access to whole-word orthographic and morpho-semantic representations. The relevance of this orthographic code distinction to the dual-route model stems from the claim that the fine-grained code informs morpho-orthographic segmentation whereas the coarse-grained code paves the way for morpho-semantic processing. Most importantly, the fine-grained code is thought to be more susceptible to the precise letter order on the basis of the idea that across-morpheme boundary letter transpositions (e.g., wor<u>ke</u>r-wor<u>ek</u>r) are much more detrimental than the within-morpheme transpositions since the precise letter order and letter identity is crucial for the recognition of affixes (e.g., Duñabeitia et al., 2007). The coarse-grained code, however, is less likely to be affected by such transpositions. Accordingly, the second panel (B) in Figure 2 shows that transparent primes (e.g., worker) are still capable of creating facilitatory priming effects although the activation arising from the morpho-orthographic route is blocked as a result of across-morpheme boundary transposition. The morpho-semantic route, however, remains intact and provides sufficient amount of activation for transparent pairs to reveal significant priming effects. On the other hand, opaque pairs (e.g., corner) are unable to show facilitation since the only source of activation, which is the morpho-orthographic route, is now blocked by the detrimental effects of across-morpheme boundary transposition.

Diependaele et al. (2013) tested the dual-route model of morphological processing to see whether semantic information was available during the early processing of morphologically complex words and to explore whether the morpho-semantic route informs segmentation as a separate source. Adapting the purportedly detrimental effects of across-morpheme boundary letter transpositions, they presented a novel design to scrutinize the long-standing debate on possible role of semantic transparency during the early processing. Diependaele et al. (2013), however, raised another question mark by assuming that across-morpheme boundary transpositions spoil the morpho-orthographic structure of complex forms. This issue should also be addressed since Rueckl & Rimzhim (2011) already showed that such transpositions might not pose any problem for morpho-orthographic segmentation. It is therefore essential to review the debates on letter transpositions and their possible effects. Accordingly, the following section focuses on the discussion on how letters are encoded in the brain and how letter transpositions inform us about the processing of words.

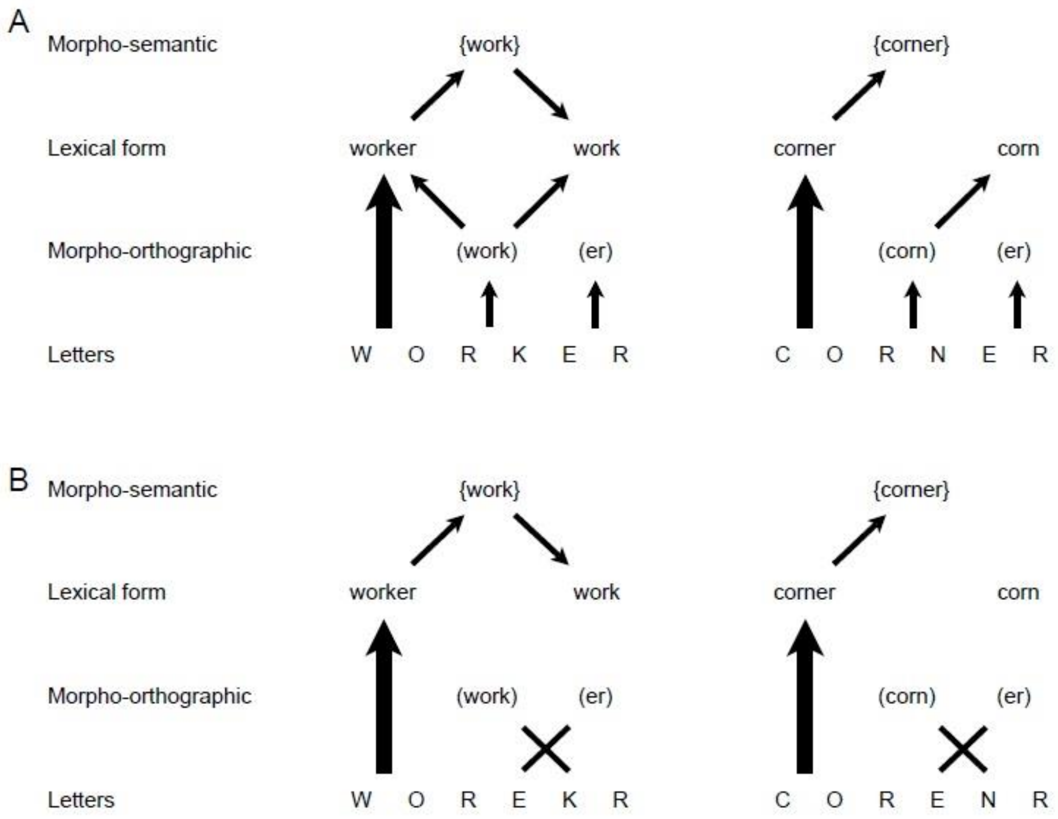

Figure 2. The Dual-route Model of Morphological Processing (Diependaele et al., 2013).

2.2. Letter Encoding Models and The Transposed-letter Effect

To be able to convey a written message in any alphabetical language, it is necessary to combine a set of letter strings in a way that they can form a legal sequence in that specific language. Similarly, the receiver of the message should be able to decode those letter strings to comprehend the intended meaning. For this to happen without giving rise to any conflicts, the identity and the position of the letters must be presented correctly. For instance, the information on the precise letter order is indispensable so that the reader can distinguish between anagrams such as *life* and *file*. Taking a glance at the sentence "As a result of the selfish attitudes of human beings, the Sumatran Rhinoceros are now on the egde of extinction," however, one may or may not notice that the two internal letters of a word were actually misspelled. Those who failed to detect the misspelled word probably perceived the nonword *egde* as *edge* by tolerating the incorrect spelling in the course of fluent reading. Such incidents, which are prevalently encountered in daily life and the social media, raise the question how sensitive the letter encoding system in our brain is to disrupted letter orders.

Following the publication of experimental evidence, it was argued that such transpositions only slightly disrupt the flow of reading (Rayner et al., 2006), and that the human visual word recognition system could in fact tolerate such letter order violations (Perea & Lupker, 2003b). This phenomenon, which is called the transposed-letter (confusability) effect, corresponds to the failure to detect certain letter order disruptions. It is very crucial to dwell on this notable phenomenon since the transposed-letter effect (or *TL effect*) is of critical importance for examining the letter encoding mechanism of the brain. To elaborate, the TL effect has been interpreted in two different ways in the relevant literature. On the one hand, it refers to the slowdown in the processing of words that form already existing letter sequences in the same language when certain letters are exposed to transpositions (e.g., dairy-diary, scared-sacred). That is, it has been documented that it takes more time to process such pairs when compared to match control words (e.g., Andrews, 1996). On the other hand, the TL effect also refers to the facilitative effects of the transposed-letter non-words in studies adopting (masked) priming lexical decision tasks. More precisely, it has been found that non-word primes created by transposing two adjacent or non-adjacent letters of existing words (e.g., *transposed-letter non-words*: egde-EDGE, snece-SCENE) speeded up the recognition of their base form targets more efficiently than non-word primes created by replacing the already transposed letters with two distinct letter pairs (e.g., *replace-letter non-words*: epbe-EDGE, smese-SCENE) when the primes were presented very briefly (e.g., Perea & Lupker, 2003a; Perea & Lupker, 2004). Following this finding, it was concluded that transposed-letter non-words were more similar to their base forms compared to replaced-letter non-words.

Accordingly, the presence of the TL effect indicates that position coding is a highly flexible process at the early stages of visual word recognition as the letter encoding mechanism apparently tolerates letter order violations in transposed-letter primes, which leads to facilitatory effects (*Position Uncertainty*: Duñabeitia, Lallier, Paz-Alonso, & Carreiras, 2015). At some point in processing, however, this uncertainty in letter position encoding must nevertheless be resolved because it is crucial to differentiate anagrams like *trail* and *trial* (Perea & Lupker, 2003a). Further, it could also be argued that the letter position encoding must follow the letter identity coding process since changing the identity of the letters (in replaced-letter primes) results in the disappearance of a priming effect. This clearly shows that the letter encoding mechanism is not that much insensitive in the case of letter identity coding. Taken all together, the transposed-letter effect poses serious problems for some letter encoding models that suggest the position-specific coding of each and every letter in a word. The models that propose position independent coding, on the other hand, can explain why transposed-letter non-words could be more similar to their base forms. To be able to examine how TL effect informs the arguments of these models more elaborately, the following section dwells on some prominent models adopting position specific and position independent letter encoding.

2.2.1. Letter Encoding Models

The earliest models suggesting position-specific letter encoding were the interactive activation model (*IA model:* McClelland & Rumelhart, 1981) and some other models that were created based on the IA model such as the multiple read-out model (Grainger & Jacobs, 1996) and the dual-route cascaded model (*DRC*: Coltheart et al., 2001). These models try to explain how the letter encoding mechanism works based on a slot coding scheme. That is, the models assume that each letter (with their specific identities) is assigned to a certain position within a letter string and processed separately within its own slot. Such a coding scheme could be compatible with the idea that the letter encoding system distinguishes between anagrams. The coding of the word *tea*, for instance, would be demonstrated as $T_1E_2A_3$ based on the interactive activation model (McClelland & Rumelhart, 1981). This representation indicates that the first slot is occupied by the letter *T*, the second slot by the letter *E*, and the third slot by the letter *A.* On the other hand, the word *eat*, which is an anagram of the word *tea*, would be represented as $E_1A_2T_3$. In this case, however, the letter *E* occupies the first slot whereas the letters *A* and *T* occupy the second and the third slots respectively. Although both words contain exactly the same letters, the IA model would suggest that the letter T_1 in the word *tea* and the letter T_3 in the word *eat* are entirely different. The same is valid for the letter *E* and the letter *A* since they also occupy different slots in the two words (E_2 in *tea* but E_1 in *eat*, A_3 in *tea* but A_2 in *eat*). In effect, the model is successful at identifying these anagrams as two distinct words. Considering the words that comprise a relatively small number of letters (e.g., three or four-letter words), it can be seen that anagrams are very common (for English see Shillcock, Ellison, & Monaghan, 2000), and therefore differentiating such letter strings could be very important for orthographic processing.

As previously mentioned, the models adopting a slot coding scheme, however, fail to account for the robust TL effect found in masked priming studies. Applying the same coding representation procedure, the word *edge*, for example, would be coded as $E_1D_2G_3E_4$ whereas the TL non-word *egde* would be represented as $E_1G_2D_3E_4$. Evidently, the word *edge* and the TL non-word *egde* have two overlapping letters occupying the exactly the same slots (i.e., E_1 and E_4). The letters *D* and *G*, however, occupy different slots in the two words (D_2 in *edge* but D_3 in *egde*, G_3 in *edge* but G_2 in *egde*), and are therefore identified as two different letters. Similarly, the replaced-letter non-word *epbe* ($E_1P_2B_3E_4$) also shares the first and the last letters (i.e., E_1 and E_4) with the base form *edge* and the two internal letters (D_2 in *edge* but P_2 in *epbe*, G_3 in *edge* but B_3 in *epbe*) are the differentiating letters between these two letter strings as in the case of *egde*-*edge* comparison. On the basis of these comparisons, the IA model assumes that the TL non-word *egde* and the RL non-word *epbe* can be considered identical in terms of their similarity to the base form *edge*. Depending on models adopting slot coding, therefore, one would expect both non-word kinds to produce statistically equal priming effects when presented before the target *edge*, which is contradictory to the experimental results (e.g., Norris, Kinoshita, & Casteren, 2010; Perea & Lupker, 2003a; Perea & Lupker, 2004; Schoonbaert & Grainger, 2004).

The problems with the slot coding scheme, however, is not limited to the TL priming effect. The models adopting this scheme also fail to capture a kind of priming effect called the *relative priming effect*, which arises when primes with deleted or inserted letters (e.g., csn-CASINO, journeal-JOURNAL) effectively prime their base form targets (e.g., Duñabeitia & Carreiras, 2011; van Assche & Grainger, 2006). It should be noted that the relative positions of the letters in such primes are preserved. Depending on the IA model, for instance, the only overlapping letter with the prime *csn* and the target *casino* is the first letter *C*. Thus, these two letters strings seem to be quite distinct based on this model. In a similar vein, the dual-route cascaded model (Coltheart et al., 2001) also fails to account for this effect since it assumes a beginning-anchored slot-coding scheme. Such a scheme postulates that two letter strings with overlapping initial letters (e.g., *sigh* and *sight*) but not overlapping final letters (e.g., *present* and *represent*) can be regarded as similar. Thus, the primes used in relative position priming studies are quite different from their base form targets depending on the assumptions of the DRC model, and therefore this model cannot explain the priming effects obtained via such prime-target pairs.

Referring back to the TL priming effect, however, models such as the SERIOL (*sequential encoding regulated by inputs to oscillations within letter units*: Whitney, 2001; 2008), the SOLAR *(the self-organising lexical acquisition and recognition*: Davis, 1999; 2010b), and the open bigram models (e.g., *the parallel open bigram model*: Grainger & van Heuven, 2003) could explain why the TL priming effect occurs. For instance, a letter-tagging coding scheme is used by the SERIOL model which involves labelling the letters according to their sequential order within a string (e.g., *Edge*: E-1, D-2, G-3, E-4). The model assumes that the representations of the individual letters are activated sequentially through the firing of letter detectors. The firing sequence in turn informs open bigram units, which hold information about the relative positions of the letters in a string. That is, open bigrams could be considered as the coding level located between individual letters and whole-word representations (Whitney & Cornelissen, 2008). The basic structure of open bigrams comprises adjacent or non-adjacent two-letter strings which are formed depending on the canonical order of the letters appearing in a certain word.

As a result of the activation of bigram units, the word *bold*, for instance, would be represented with the contiguous bigrams #*B*, *BO*, *OL*, *LD*, *D*# (the symbol # corresponds to a word boundary) and also with the noncontiguous bigrams *BL*, *BD*, *OD*. It is worth noting, however, that the activation weight of the contiguous and the noncontiguous bigrams are not equally distributed. The weight of the contiguous bigrams and the edge bigrams (i.e., #*B* and *D*#) is indicated as 1.0 whereas the weight of noncontiguous bigrams with only one intervening letter in between is determined as .8. The weight of the noncontiguous bigrams with two intervening letters in between, on the other hand, is determined as .4 (Whitney, 2008). Applying the same bigram coding procedure to the TL non-word *blod*, the following contiguous and noncontiguous bigram nodes arise: #*B*, *BL*, *LO*, *OD*, *D*# and *BO*, *BD*, *LD*. The RL non-word *bkad*, on the other hand, is represented by the following bigram sets: #*B*, *BK*, *KA*, *AD*, *D*# and *BA*, *BD*, *KD*. Simply comparing the non-words and the base form *bold*, one can easily notice that the TL non-word *blod* shares more bigram nodes with the base form (i.e., #*B*, *BO*, *LD*, *BL*, *BD*, *OD*, *D*#) compared to the RL non-word *bkad* (i.e., #*B*, *BD*, *D*#). Therefore, it can be concluded that the TL non-word is more similar to the base form than the RL non-word, which could yield greater priming effects for the TL primes. Similarly, the relative position priming effect could also be explained by the SERIOL model since the primes with deleted or inserted letters share more overlapping bigrams with the base form than that of control words.

The models adopting open bigram coding, however, are not limited to the SERIOL model (Whitney, 2001; 2008), but they propose different ideas based on the way the bigrams are formed. For instance, the earlier versions of open bigram models, on the one hand, suggest the involvement of each and every bigram node regardless of how distant the two letters are relative to each other (e.g., all the following noncontiguous bigrams of the word *chicken* are counted: *CI*, *CC*, *CK*, CE, *CN*). On the other hand, the latest versions of the open bigram models tend to include only the noncontiguous bigrams with at most two intervening letters in between (e.g., the following bigrams of *chicken* are left out: *CK*, CE, *CN*). This two-intervening-letters constraint is grounded on the evidence from neurobiological studies (e.g., Dehaene, Cohen, Sigman, & Vinckier, 2005). Further, it must be recalled that the weight of the bigrams show variations according to bigram types in the SERIOL model (Whitney, 2001; 2008); however, the parallel open bigram model proposed by Grainger & van Heuven (2003) suggests that the weight of each bigram in a certain word is identical. Although variations exist among the open bigram models, they successfully account for the TL effect and the relative position priming effect.

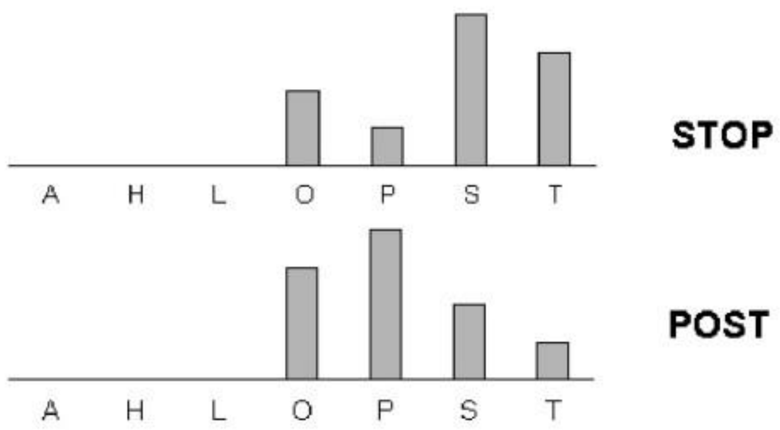

Figure 3. Representations of the Anagrams STOP and POST Based on Spatial Coding (Davis & Bowers, 2006).

Moreover, the SOLAR model (Davis, 1999; 2010b) can also predict the TL effect since it suggests that the letters are coded in a position-independent manner (hereafter *spatial coding*, see Figure 3). The model also posits that each letter in a letter string receives a different amount of activation to be able to distinguish between anagrams, which require ultimate encoding of letter positions. As presented in Figure 3, the word *stop* and the word *post*, for example, share the same letters but the letter *s* receives more activation in *stop* than in *post* since the first letter of the string is claimed to receive the highest activation and the amount of the activation received by the letters gradually decreases towards the end of the string. Based on the position independent coding assumed by the SOLAR model, it can be concluded that the TL non-word *blod* and the base form *bold* contain exactly the same letter codes. The RL non-word *bkad*, on the other hand, contains two different letter codes compared to the base form *bold*. Accordingly, the TL non-words are assumed to be orthographically more similar to the base forms. The similarity between the TL nonwords and their base forms could therefore be the source of the robust TL priming effect. It is noteworthy that the SOLAR model was reported to show neurologically more plausible assumptions compared to the SERIOL model; however, the readers are directed to Davis (2010a) and Whitney (2008) to learn about the differences between the SERIOL and the SOLAR models.

Reviewing the literature, it can be seen that the debate on how letters are encoded has not arrived at a consensus yet, but there is ample evidence that the letter encoding mechanism shows some sort of position uncertainty in the course of visual word recognition. As discussed earlier, the idea of position independent letter encoding stems from the results of studies using transposed-letter manipulations. The TL effect suggests that letter encoding based on slot coding scheme is in fact empirically less plausible; otherwise, the transposed-letter and the replaced-letter nonwords would behave indistinguishably and would therefore produce similar priming effects. To inspect the TL effect further, the following section focuses on studies applying transposed-letter manipulations and the cases where the facilitatory effects of the TL primes fail to arise.

2.2.2. The Transposed-letter Effect

As discussed earlier, the existence of the TL effect was reported for cases where primes created by transposing two letters of a word (i.e., TL primes: egde) facilitated the recognition of their base forms (*EDGE*) significantly greater than primes created by completely altering the two transposed letters under certain constraints (i.e., replace-letter primes: epbe). Arriving at statistically indistinguishable facilitation from TL primes and identity primes (i.e., the base form itself used as prime: edge) was also considered as indicative of the TL priming effect. Several studies have so far shown that the TL effect is a robust phenomenon (cf. Rastle et al., 2019) and this has been been supported by studies testing various languages (e.g., Perea & Lupker, 2003a; Perea & Lupker, 2003b in English, Schoonbaert & Grainger, 2004 in French, Colombo, Sulpizio, & Peressotti, 2017 in Italian, Perea & Lupker, 2004; Perea & Lupker, 2007 in Spanish, Yakup, Abliz, Sereno, & Perea, 2015 in Uyghur). One of the most prominent studies investigating the TL effect was conducted by Forster, Davis, Schoknecht, & Carter (1987). The authors ran a masked priming lexical decision task (Experiment 1) with a 60 ms SOA. The participants were presented with four different prime type conditions before each base form target: (a) identity primes (answer-ANSWER), (b) TL primes (anwser-ANSWER), (c) one-letter substituted primes (antwer-ANSWER), and (d) unrelated control primes (dinner-ANSWER). As a result, using the unrelated control condition as the baseline, the facilitations obtained in the identity condition (64 ms) and the TL condition (63 ms) were statistically identical, indicating that the TL non-word primes could facilitate the processing of the targets as strongly as the primes identical to the targets. Further, the facilitation obtained from the one-letter substituted primes was relatively smaller than that of the identity and TL primes. Thus, it can be concluded that the participants perceived TL non-word primes as more similar to the base form compared to the RL non-words primes.

Further, Perea & Lupker (2003a) also examined the transposed-letter effect with monomorphemic five-letter long English words using masked priming lexical decision task in Experiment 1 (40 ms SOA). In line with the previously reported studies, the authors arrived at the conclusion that both identity (usher-USHER) and TL-internal (uhser-USHER) primes produced significant priming effects (47 ms and 30 ms respectively) and these effects were greater than that of RL primes (ufner-USHER). Moreover, to test whether transposing two non-adjacent letters in a word would also yield priming effects, Perea & Lupker (2004) conducted a masked priming lexical decision task (50 ms SOA). The primes were created by transposing two non-adjacent consonants of Spanish words (e.g., caniso-CASINO) in Experiment 1. The results replicated the findings of the studies that implemented adjacent letter transpositions. That is, the TL non-words created by transposing two non-adjacent letters also produced greater facilitation than that of orthographic control primes (e.g., caviro-CASINO). The existence of the TL priming effect was also reported for French. With a masked priming lexical decision task (53 ms SOA), Schoonbaert & Grainger (2004) found the facilitatory effects of TL non-word primes. TL primes created by transposing two internal letters of a word (e.g., corut-COURT, *short*) significantly speeded up the recognition of their base form targets compared to a set of unrelated non-word primes (e.g., polab-COURT). Even more interestingly, it was reported that the TL non-words could also produce associative priming effects. For instance, Perea & Lupker (2003b) showed that the TL prime *jugde* significantly facilitated the recognition of the target *COURT*, which is semantically related to the base form *judge*. The RL non-word prime *judpe*, on the other hand, revealed no facilitation at all when presented before *COURT*. This study therefore demonstrated that the facilitatory effects of TL non-words was not limited to form priming; the TL non-words could also facilitate the recognition of targets that are semantically but not orthographically related to their base forms.

Taken together, the obtained findings indicate that the TL effect is a notable and well-documented phenomenon; however, the studies also provided evidence for the fact that the TL effect could disappear under certain conditions. For instance, Perea & Lupker (2003a) also tested the possible modulating effects of the position of transposition. Testing a TL-final condition (ushre-USHER), the authors found that the TL-final non-word primes could not facilitate the recognition of their targets significantly stronger than the RL-final non-word primes (ushno-USHER). Compared to the TL-internal primes (uhser-USHER), it turned out that the TL-final primes produced relatively weaker facilitation when corresponding control conditions were treated as baseline (i.e., TL-internal vs. RL-internal and TL-final vs. RL-final). However, Perea & Lupker (2003a) drew attention to the fact that there were in fact only 2 ms difference between TL-internal (556 ms) and TL-final (554 ms) conditions when these two conditions were compared numerically irrespective of their corresponding RL conditions. To further investigate this ambiguous result, the authors compared the facilitatory effects of TL-internal and TL-final primes using two more baseline control conditions that contained completely unrelated non-word primes (unrelated control conditions for TL-internal: bausn-USHER and for TL-final: bacse-USHER) in Experiment 2. The findings once again showed the presence of robust TL priming effect, but the divergent results regarding the position of transposition were replicated. That is, TL-internal primes revealed significantly greater priming effects than that of TL-final primes.

The disappearance of TL priming effect when the transpositions involved the external letters of the words was also reported by Schoonbaert & Grainger (2004). However, unlike Perea & Lupker (2003a), the authors tested the effects of TL-initial (<u>oc</u>urt-COURT) along with TL-final primes (cou<u>tr</u>-COURT). To compare the effects of these external letter transpositions, a TL-internal prime condition (corut-COURT) was used as a baseline. Further, Schoonbaert & Grainger (2004) tested whether the legth of the input would reveal differential patterns as well. Accordingly, two groups of items including 5-letter and 7-letter long words were formed. The effect of prime type was significant and it turned out that TL-inner condition produced significant TL priming effect in both 5-letter and 7-letter targets. TL-initial and TL-final primes, on the other hand, failed to show significant priming effects in 5-letter long targets (for further evidence, see Rayner et al., 2006; Perea & Lupker, 2007). However, interestingly, the significant facilitatory effects of external letter transpositions were observed in 7-letter long targets. Therefore, length of the input could also be considered as a significant factor affecting the TL priming. Moreover, Perea & Lupker (2004) found evidence for the fact that transposing two vowels could also have detrimental effects on TL prime facilitations unlike transpositions comprising two consonants. This discrepancy between consonant-consonant and vowel-vowel transpositions was attributed to the fact that vowels might be receiving more activation than consonants and transpositions involving vowels lead to a decrease in the number of overlapping vowel-vowel bigrams; therefore, making the TL non-words less similar to their base forms. The same asymmetry between consonant-consonant and vowel-vowel transpositions was also observed in Lupker, Perea, & Davis (2008). However, the most prominent case where the TL effect has been reported to be blocked is the case of cross-morphemic transpositions. Although a substantial number of studies already showed that the TL effect was still intact despite the letter transpositions crossing a morpheme boundary, the studies arriving at the detrimental effects of such transpositions are also well-documented. In this regard, the debate on the effects of cross-morphemic transpositions displays a similar dichotomy as in the case of form-first versus form-with-meaning account. Further, depending on the claim that cross-morphemic transpositions incapacitate the activation arising from the morpho-orthographic route, testing the effects of TL-across non-words together with semantic transparency might potentially inform the debate on the role of semantic information in the early processing significantly. Thus, the following section dwells on the divergent results regarding cross-morphemic transpositions and how these results were interpreted based on the letter/word recognition models.

2.2.3. Cross-morphemic Letter Transposition Studies

As discussed earlier, the dual-route model of morphological processing (Diependaele et al., 2013) predicts the detrimental effects of cross-morphemic letter transpositions. That is, transposing the last letter of a root word and the first letter of a suffix would prevent the fine-grained code to inform morpho-orthographic segmentation. The letter transpositions at morpheme boundary in turn result in the disappearance of a priming effect depending solely on the morpho-orthographic route for facilitation (i.e., for opaque pairs) since the activation from the morpho-semantic route is not available for semantically unrelated prime-target pairs. Further, it is claimed that such transpositions have detrimental effects on the recognition of semantically transparent forms as well; however, the activation arising from the morpho-semantic route provides sufficient boost for priming in the presence of semantic transparency. Taking a look at the relevant literature, however, it can be seen that the experimental evidence available does not unambiguously support the claim concerning the detrimental effects of cross-morphemic transpositions. Studies have instead displayed a controversy over the possible disappearance of a TL priming effect when the transpositions cross a morpheme boundary. Due to the fact that the predictions of the dual-route model were tested within the scope of the present study, it is of great concern to scrutinize the divergent experimental evidence on this issue.

To be able to see whether cross-morphemic transpositions in fact eliminate a possible priming effect, studies usually compared the facilitatory effects of TL non-words that were exposed to within-morpheme (e.g., *vrebal-verbal*) and across-morpheme (e.g., *verabl-verbal*) transpositions. It was found that only within-morpheme TL non-words significantly speeded up the recognition of their targets whereas across-morpheme TL non-words failed to reveal any priming effects. This result was taken as evidence for the co-occurrence of morpho-orthographic segmentation and a letter encoding process. That is, the absence of priming in the case of across-morpheme transpositions was attributed to the fact that cross-morphemic transpositions could only prevent the parser from identifying the individual morphemes if decomposition had already begun in the course of letter encoding process. However, a substantial number of studies have reported supportive evidence for the existence of a priming effect irrespective of the position of the transposition in a word. Although there has been agreement on the interpretation of the absence of priming effect for cross-morphemic transpositions, it can be seen that arriving at facilitatory effects of transpositions crossing a morpheme boundary has been interpreted in two different ways.

On the one hand, it has been claimed that the letter encoding process must precede morpho-orthographic segmentation, which enables priming to arise despite the disruption of morpheme boundaries since morpho-orthographic information has not been processed yet. The theoretical background of this claim in fact is based on the assumptions of letter encoding models that assume position independent coding such as the SOLAR (Davis, 1999; 2010) and the overlap models (Gómez, Ratcliff, & Perea, 2008). On the other hand, it has been considered that cross-morphemic transpositions disrupt the morpho-orthographic channel in any case since the fine-grained code, which informs morpho-orthographic processing, is thought to be susceptible to the precise letter order (Diependaele et al., 2013; Grainger & Ziegler, 2011). However, facilitation from cross-morphemic TL non-words is still possible since the early processing of morphologically complex forms involves the activation of the whole word representation along with the constituent morphemes. The whole-word representation, therefore, provides a channel for priming based on the dual-route model (Diependaele et al., 2013).

Christianson, Johnson, & Rayner (2005), for example, investigated how the position of transposition would affect the priming of TL non-words using three masked priming naming tasks. The stimuli were presented visually and the participants were expected to respond by naming the target words out loud. The linguistic focus of the first experiment was English compound words. Applying within-morpheme and across-morpheme transpositions along with two control conditions, Christianson et al. tested the following four prime conditions: (a) identity (e.g., sunshine-SUNSHINE), (b) within-morpheme TL (e.g., sunhsine-SUNSHINE), (c) across-morpheme TL (e.g., susnhine-SUNSHINE), and (d) one–letter-different orthographic control (e.g., sunsbine-SUNSHINE). It is important to point out that unlike the common formation of orthographic control words in TL studies, which involves replacing the already transposed two letters with a letter pair consisting of two different letters, Christianson et al. preferred creating the orthographic control words by altering only one letter of the base form.

With a 100 ms SOA (60 ms prime display and 40 ms backward mask), the results of Experiment 1 showed that the identity and the within-morpheme TL primes significantly facilitated the naming of their targets. In the across-morpheme TL prime condition, however, the priming effect disappeared as the facilitatory effects of these primes did not statistically differ from that of the orthographic controls. Drawing attention to the fact that within-morpheme TL primes speeded up naming to a greater extent relative to one-letter-replaced primes, Christianson et al. challenged the letter encoding models suggesting position specific coding. More precisely, the one-letter-replaced primes would be expected to yield significantly greater priming since these primes were in fact more similar to the corresponding base forms compared to within-morpheme TL primes according to the assumptions of such models. The empirical evidence, however, showed that it seems unlikely. Most importantly, the disruptive effect of across-morpheme primes was replicated with pseudo compounds (e.g., identity: *mayhem*, TL: *mahyem*, and RL: *malpem*) in Experiment 2 and with agentive derivatives (e.g., identity: *boaster*, TL: *boasetr*, and RL: *boasler*) in Experiment 3. On the basis of their findings, Christianson et al. took in concluded that the fast-acting effects of morphological decomposition might occur simultaneously with letter order coding at the early stages of word recognition. However, the authors indicated that it could be hard to draw firm conclusions on this claim since they used a 100 ms stimulus onset asynchrony. Thus, it could only be suggested that morphological processing took place at one point within 100 ms upon visually encountering the input.

Following a similar procedure, Perea & Carreiras (2006) explored whether cross-morphemic transpositions would be more detrimental than the morpheme-internal transpositions by focusing on Basque, which holds a rich and highly agglutinating morphology (Trask, 1998). Using a masked priming lexical decision task, the authors tested compounds and non-compounds applying transposed-letter and replaced-letter prime manipulations. It should be noted that the transpositions involved switching two non-adjacent letters in the experimental items, but such transpositions were already shown to produce significant priming effects as discussed in section 3.1.1 (e.g., Perea & Lupker, 2004). Cross-morphemic transpositions were formed with compounds (e.g., identity: argibide-ARGIBIDE, *explanation*, TL: arbigide-ARGIBIDE, RL: arkipide-ARGIBIDE) whereas the transpositions in non-compounds (e.g., identity: orkatila-ORKATILA, *ankle*, TL: ortakila-ORKATILA, RL: orbahila-ORKATILA) were treated as morpheme internal. The primes remained on the screen for 47 ms and the participants decided whether the presented targets were existing Basque word by pushing the specified buttons on a keyboard.

Unlike the findings of Christianson et al., it was found that the position of the transposition did not significantly affect the magnitude of the priming effects obtained with TL primes. That is, transpositions that were applied to both compounds and non-compounds yielded significant facilitatory effects (i.e., 28 ms and 31 ms, respectively) when compared to the replaced-letter primes. Based on these findings, Perea & Carreiras (2006) concluded that the TL effect could be a phenomenon pertaining to a very early stage of processing (possibly the orthographic level). Lastly, it was argued that the results supported the successive processing of letter encoding and morpho-orthographic information since the disruption of the mere presence of morphological complexity did not interfere with the priming effects in the case of the across-morpheme TL condition. It was therefore suggested that obtaining facilitation with cross-morphemic transpositions could only be possible if the parsers showed a tendency towards decomposing the complex forms following the letter encoding process. Perea & Carreiras (2006) speculated that the divergent results of Christianson et al. (2005) might have stemmed from the use of a relatively long SOA (100 ms) since the vast majority of the studies investigating the TL effect in the masked priming paradigm tended to opt for shorter SOAs (e.g., 60 ms). Further, it was argued that implementing a masked priming naming task rather than a lexical decision task might also have yielded the observed findings in Christianson et al. (2005). Lastly and most importantly, Perea & Carreiras (2006) mentioned that the critical interaction between the compounds and non-compounds turned out to be insignificant when identity primes and orthographic controls were treated as baselines in Experiment 2 in Christianson et al. (2005). This could be interpreted as suggestive of similar priming effect patterns for within-morpheme and across-morpheme transpositions. Thus, Perea & Carreiras (2006) concluded that the findings of Christianson et al. (2005) were not compelling but ambiguous.

To see whether the effects of cross-morphemic transpositions could be observed cross-linguistically, Duñabeitia, Perea, & Carreiras (2007) focused on prefixed and suffixed forms in Basque and Spanish using three masked priming lexical decision experiments. The critical items of the first experiment were suffixed Basque words. As in Perea & Carreiras (2006), across-morpheme transpositions were applied to complex forms (in this case, suffixed forms) while within-morpheme transpositions were presented through non-affixed forms. Further, replaced-letter primes were formed for both suffixed and non-suffixed forms by altering the transposed two letters. Overall, the prime-target conditions in Experiment 1 were the following: (a) TL condition (e.g., suffixed: txape<u>dl</u>un-TXAPELDUN, *winenr-WINNER*; non-suffixed:

txapnona-TXANPONA, *cion-COIN*) and (b) RL condition (e.g., suffixed: txapebtun-TXAPELDUN, *winasr-WINNER*; non-suffixed: txagsona-TXANPONA, *cuen-COIN*). Despite testing the same language, the findings of Experiment 1 were in sharp contrast with the findings of Perea & Carreiras (2006), showing that cross-morphemic transpositions eliminated the priming effect while within-morpheme TL primes significantly facilitated the recognition of their targets (with a 66 ms SOA). It was therefore claimed that morphological decomposition could be taking place at very early stages of word recognition and coinciding with the letter encoding process. Concerning the divergent findings compared regard to Perea & Carreiras (2006), Duñabeitia et al. entertained the possibility that the use of compounds might have resulted in the observed pattern in Perea & Carreiras (2006) since it would be unlikely for parsers to identify lexeme boundaries in such structures because of the lack of cues marking the boundaries.

With the aim of investigating whether the findings of Experiment 1 would also apply to prefixed words in a structurally different language, Duñabeitia et al. tested the same prime conditions in Spanish and replicated the exact pattern found with Basque suffixed words. Importantly, it was found that the affix type did not modulate the observed pattern, indicating that the absence of priming effect for across-morpheme TL primes was observed with suffixed and prefixed forms. Depending on this finding, the fast-acting effects of morpho-orthographic segmentation, which was claimed to be processed concurrently with letter order information, turned out to be language-independent. However, it is crucial to mention that that the across-morpheme and within-morpheme transpositions were tested via two different item sets (across-morpheme with complex forms and within-morpheme with simplex forms) in the previous experiments. Therefore, Duñabeitia et al. conducted an additional experiment making use of the materials of Experiment 2; however, this time both within-morpheme and across-morpheme transpositions were applied to the same item set (i.e., suffixed or prefixed Spanish words). Unsurprisingly, the findings of Experiment 3 were consistent with the earlier two experiments. As a result, Duñabeitia et al. argued that the disruptive effects of cross-morphemic transpositions apply to suffixed and prefixed forms alike, irrespective of cross-language differences.

Addressing the problems with utilizing two different set of items to investigate within-morpheme and across-morpheme transpositions, Rueckl & Rimzhim (2011) also aimed to find out whether cross-morphemic transpositions would eliminate any priming effect by applying TL and RL manipulations to the same set of items in English. However, to be sure that the facilitatory effects of within-morpheme primes were in fact unequivocal, the authors solely focused on the TL-within condition in Experiment 1. The experiment was a standard masked priming lexical decision task with a 48 ms prime display duration. The TL-within condition was formed by transposing the last two letters of root words whereas the orthographic control RL condition was formed by replacing the two transposed letters with two different letters under certain constraints (e.g., replacing vowels with vowels and consonants with consonants). As the baseline condition, identity primes were used (e.g., teacher-TEACH or speaker-SPEAK). It must be emphasized that Rueckl & Rimzhim (2011) presented the non-suffixed forms of the primes as targets unlike the previously reported studies, which presented whole-word targets. The choice of root targets was justified through the claim that it would be unlikely to determine whether any observed priming effects stemmed from morphological processes or simply from orthographic overlap when primes and targets were both morphologically complex. In addition to the TL manipulation, the transposed letter pairs were further divided into two groups as comprising Consonant-Consonant (CC, transposed-letter: tea<u>hc</u>er-TEACH, replaced-letter: tea<u>ks</u>er-TEACH) and Vowel-Consonant (VC, transposed-letter: spe<u>ka</u>er-SPEAKER, replaced-letter: spe<u>fu</u>er-SPEAKER) configurations to see whether the transposed letter type would interact with the priming effect. Not surprisingly, Rueckl & Rimzhim (2011) found facilitatory effects of TL-within primes and this effect was not modulated by the type of the transposed letters; both CC and VC transpositions yielded the same pattern.

The main focus of Rueckl & Rimzhim's second experiment was to see whether across-morpheme transpositions would interfere with the priming effect. Experiment

2 was hence identical to the Experiment 1, the only difference being the use of TL-across (e.g., CC: teacehr-TEACH or VC: speaekr-SPEAK) primes rather than TL-within primes. Contrary to earlier evidence indicating that cross-morphemic transpositions eliminate priming effects, Rueckl & Rimzhim (2011) found that TL-across primes significantly facilitated the recognition of their targets as in the case of TL-within primes. More importantly, testing both TL-within and TL-across conditions in a single experiment (Experiment 3), the authors again obtained facilitation from the primes displaying across-morpheme transpositions and this effect was indistinguishable from that of TL-within primes.

Regarding the fact that the findings reported by Rueckl & Rimzhim diverge considerably from those obtained in earlier studies (e.g., Christianson et al., 2005; Duñabeitia et al., 2007), the authors entertained the possibility that the use of root targets might have affected the results. The authors drew attention to the claim that TL-across primes could in fact be perceived as more similar to the targets in comparison to the TL-within primes since the shared letters in the same position were greater in number between TL-across primes and the targets (3 letters in TL-within: *teahcer-TEACH*, but 4 letters in TL-across: *teacehr-TEACH*). Keeping this possible confound in mind, Rueckl & Rimzhim decided to test the same conditions with suffixed targets in Experiments 4 and 5. Experiment 5 differed from Experiment 4 in that the authors preferred using a longer SOA (80 ms) to see whether the observed pattern was a consequence of a relatively shorter prime display duration since earlier studies arriving at the lack of priming in the case of cross-morphemic transpositions used longer SOAs (e.g., 100 ms in Christianson et al., 2005 and 66 ms in Duñabeitia et al., 2007). The authors found that the TL-across condition yielded significantly longer reaction times compared to the baseline identity primes; however, the facilitation obtained for the TL-within and the TL-across conditions were statistically indistinguishable in Experiment 4. This result needs to be treated with caution as it would be expected that the TL-across primes produce statistically similar priming as the identity primes when the position of transposition does not modulate priming effects. Despite the fact that the findings regarding the TL-across condition were open to question in Experiment 4, the results of Experiment 5 were straightforward. Even with a longer SOA, it was found that both TL-within and TL-across primes showed as high priming effects as the identity primes and that the position of the transposition did not induce any change in the priming pattern. Thus, the results of all five experiments challenged the view that transpositions crossing a morpheme boundary would display detrimental effects on prime facilitation (hereafter *boundary effect*: Rueckl & Rimzhim, 2011). Now that the results consistently rejected the existence of a boundary effect, it could be argued based on these findings that morphological decomposition follows the processing of letter position information in the course of the early visual word recognition.

To see whether cross-language differences would lead to distinct patterns for the priming effects obtained with TL-within and TL-across transpositions, Sánchez-Gutiérrez & Rastle (2013) conducted two masked priming lexical decision experiments in Spanish and in English. In order to avoid item-related confounds that could arise because of using completely distinct item samples in the Spanish and the English experiments, the authors preferred using cognate words that were orthographically identical (e.g., accidental-accidental) or almost identical (e.g., incorrect-incorrecto) across the two languages. Testing the TL-within and TL-across conditions together in each experiment, Sánchez-Gutiérrez & Rastle (2013) found facilitative effects of TL primes in Spanish and English, irrespective of the position of the transposition. Relying on the claim that Spanish morphology displays greater productivity and diversity (Beyersmann, Coltheart, & Castles, 2012), the authors considered that the discrepancy between the findings of Duñabeitia et al. (2007) in Spanish and the findings of Rueckl & Rimzhim (2011) in English might have been the result of these morphological differences. Given the fact that the stimuli in Sánchez-Gutiérrez & Rastle (2013) were very tightly controlled, it seems unlikely that the divergent results between Spanish and English studies were the outcome of cross-language variations. Sánchez-Gutiérrez & Rastle (2013), therefore, claimed that their results unambiguously supported the non-disruptive effects of cross-morphemic transpositions and entertained the possibility that the results of Duñabeitia et al. (2007)

might have "reflected idiosyncratic properties of the stimuli or the participants, or a Type I error" (p. 992). Further, the authors also called the findings of Christianson et al. (2005) into question because of the fact that the latter failed to arrive at a significant interaction between the target type and prime conditions as also specified by Perea & Carreiras (2006) and that a very limited item sample was tested in the study.

Earlier experimental evidence showed that transpositions involving the external letters of a word (the first and the last letters) displayed greater positional certainty whereas transposing the internal letters of a word resulted in imprecise letter order coding (e.g., Perea & Lupker, 2007; Rayner et al., 2006). Following this evidence, Beyersmann, McCormick, & Rastle (2013) also focused on whether letter transpositions crossing the morpheme boundary would yield detrimental effects since such transpositions could in effect involve transposing the external letters of a root and an affix, as discussed earlier. However, Beyersmann et al.'s findings, provided counter evidence against these claims since the results of the masked priming lexical decision task (Experiment 1, 43 ms SOA) revealed that there was no boundary effect, indicating significantly indistinguishable facilitation from both within-morpheme and across-morpheme transpositions. The authors additionally took into consideration that the overall proportion of trials that included affixed primes could affect how TL-within and TL-across prime-target pairs were processed. The issue of the proportion of affixed trials was brought into question based on the probability that using a low proportion of affixed primes (e.g., presenting affixed primes before the critical items but not before non-word filler trials) might have led the participants to depend more on morpheme-based analysis for experimental items as they could strategically benefit from affixes as processing cues. This, in turn, might cause reduced priming effects for across-morpheme transpositions. Beyersmann et al. (2013), therefore, suspected that the lack of priming for cross-morphemic transpositions in Duñabeitia et al. (2007) could be the result of using affixed primes only for the experimental item set.

Accordingly, in Experiment 2, Beyersmann et al. (2013) tested the effect of TL-within and TL-across conditions by replacing the affixed primes of the non-word filler trials with non-affixed primes to be able to see whether the proportion of affixed trials was a significant source of the absence of priming in the TL-across condition. However, the results of Experiment 2 showed that the proportion of affixed primes did not have an effect on the observed priming pattern. That is, the authors replicated the findings of Experiment 1, which included affixed primes for non-word trials. Further, Beyersmann et al. also tested whether the differences between the frequencies of primes relative to their corresponding targets might have been the source of the discrepant results. Using primes that were at least twice as frequent as their targets (e.g., government-GOVERN) and primes that were less frequent than their targets (e.g., concretely-CONCRETE), the authors applied the usual TL-within and TL-across manipulations in Experiment 3. The results once again revealed that there were no modulating effects of the relative frequency differences between the primes and the targets in the across-morpheme condition. Referring to earlier studies that reported a boundary effect, Beyersmann et al. also indicated that the results of Christianson et al. (2005) were disputable due to the limited sample size. Moreover, the authors speculated that the boundary effect found by Duñabeitia et al. (2007) might have stemmed from the morphological differences between Spanish and English; however, it should be recalled that Sánchez-Gutiérrez & Rastle (2013) found no differences between these two languages in terms of the facilitation obtained with cross-morphemic TL primes.

Beyersmann et al. interpreted these results in two different ways. First, it was claimed that the affixes might also be displaying position uncertainty as in the case of monomorphemic words. However, it was considered to be unlikely that the affixes could potentially be coded in a position-independent manner as the parser may then end up decomposing words that are in fact non-decomposable. For instance, as a consequence of position-independent coding of affixes, the word *nuclear* would be analyzed incorrectly as *unclear* (un + clear). Thus, in such a scenario, the parsing mechanism could yield the misanalysis of a vast number of forms, which may pose serious problems the processing of complex forms, especially in morphologically rich languages like Turkish and Basque. The second explanation for the absence of a boundary effect was based on the idea that morphemic subunits and whole-word representations of complex words are activated simultaneously as proposed by Diependaele, Sandra, & Grainger (2009) and Diependaele et al. (2013). This provides an alternative activation route for facilitation (activation of whole-word representations) although cross-morphemic transpositions incapacitate the morpho-orthographic route. However, this explanation only holds for truly-suffixed words like *cleaner* since only such structures provide access to whole-word representations based on the dual-route model of morphological processing (Diependaele et al., 2013). As discussed in section 2.2, the model predicts the disappearance of priming for pseudo-complex forms like *corner* as the target *corn* is not semantically compatible with the input (prime) *corner*, which eliminates any facilitation arising from the whole-word mapping. Therefore, the morpho-orthographic route turns out to be the only source of facilitation for pseudo-complex forms; however, this route is incapacitated by cross-morphemic transpositions. Since Beyersmann et al. (2013) did not test whether across-morpheme transpositions would affect truly-suffixed and pseudo-suffixed words differently, drawing the conclusion that the activation of whole-word representations along with constituent morphemes provides an alternative source for facilitation despite the detrimental effects of cross-morphemic transposition should be approached cautiously. Further, it should also be recalled that this result was interpreted differently by other researchers arriving at the same pattern (e.g., Perea & Carreiras, 2006; Rueckl & Rimzhim, 2011). Therefore, the probability that the absence of a boundary effect might also be indicative of the sequential processing of letter order and morpho-orthographic information cannot be simply ruled out.

As can be seen from the reported studies, the investigation of cross-morphemic transpositions has mostly focused on derivation or compounding. To see whether the processing of inflectional affixes would reveal a divergent pattern, Zargar & Witzel (2016) tested within-morpheme and across-morpheme conditions with regularly inflected forms in English. The main purpose of the study was to examine whether and how morpho-orthographic segmentation and letter encoding would interact with each other. That is, the authors investigated whether these two processes would take place successively or in a cascaded manner. The critical inflectional suffixes used in the study were *-ing, -est, -er,* and *-ed*. Zargar & Witzel formed four conditions by implementing TL-within (e.g., luoder-LOUDER) and TL-across (e.g., louedr-LOUDER) manipulations together with their orthographic control counterparts (e.g., RL-within: liader-LOUDER, RL-across: (e.g., lousur-LOUDER). As in the previously mentioned studies, Zargar & Witzel (2016) made use of the classic masked priming lexical decision paradigm (SOA: 50 ms). It is noteworthy that the authors made use of affixed targets in Experiment 1 and non-affixed targets (e.g., LOUD) in Experiment 2 in order to understand whether morphological decomposition occurred during the recognition of targets. Both experiments yielded supportive evidence for the facilitatory effects of TL primes, irrespective of the position of the letter transposition. TL-across primes facilitated the recognition of their base form targets as effectively as TL-within primes. On the basis of these findings, Zargar & Witzel (2016) claimed that the type of morphology (i.e., inflection vs. derivation) did not affect the processing of complex forms. Unlike Beyersmann et al. (2013), the authors interpreted the absence of a boundary effect as evidence for the fact that morphological segmentation was initiated after the letter encoding process, which enabled the facilitation from cross-morphemic transposition. It should be recalled that Beyersmann et al. (2013) attributed exactly the same finding to the existence of an alternative route (whole-word representations) that provided facilitation when the transpositions crossed the morpheme boundary even though such transpositions incapacitated the morpho-orthographic route.

As mentioned in section 2.1, Andrews & Lo (2013) brought a novel perspective to the debate on how morphologically complex words are processed as a result of revealing the possibility that individual differences among readers could be crucial factors modulating the way of processing. It was shown that some readers rely more on morpho-semantic processes whereas some rely more on morpho-orthographic information in the course of the early processing of morphologically complex forms. As a result, the difference in terms of the degree of reliance on the two distinct sources yielded different findings regarding the effect of semantic transparency (see section 2.1.). Depending on this evidence, Duñabeitia, Perea, & Carreiras (2014) considered that the inconsistent results on the effects of cross-morphemic transpositions might have stemmed from the different strategies employed by readers while coding letter order and processing morphological information. Accordingly, the authors conducted a masked priming lexical decision experiment (55 ms SOA) in Spanish and tested whether the transposition location would show differential effects for TL-within and TL-across conditions. Based on their response latencies in the lexical decision task, the participants were divided into two groups as *faster* and *slower* readers. The experimental conditions were (a) TL-across (e.g., violiinsta- VIOLINISTA, *violinist*), (b) RL-across (e.g., violiersta-VIOLINISTA), (c) TL-within (e.g., vioilnista-VIOLINISTA), and (d) RL-within (e.g., vioatnista-VIOLINISTA).

It is important to remind the reader that the null effect of cross-morphemic transpositions reported in Duñabeitia et al. (2007) was criticized by Sánchez-Gutiérrez & Rastle (2013). It was suspected that the findings might have been affected by participant or item related problems or that a Type I error had been committed. Addressing this problem, Duñabeitia et al. this time tested 420 suffixed Spanish words with 80 participants to deal with the statistical power issue. Disregarding the reading speed variable, it was found that the TL-across condition might potentially yield facilitatory effects (10 ms). Thus, based on this result, it is plausible to assume that the findings in Duñabeitia et al. (2007) could be the consequence of accepting the null hypothesis (viz., there is no priming effect difference between the TL-across condition and the orthographic control condition) when it should have actually been rejected. However, when the reading speed was included as an independent variable, the results of Duñabeitia et al. (2014) displayed a clear-cut distinction between faster and slower readers. More precisely, the slower readers were ignorant with regard to the location of the TL manipulation and showed facilitation both in TL-within and in TL-across conditions whereas only the facilitation obtained from TL-within condition turned out to be significant for the faster readers. Accordingly, the authors highlighted the possibility that the faster readers might predominantly rely on morpho-orthographic factors and that the processing of slower readers could be based more on morpho-semantic information. It was concluded that the readers were not so insensitive to the location of the transposition and that the differences between readers in terms of orthographic skill might be a significant factor modulating the degree of sensitivity to the precise letter order at morpheme boundaries. Like Andrews & Lo (2013), the study conducted by Duñabeitia et al. (2014) was highly influential as it showed that individual differences among readers regarding the reliance on semantic or orthographic information should not be overlooked while examining the morphological processing of complex words.

The majority of earlier studies has focused on truly-suffixed forms to investigate the potential effects of cross-morphemic transpositions. To account for the claim that the lack of a boundary effect is a result of the activation of whole word representations while the morpho-orthographic route sustains the detrimental effects of across-morpheme transpositions, it is also essential to examine how such transpositions affect pseudo-affixed forms like *corner.* Following the assumptions of the dual-route model (Diependaele et al., 2013), the boundary effect is expected to arise for such opaque words as the morpho-semantic route is not available for activation due to the absence of a semantic relationship between opaque prime-target pairs. However, failing to observe the detrimental effects of (pseudo) cross-morphemic transpositions for opaque words could pose serious problems for the dual-route model. In such a case, it would be more plausible to assume that the successive processing of letter encoding and morpho-orthographic information enables the facilitatory effects of across-morpheme TL non-words and that morpho-semantic information is not yet available at that early stage of processing. Thus, as in the case of the form-first vs. form-then-meaning debate, opaque pairs have the potential to contribute significantly to the cross-morphemic transposition debate as well.

Accordingly, Diependaele et al. (2013) tested their dual-route of morphological processing by applying cross-morphemic transposition manipulations to the classic transparent-opaque-form design. As illustrated in Figure 4, the authors expected to obtain priming effects from TL non-word primes with transparent items (sinegr-SING) although the transpositions were applied to the morpheme boundaries. Across-morpheme TL non-words in opaque pairs (motehr-MOTH), on the other hand, were predicted to reveal no priming. As already discussed, the rationale behind expecting different patterns for transparent and opaque items was attributed to the claim that it is possible to map the input onto the whole-word representations in the case of semantically transparent pairs, but not in the case of opaque pairs. Diependaele et al., therefore, anticipated the parallel activation of morpho-semantic information and morpho-orthographic processes and the disruptive effects of cross-morphemic transpositions.

As a result of the masked priming lexical decision experiment (SOA: 50 ms), the authors arrived at facilitatory effects for intact primes only in transparent and opaque conditions (singer-SING, mother-MOTH). This could be interpreted as evidence for morpho-orthographic decomposition which applies to truly-suffixed and pseudo-suffixed words alike. Most importantly, transpositions crossing a morpheme boundary resulted in the absence of a priming effect for opaque pairs. The transparent pairs, on the other hand, revealed significant facilitation in the TL-across condition despite the disruption of morpho-orthographic route. That is, when the replaced-letter primes were treated as a baseline, TL-across primes speeded up the recognition of their targets significantly greater than RL primes. Compared to the intact primes, however, TL-across primes yielded significantly weaker priming effects. The relatively reduced priming from the TL-across condition compared to the intact primes for transparent words was interpreted as a consequence of the blocked morpho-orthographic route. The morpho-semantic route then remains as the only source for priming and cannot produce as strong facilitation as the one obtained in cases where the morpho-orthographic and morpho-semantic routes operate together. It can be seen that these results were quite similar to the expected reaction time patterns depicted by Diependaele et al. in Figure 4. Thus, the findings met the assumptions of the dual-route model of morphological processing. Cross-morphemic transpositions were found to be detrimental and the reason behind obtaining facilitation in the TL-across condition was claimed to be the active role of morpho-semantic processing at the early stages of visual word recognition.

Overall, looking at the inconsistencies in the literature, it can be clearly seen that there is still no consensus in the debate whether cross-morphemic transpositions disrupt morpho-orthographic processing. Studies discussed the problems of the previous findings such as drawing attention to insufficient power and committing false positive or false negative. It was also considered that the divergent findings might have been the consequence of structural differences between the tested languages, but some studies failed to show modulating effects of cross-language variations. In this respect, the potential effects of individual differences among readers could be regarded as one of the most plausible sources of inconsistent results. However, it requires further investigations to account for the significant effects of individual differences as the evidence is quite limited. At this point, therefore, the debate on the detrimental effects of cross-morphemic transpositions is far from being resolved.

As pointed out earlier, previous studies predominantly focused on truly-affixed forms to test the effects of letter order disruptions at morpheme boundaries. It must be recalled that there is ample evidence favoring the decomposability of seemingly complex forms (opaque forms) along with true complex forms at the early stages of processing. Additionally, it was claimed that the only source informing the segmentation is morpho-orthographic route for these semantically opaque words. Keeping these in mind, it was argued that different kinds of letter codes inform morpho-orthographic and morpho-semantic processes and the one informing the morpho-orthographic segmentation (i.e., fine-grained code) is considered to be sensitive to precise letter order. The coarse-grained code, on the other hand, is less sensitive to such letter order violations (see section 2.1.3.). Accordingly, it can be expected that cross-morphemic transpositions might show different effects on the recognition of truly-affixed and pseudo-affixed forms. Taken all together, it is of importance to examine the effects of cross-morphemic transpositions using alternative designs such as the one in Diependaele et al. (2013). Applying cross-morphemic transpositions to semantically opaque as well as transparent forms, the authors in fact provided valuable insights on the nature of the early processing of morphologically complex forms by showing that the transpositions crossing a morpheme boundary caused the disappearance of priming effect obtained from opaque but not from transparent forms. This finding was taken as evidence for the active role of morpho-semantic information in the early processing since it was suggested that the morpho-semantic route provided an alternative activation channel when the morpho-orthographic route was incapacitated by the letter order disruption. Similar to Diependaele et al. (2013), the present study also aimed to see whether morphological analyses are semantically blind or operates simultaneously with morpho-semantic information at the early stages of visual word recognition and to see how cross-morphemic transpositions inform us about the relationship between these two processes. Given that the tested language was English in Diependaele et al. (2013), the question was also addressed whether a typologically distinct language (i.e., Turkish) would show different patterns.

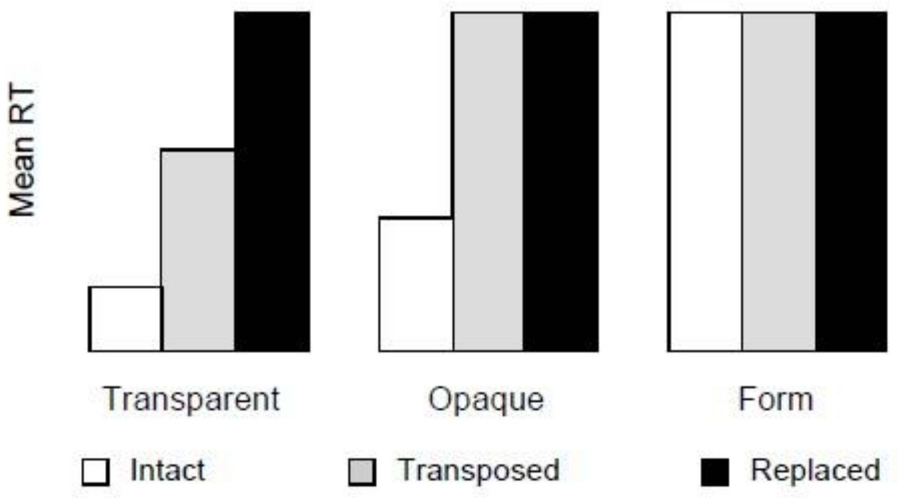

Figure 4. The Expected Reaction Time Pattern for Transparent, Opaque and Form Overlap Conditions Based on the Dual-route Model (Diependaele et al., 2013).

CHAPTER 3

THE PRESENT STUDY

3.1. Method

3.1.1. Experiment 1

3.1.1.1. Participants

The experiment was conducted with 42 adult Turkish native speakers who were graduate or undergraduate students in the department of Foreign Language Education at Middle East Technical University (34 females, Mean age= 21.4, *SD*= 2.4). All participants had normal or corrected-to-normal vision. This thesis was approved by Human Subjects Ethics Committee of METU (see Appendix B).

3.1.1.2. Materials

The critical targets in this experiment were 96 three- to four-letter-long monomorphemic Turkish root words. These roots consisted of nominal (e.g., HIZ; *speed*), adjectival (e.g., KEL; *bald*), and verbal (e.g., BUL; *to find*) roots. Among these items, 48 were preceded by primes that shared no semantic relationship with the corresponding target but could be analyzed as the combination of a root and a (pseudo) suffix (e.g., tuzak-TUZ; *trap-SALT*, opaque items, intact primes). The (pseudo) suffix endings used in the opaque items were the following derivational suffixes: -Ar (as in yaz**ar**, *writer*), -An (as in böl**en**, *divider*), -Ak (as in kaç**ak**, *fugitive*), -Et (as in yön**et-**, *manage*), -Ik (as in kes**ik**, *cut*), and -It (as in yak**ıt**, *fuel*). The rest of the items (*n*=48) were preceded by primes that were, again, semantically unrelated to the corresponding target but could be analyzed as a root with a non-suffix ending (e.g., kasap-KAS; *butcher-MUSCLE*, form overlap items, intact primes). These non-suffix endings were carefully formed so that they could not be analyzed as an existing Turkish word (e.g., words like 'kumaş, *fabric*' were not included since it could be analyzed as 'kum-aş' (*sand-food*). None of the targets were repeated within/across item lists. Following Beyersmann et al. (2016), none of the opaque pairs shared an etymological relation and the pseudo-suffixes never retained their original meaning and function. Thus, the experimental items were tightly controlled and it was ensured that the opaque primes were completely unrelated to their targets in term of semantics.

Table 1. *The Experimental Conditions.*

Target Type	**Prime Type**		
	Intact	**Transposed-letter**	**Replaced-letter**
Transparent	çizim-ÇİZ (drawing-DRAW)	çiizm-ÇİZ	çiurm-ÇİZ
Opaque	tuzak-TUZ (trap-SALT)	tuazk-TUZ	tuurk-TUZ
Form Overlap	kasap-KAS (butcher-MUSCLE)	kaasp-KAS	kaorp-KAS

For each of the two item types, two more prime types were formed either by transposing the last letter of the stem and the first letter of the (pseudo) suffix/non-suffix ending (i.e., Transposed-letter primes, tuazk-TUZ or kaasp-KAS), or by replacing these two letters with completely different letter pairs (i.e., Replaced-letter primes, tuurk-TUZ or kaorp-KAS). These replacements were applied following certain restrictions. For instance, consonants were always replaced by consonants, vowels by vowels, ascenders by ascenders (e.g., t, l, h), and descenders by descenders (e.g., g, p, y). A replaced-letter condition was included due to the fact that it better serves as an orthographic control condition in transposed-letter experiments compared to a completely unrelated control word, which helps to attribute a possible priming effect to the transposition manipulation per se (see Perea & Lupker, 2003a) As presented in Table 2, opaque and form overlap items were matched listwise on various important psycholinguistic measures (in all cases, except the word ending length measure, $p > .05$). Stem frequency and derived word frequency values were obtained from the

Turkish National Corpus (*TNC*: Aksan, Mersinli, Yaldır, & Demirhan, 2012), whereas bigram frequency values were extracted from the BOUN Corpus (Sak, Güngör, & Saraçlar, 2008). The experimental conditions are presented in Table 1 and the whole item list is provided in Appendix A.

Table 2. *Matched Psycholinguistic Measures of Transparent, Opaque and Form Overlap Items.*

	Transparent	Opaque	Form Overlap	*p*
Stem Length	3.19 (.39)	3.12 (.33)	3.13 (.33)	.611
Stem Frequency	26,57 (31,75)	27,27 (40,29)	27,16 (38,76)	.995
Stem Cumulative Bigram Frequency	63557,96 (47077,47)	63615,37 (37436,89)	76383,72 (46847,49)	.262
Derived Word Length	5.19 (.39)	5.13 (.33)	5.25 (.44)	.297
Derived Word Frequency	10,94 (16,81)	10,22 (16,69)	10,04 (13,94)	.958
Derived Word Cumulative Bigram Frequency	112748,25 (64314,4)	136911,49 (62371,82)	128090,69 (57361,77)	.153
Word Ending Length	2 (0)	2 (0)	2.10 (.31)	.005
Critical Bigram Frequency	27639,24 (19977,48)	29787,88 (26021,68)	28380,3 (29583,88)	.916
Transposed Bigram Frequency	28018,56 (26900,98)	27482,95 (22580,06)	28878,06 (30383,86)	.967
Replaced Bigram Frequency	27702,06 (21821,98)	28436,47 (23585,47)	28667,32 (28755,21)	.981
Transposed-letter Prime Cumulative Bigram Frequency	66141,52 (50114,51)	73186,52 (51292,85)	81338,68 (43217,85)	.308
Replaced-letter Prime Cumulative Bigram Frequency	65077,12 (43298,57)	75133,94 (52119,53)	78950,38 (42003,42)	.315

To balance the yes/no responses in the lexical decision task, 96 phonotactically and orthographically legal non-words were created by changing one or two letters of existing Turkish roots and were added to the experiment as fillers. The primes of the non-word targets were formed in the same way as in the critical targets, with the only difference that the primes were generated based on the unaltered forms of the non-word targets (e.g., target *SÖL*, intact prime: *bölen*, TL prime: *böeln*, RL prime: *böakn*).

Three experimental lists were created and each list comprised only one prime type of the same target. Reversing these lists, three more lists were formed to prevent confounding effects of fatigue. Each participant was randomly assigned to one of these six lists. E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA: Schneider, Eschman, & Zuccolotto, 2012) running on a Lenovo Ideapad 520 notebook was used to control the stimuli presentation and reaction time data recordings. The participants' lexical decision recordings were obtained using a Logitech F310 gamepad.

3.1.1.3. Procedure

Each participant initially signed an informed consent form (Appendix D) and filled out a participant background questionnaire (Appendix C). Afterwards, they completed a masked-priming lexical decision task individually in a quiet room. Before the experiment, the participants were instructed that they would see a series of letter strings in the center of the computer screen. They were expected to decide whether the presented letter string was an existing word in Turkish by pushing one of two specified buttons on the gamepad as fast and as accurately as possible. The 'yes' response was always controlled with the dominant hand of the participants. For each trial, the event sequence began with an initial blank screen presented for 500 ms. The blank screen was followed by a 500-ms forward mask of hashtags (#####) and a 50-ms prime in lowercase. Immediately after the prime, the target appeared on the screen in uppercase letters and remained there until the participant responded or until the 2000-ms upper limit expired. Lastly, another 500-ms blank screen was presented before the next trial. The number of the hashtags was the same as the number of letters in the corresponding prime. The participants were not informed about the presence of the primes. None of the participants reported that they had seen the prime words.

The presentation order of the 192 prime-target pairs was determined using Latin Square design to avoid the consecutive presentation of two prime-target pairs of the same kind. All the stimuli were displayed in white on a black background in bold, 18-point Courier New font. The participants were provided with 9 practice trials to familiarize themselves with the procedure. They were also provided with two breaks during the experiment. Overall, it took them about 15 minutes to complete the experiment. After the experiment, the participants were asked to complete a definition task (see Appendix E) in which they were expected to define fourteen prime words that have frequency values below 1 appearance per million in the corpus. This task was administered to be able to identify the whole forms unknown to the participants and exclude them from the analysis since there was no apparent semantic relationship between the prime-target pairs in this experiment.

3.1.2. Experiment 2

The critical materials of Experiment 2 were originally planned to be presented within Experiment 1. However, using the same suffix set in both transparent and opaque lists did not provide sufficient amount of item samples satisfying each list and posed difficulty in matching the required psycholinguistic measures. The transparent item list was therefore created using a mostly different suffix set and tested with a separate experiment. Further, following the claim that the overall proportion of affixed primes could affect the way of processing complex words (Beyersmann et al., 2013), it was suspected that presenting transparent primes (truly-affixed primes) along with opaque primes (pseudo-affixed forms) might lead participants to develop strategies in the course of the experiment. Accordingly, the participants might tend to decompose the opaque forms when they normally would not as a result of repeated exposure to truly-affixed forms. Keeping this in mind, transparent and opaque items were preferred to be tested in two different experiments in order to avoid such a potential strategic confound. The two experiments were conducted on separate days with an interval of at least two weeks. In this way, possible priming effects obtained from opaque items could be attributed to the fact that the word recognition system indeed decomposes these pseudo-complex forms.

3.1.2.1. Participants

The participants were the same as the ones recruited for Experiment 1.

3.1.2.2. Materials

The critical targets were 48 three- to four-letter-long monomorphemic Turkish root words (see Appendix A). These roots consisted of nominal (e.g., KİRA; *rent*), adjectival (e.g., ACİL; *urgent*), and verbal (e.g., SEÇ; *to choose*) roots. The intact primes of this item group were semantically related to the targets and could be analyzed as containing a root and a real suffix (e.g., çizim-ÇİZ, *drawing-DRAW*, transparent items). The suffix set used in the transparent items was comprised of the following derivational suffixes: -Iş (as in gör**üş**, *view*), -Im (as in öl**üm**, *death*), -lI (as in tuz**lu**, *salty*), -CI (as in av**cı**, *hunter*), -Ik (as in aç**ık**, *open*), and -An (as in dur**an**, *standing*). The suffixes yielded no stem alternations in any of the trials. The transposed-letter and the replaced-letter prime manipulations were applied to the transparent items in the same way as in opaque and form overlap items (e.g., Transposed-letter prime: çiizm-ÇİZ; Replaced-letter prime: çiurm-ÇİZ). The same constraints were considered for the letter replacements (e.g., replacing a vowel with a vowel). As seen in Table 2**,** transparent items were matched listwise with opaque and form overlap items on various psycholinguistic measures (in all cases except the word ending length, $p > .05$). The frequency values were again obtained from the same resources as in Experiment 1 (i.e., *TUD:* Aksan et al., 2012; *BOUN:* Sak et al., 2008).

In addition to the 48 critical items, 48 phonotactically and orthographically legal non-words were added to balance the yes/no responses. These non-words were generated altering one or two letters of existing Turkish roots. The same operations as in Experiment 1 were implemented to form the prime words of these non-words (e.g., target *PİZ*, intact prime: *gizle*, TL prime: *gilze*, RL prime: *gihre*). The way the lists were formed and the apparatus that was used for stimuli presentation and data recording were all identical to Experiment 1.

3.1.2.3. Procedure

The procedure was the same as in the Experiment 1. The minor exceptions were the following. For this experiment, the participants were exempt from signing the informed consent and filling out the participant background questionnaire since they have already fulfilled these requirements. Unlike Experiment 1, the participants responded to 96 prime-target pairs in total. There was only one break that occurred in the middle of the experiment and it took approximately 7 minutes to complete this experiment. Finally, they did not take a definition task after this experiment since the prime-target pairs were semantically related.

3.1.3. Data Analysis

The data from Experiment 1 and Experiment 2 were analyzed together. All incorrect decisions (i.e., classifying an existing word as a non-word) and skipped trials were eliminated. The reaction times above 2 and below -2 standard deviations (i.e., extreme values) in each participants' data were also trimmed. Based on the results of the definition task, four items (i.e., halef, banket, hızar, güruh) were discarded as they revealed accuracy rates less than 60%. The accuracy rates for three of these items were in fact below 35%. Further, seven items in opaque condition (i.e., anten, basen, butik, dinar, halter, saten, tanker; *antenna*, *hip*, *boutique*, *dinar*, *barbell*, *satin*, *tanker*) had to be removed from the analyses as the pseudo-suffixes in these items appear to violate vowel harmony[1]. Given the fact that suffixation is almost always subject to vowel harmony in Turkish (Lewis, 2000; Topbaş, 1997), it was suspected that these items

[1] According to Lewis (2000), three rules were identified for Turkish vowel harmony. First, it is suggested that when the initial vowel in a word is a back vowel (*a*, *ı*, *o*, *u*) then the following vowels are also back. On the other hand, when the initial vowel is front (*e*, *i*, *ö*, *ü*), then the following vowels are also front. Second, it is pointed out that unrounded first vowel is followed by again unrounded vowels (*a*, *e*, *ı*, *i*). Last, when the first vowel is rounded (*o*, *ö*, *u*, *ü*); however, the following vowels are either rounded and close (*u*, *ü*) or unrounded and open (*a*, e). The listed items violated at least one of these three vowel harmony rules. For instance, the back vowel *a* in the word *anten* is followed by the front vowel *e*, which is contradictory to the first rule.

could be analyzed as whole-units rather than decomposable forms. This subset of items would then be unrepresentative among the rest of the opaque items. Therefore, all opaque pairs displaying a vowel harmony violation were excluded to avoid potential confounding effects that could stem from this variation.

Moreover, it was detected that five participants displayed deviant mean reaction times in certain conditions. Among these participants, two showed reaction times that were three standard deviations above the mean in Opaque RL condition (i.e., above 867 ms when the mean reaction time was 647). Moreover, another two of the participants showed reaction times that were three standard deviations above the mean both in Opaque Intact and Form Intact conditions (i.e., above 865 and 866 ms when the mean reaction times were 631 and 644 respectively). The mean reaction times of the last participant were deviant in almost all the conditions (i.e., three, four, or five standard deviations above the mean in the corresponding conditions). These participants, therefore, were not included in any of the analyses. Excluding the data from these discarded participants, 17% of the remaining critical data had to be removed from the analyses.

Two-factor repeated measures ANOVAs were conducted to analyze the data. Target Type (i.e., Transparent, Opaque, Form Overlap) and Prime Type (i.e., Intact, Transposed-letter, Replaced-letter) were treated as independent variables whereas reaction time and error rate were treated as the dependent measures. Both Target Type and Prime Type were within-subjects variables in by-participant (F_1) analyses. However, Target Type was a between-subjects variable while Prime Type was still a within-subjects variable in by-item (F_2) analyses. The reaction time analyses were conducted with logarithmically transformed RTs to satisfy the normality assumption as RT data tend to be negatively skewed inherently.

3.2. Results

The mean reaction times for each condition are presented in Table 3. A two-factor repeated-measures ANOVA was conducted to see the effects of Target Type and Prime Type on the participants' reaction times. The results revealed the significant main effect of Target Type (F_1 (1.72, 45.78) = 43.886, $p < .0001$; F_2 (2, 130) = 24.471, $p < .0001$) and of Prime Type (F_1 (2, 72) = 11.222, $p < .0001$; F_2 (2, 260) = 8.906, $p < .0001$) both in by-participant and by-item analyses. The pairwise comparisons on Target Type showed that the targets in Transparent condition were processed significantly faster than those of Opaque ($p = .001$) and Form Overlap ($p < .0001$) conditions. Further, the participants recognized the targets in Opaque condition significantly faster than that of Form Overlap condition ($p < .0001$). For the pairwise comparisons on Prime Type, the results showed that the targets preceded by the Intact primes yielded significantly shorter reaction times than the ones preceded by Transposed-letter ($p = .002$) and Replaced-letter primes ($p < .0001$). The difference between Transposed-letter and Replaced-letter primes, however, turned out to be statistically non-significant ($p = .281$).

Most importantly, the results of the two-factor repeated measures ANOVA also yielded a significant interaction between Target Type and Prime Type (F_1 (4, 144) = 2.525, $p = .043$; F_2 (4, 260) = 2.625, $p = .035$). Follow-up paired-samples t-tests were conducted to investigate the source of this interaction. As a result, it turned out that Intact primes facilitated the recognition of Transparent targets significantly greater than RL primes (t (36) = 4.470, $p < .0001$). Similarly, TL primes also yielded a significantly greater priming effect than that of RL primes (t (36) = 3.140, $p = .003$). The mean reaction time difference between Intact and TL primes, however, was non-significant (t (36) = 1.831, $p = .075$). As in the case of Transparent condition, Intact primes again facilitated the recognition of their targets significantly greater than RL primes in Opaque condition (t (36) = 2.273, $p = .029$). However, both TL-RL (t (36) = .483, $p = .632$) and Intact-TL (t (36) = 1.700, $p = .098$) comparisons revealed statistically non-significant results. Lastly, Intact-RL (t (36) = 1.437, $p = .159$) and TL-RL (t (36) = .483, $p = .632$) comparisons did not reach statistical significance in Form Overlap condition. Only Intact-TL comparison showed significant mean difference (t (36) = 1.211, $p = .234$). More precisely, Intact primes revealed significantly greater priming effect than that of TL primes when presented before Form Overlap targets.

Table 3. *Mean Reaction Times (ms) Across Conditions.*

Target Type	**Prime Type**			**Priming Effects (ms)**		
	Intact	Transposed-letter	Replaced-letter	Intact vs. RL	Intact vs. TL	TL vs. RL
Transparent	582 (78)	593 (82)	608 (83)	26	11	15
Opaque	631 (78)	642 (75)	644 (73)	13	11	2
Form	644 (74)	661 (77)	651 (73)	7	17	10

**Standard deviations are given in parentheses.*

Further, a two-factor repeated measures ANOVA was conducted to see whether Target Type and Prime Type also modulated the participants' error rates. The results revealed no main effect of Target Type (F_1 (2, 72) = 1.321, p = .273; F_2 (2, 141) = .293, p = .746) and Prime Type (F_1 (1.60, 57.86) = 3.0005, p = .068; F_2 (2, 282) = 2.102, p = .124). The interaction between these two factors was also turned out to be non-significant (F_1 (4, 144) = 1.549, p = .191; F_2 (4, 282) = .729, p = .573). Thus, no further analyses were conducted on the error rates.

CHAPTER 4

DISCUSSION AND CONCLUSION

This study set out to investigate whether the decomposition of morphologically complex forms was informed by morpho-semantic as well as morpho-orthographic processes at the early stages of visual word recognition in Turkish. To this end, two masked priming lexical decision tasks were implemented. To be able to test the potential role of semantic information in the early processing, the semantic transparency of the prime-target pairs was manipulated. Accordingly, the well-studied semantically transparent, semantically opaque and form overlap prime-target conditions were formed. It should be recalled that the significant priming effects of both transparent and opaque items were taken as evidence for semantically blind decomposition. However, arriving at reduced or no facilitation in opaque with respect to the transparent condition was attributed to the fact that semantic transparency also plays an active role in the morpho-orthographic segmentation. Following the research design used in Diependaele et al. (2013), the present study also included cross-morphemic transpositions to see if and how transparent and opaque items would be affected by the purportedly detrimental effects of such manipulations. Based on the argument that letter encoding and morpho-orthographic segmentation are performed successively, the TL effect was expected to arise both in transparent and opaque conditions despite implementing cross-morphemic transpositions. However, relying on the idea of simultaneous processing of letter encoding and morpho-orthographic segmentation, the TL effect was predicted to disappear due to across-morpheme transpositions both for transparent and opaque items when the form-first account is purported to be true. Following the assumptions of the dual-route model of morphologically complex words (see Figure 2), it was also taken into account that the

TL effect could be observed with transparent items but not with opaque items despite the detrimental effects cross-morphemic transpositions.

With tightly controlled items, the finding of the study revealed that both transparent and opaque primes (i.e., intact primes) significantly facilitated the recognition of their targets when compared to the orthographic control condition (i.e., RL condition). In effect, this finding is consistent with studies arguing for the form-then-meaning account (e.g., Beyersmann et al., 2016; Marslen-Wilson et al., 2008; Rastle et al., 2004; Rastle & Davis, 2008). On the other hand, it directly contested the results of the studies that found null effects of opaque primes (e.g., Feldman et al., 2009). Unsurprisingly, there were no facilitatory effects of form overlap items. Closely inspecting the magnitude of the priming effects observed in transparent and opaque conditions, however, it can be seen that transparent primes yielded twice as strong facilitation as that of opaque primes numerically (i.e., 26 ms and 13 ms respectively, see Table 3). This result was not in line with the meta-analyses of Rastle & Davis (2008) and Davis & Rastle (2010), who displayed only 7 ms priming effect difference between the two conditions. The studies supporting the claim that both morpho-orthographic and morpho-semantic routes are accessed in the course of segmentation, however, could account for this numerical difference (e.g., Diependaele et al., 2009; Diependaele et al., 2011; Diependaele et al., 2013; Zhang, Liang, Yao, Hu, & Chen, 2017). However, the current design does not enable direct comparison of the priming effects obtained in transparent and opaque conditions to each other. Thus, based solely on observed numerical difference between the conditions, it seems unlikely to claim that both morpho-orthographic and morpho-semantic information are available in the process of morphological decomposition in Turkish. In this respect, the results regarding the magnitude of the priming effect difference obtained via intact primes of transparent and opaque conditions seem to be inconclusive.

To be able see whether the role of semantics is in fact significant at the early stages of complex word processing, the potential effects of cross-morphemic transpositions were considerably more informative in the design of the present study. The results of the TL-across manipulation on transparent and opaque items were clear-cut. In line with the dual-route model of morphological processing (Diependaele et al., 2013), the findings revealed significant facilitatory effects of TL-across primes in transparent condition but not in opaque condition. That is, cross-morphemic transpositions showed detrimental effects on the processing of opaque pairs; however, TL-across primes could still facilitate the recognition of their targets in the transparent condition.

The results regarding the transparent condition were consistent with the studies arriving at a transposed-letter priming effect despite the cross-morphemic TL manipulation (e.g., Beyersmann et al., 2013; Perea & Carreiras, 2006; Rueckl & Rimzhim, 2011; Zargar & Witzel, 2016). The results of the opaque condition, on the other hand, replicated the pattern observed in the studies that fail to arrive at priming effects in the presence of cross-morphemic transpositions (e.g., Christianson et al., 2005; Duñabeitia et al., 2007; Duñabeitia et al., 2014). Accordingly, it could be argued that applying letter transposition at morpheme boundary indeed incapacitates the morpho-orthographic route (Diependaele et al., 2013; Grainger & Ziegler, 2011) since opaque pairs, which rely on morpho-orthographic route for facilitation, yielded no priming at all when exposed to transpositions crossing their (pseudo) morpheme boundary. It should be recalled that the opaque primes significantly facilitated the recognition of their targets in the absence of letter transpositions (i.e., in the case of intact primes). The reason why significant facilitation from TL-across primes was obtained in the transparent condition, on the other hand, could be explained by the activation of whole-word representations as well as constituent morphemes as proposed by the dual-route models (Diependaele et al., 2011; Diependaele et al., 2013). The activated whole-word representations then enable an alternative boost from the morpho-semantic route, which leads priming effects despite the disrupted morpho-orthographic information. In line with the dual-route model and Grainger & Ziegler (2011), it can also be argued that cross-morphemic transpositions indeed have detrimental effects on the fine-grained code but not on the coarse-grained code.

Accordingly, these results unambiguously lend support for the argument that the early processing of complex forms are informed by morpho-semantic as well as morpho-orthographic processes in Turkish. Moreover, relying on the evidence from cross-morphemic transpositions, it can be argued that the numerical priming effect difference observed between transparent and opaque pairs could in fact be the result of a semantic transparency effect. The observed patterns challenged the form-then-meaning account since it proposes that the early morphological processing is semantically blind. If it were, transparent pairs would also show a boundary effect (i.e., lack of priming in TL-across condition) like opaque pairs since an alternative route for facilitation would not exist in that case.

Most importantly, the present study replicated the finding of Diependaele et al. (2013), which tested exactly the same conditions with same manipulations in English. Looking at Figure 4, it can be seen that the priming effect patterns predicted by Diependaele et al. were almost identical to the results of this study. However, there were some notable differences between the two studies when certain pairwise comparisons are taken into account. For instance, the mean difference between intact and TL primes in the transparent condition was significant in Diependaele et al. (2013) but non-significant in the present study. According to Diependaele et al. (2013), however, it is quite plausible to obtain significant but reduced priming effects from TL primes with regard to intact primes since one of the routes feeding the activation (i.e., morpho-orthographic) would be blocked as a result of the disruptive effects of cross-morphemic transpositions. Contrary to this evidence, TL primes produced almost as strong facilitation as intact primes in the transparent condition in the present study. Although it seems to be a divergent result, observing such an effect for TL primes in the transparent condition is not surprising given the claim that whole-word representation by itself could occasionally produce significant priming effects comparable to the joint effects of morpho-orthographic and morpho-semantic information (Diependaele et al., 2011).

Further, the mean difference between intact and TL primes in the opaque condition were again statistically significant in Diependaele et al. (2013), but the results of the present study yielded no difference between these prime conditions. Considering the significant difference between intact and RL primes and the obtained boundary effect (statistically indistinguishable priming effects from TL and RL primes) in the opaque condition, this priming effect pattern seems rather surprising. One potential reason behind such a pattern might be the relatively weaker priming effect obtained from the opaque condition. Since the mean difference between intact and RL primes was only 13 ms in this condition, it might have been insufficient for intact primes to yield a reliably stronger facilitation compared to TL primes, which were processed only 2 ms faster than RL primes. It should also be taken into account that the comparison between intact and TL condition appeared to be close to statistical significance (p = .098) for opaque items. Overall, although the results of these two comparisons seem to diverge from Diependaele et al. (2013), they do not preclude the fact that a boundary effect was for opaque but not for transparent items in the presence of cross-morphemic transpositions.

Considering the interpretation of the absence of a boundary effect in the relevant literature, it was already discussed that obtaining facilitatory effects from TL-across primes stemmed from the alternative activation boost arising from the whole-word mapping. The present study showed supportive evidence for this claim testing the Turkish (pseudo) complex forms. Looking at the data at hand, it does not seem plausible to attribute the absence of a boundary effect in the transparent condition to successive processing of letter encoding and morpho-orthographic information (cf. Davis, 1999; (Gómez et al., 2008). In such a scenario, TL-across manipulation in opaque pairs would then produce significant priming effects as in the transparent condition, but it appears that this is not the case. The plausibility of simultaneous processing of letter order and morpho-orthographic information, however, is not ruled out by the present data as the findings of opaque items support the idea that cross-morphemic transpositions incapacitate the morpho-orthographic route. Accordingly, the concurrent processing of morpho-semantic information along with letter order and morpho-orthographic information could also be suggested relying on the findings of this study. The only difference being that the simultaneous processing of letter encoding might have a cost on morpho-orthographic but not on morpho-semantic processing.

To conclude, the present study aimed to investigate the role of semantics at the early stages of word recognition through the manipulation of semantic transparency and the letter order at morpheme boundary. Contrary to the form-then-meaning account, it was found that the decomposition of morphologically complex forms was not semantically blind but semantic information also played an active role in this process. The results, therefore, support the parallel activation of morpho-semantic and morpho-orthographic information upon encountering a complex form. More specifically, it appears that Turkish native speakers are able to perform semantic-based analyses on complex forms within 50 ms, which is in sharp contrast with the results of some studies testing native speakers of Indo-European languages (e.g., Beyersmann et al., 2016; Longtin et al., 2003; Rastle et al., 2004). Drawing attention to the fact that this study could be the only attempt to test the role of semantics in the early processing through applying cross-morphemic transpositions, further attempts are required to increase the robustness of these findings.

4.1. Limitations and Suggestions for Further Research

One of the limitations of the present study might be the high number of discarded items from the opaque list. As mentioned earlier (see section 3.1.3.), the vast majority of these items were not included in the analyses as they violate Turkish vowel harmony. Thus, the decomposability of these pseudo-suffixed items was arguable and it was suspected that they might be analyzed as whole units by native Turkish readers. However, excluding this much item sample from a single list might have affected the results regarding the opaque condition. For instance, it can be taken into account that the reason why the comparison between intact and TL primes for opaque forms failed to reach statistical significance might be due to a larger number of eliminated items in this condition. Accordingly, for further studies, the pseudo complex forms violating Turkish vowel harmony are suggested to be excluded from the experimental lists at the very beginning or to be tested as a different prime type condition to see whether they are in fact processed as unanalyzed whole forms.

Another limitation of this study could be the use of only one SOA (i.e., 50 ms) to test the role of semantics in the early processing of morphologically complex forms. Although the findings of the present study showed that Turkish readers can access to semantic information within 50 ms upon encountering a complex word, based on these findings, it is unknown whether the morpho-semantic information would be available earlier than 50 ms. It should be noted, for instance, that the effect of semantic transparency was obtained with a 34 ms SOA in Feldman et al. (2015) but not with a 39 ms SOA in Heyer & Kornishova (2018). It is therefore essential to test different SOAs to explore the time course of the involvement of semantic information in the early processing.

Further, as in many other studies, semantic transparency was treated as a categorical variable within the scope of the present study as well. However, (pseudo) complex forms in a language display various degrees of transparency (Heyer & Kornishova, 2018) and, therefore, it seems more plausible to treat semantic transparency as a scalar rather than categorical variable. Accordingly, testing the role of semantics at the early stages of processing with *more transparent* and *more opaque* item samples could be more informative. Lastly, Andrews & Lo (2013) and Dunabeitia et al. (2014) already lent support for the claim that individual differences among readers (regarding the reliance on morpho-orthographic or morpho-semantic information in the process of morphological segmentation) modulate the way of processing complex forms. The effects of such differences were not addressed within the scope of the present study. However, evidence supporting the reliable effects of individual differences in question provides a novel perspective on how morphologically complex words are processed. Therefore, considering the fact that the number of studies investigating the potential effects of individual differences in the early processing of morphologically complex words is quite limited, it is of great importance to examine this issue further with well-designed and robust experiments.

REFERENCES

Aikhenvald, A. (2007). Typological distinctions in word-formation. In T. Shopen (Ed.), *Language Typology and Syntactic Description* (pp. 1–65). Cambridge: Cambridge University Press.

Aksan, Y., Mersinli, Ü., Yaldır, Y., & Demirhan, U. (2012). Türkçe Ulusal Dil Derlemi projesi biçimbirim çalışmalarında belirsizliklerin sınıflandırılması ve dağılımı. 25. Ulusal Dilbilim Kurultayı Bildiri Kitabı, 219–226.

Amenta, S., & Crepaldi, D. (2012). Morphological processing as we know it: an analytical review of morphological effects in visual word identification. *Front. Psychol.*, *3*, 1–12.

Andrews, S. (1996). Lexical Retrieval and Selection Processes: Effects of Transposed-Letter Confusability. *Journal of Memory and Language*, *35*(6), 775–800.

Andrews, S., & Lo, S. (2013). Is morphological priming stronger for transparent than opaque words? It depends on individual differences in spelling and vocabulary. *Journal of Memory and Language, 68*(3), 279–296.

Baayen, R. H., Milin, P., Đurđević, D. F., Hendrix, P., & Marelli, M. (2011). An Amorphous Model for Morphological Processing in Visual Comprehension Based on Naive Discriminative Learning. *Psychological Review, 118*(3), 438–481.

Schreuder, R., & Baayen, R. H. (1995). Modeling morphological processing. In L. B. Feldman (Ed.), Morphological aspects of language processing (pp. 131–154). Hillsdale, NJ: Lawrence Erlbaum.

Beyersmann, E., Castles, A., & Coltheart, M. (2011). Early morphological decomposition during visual word recognition: Evidence from masked transposed-letter priming. *Psychonomic Bulletin and Review*, *18*(5), 937–942.

Beyersmann, E., Coltheart, M., & Castles, A. (2012). Parallel processing of whole words and morphemes in visual word recognition. *The Quarterly Journal of Experimental Psychology*, *65*(9), 1798–1819.

Beyersmann, E., McCormick, S. F., & Rastle, K. (2013). Letter transpositions within morphemes and across morpheme boundaries. *The Quarterly Journal of Experimental Psychology*, *66*(12), 2389–2410.

Beyersmann, E., Ziegler, J. C., Castles, A., Coltheart, M., Kezilas, Y., & Grainger, J. (2016). Morpho-orthographic segmentation without semantics. *Psychonomic Bulletin and Review*, *23*, 533–539.

Butterworth, B. (1983). Lexical representations. In B. Butterworth (Ed.), *Language production* (pp. 257–294). London: Academic Press.

Bybee, J. (1995). Regular morphology and the lexicon. *Language and Cognitive Processes*, *10*(5), 425–455.

Christianson, K., Johnson, R. L., & Rayner, K. (2005). Letter Transpositions Within and Across Morphemes. *Journal of Experimental Psychology*, *31*(6), 1327–1339.

Colombo, L., Sulpizio, S., & Peressotti, F. (2017). Serial mechanism in transposed letters effects : A developmental study. *Journal of Experimental Child Psychology*, *161*, 46–62.

Coltheart, M., Rastle, K., Perry, C., Langdon, R., & Ziegler, J. (2001). DRC: A dual route cascaded model of visual word recognition and reading aloud. *Psychological Review*, *108*(1), 204–256.

Davis, C. J. (1999). *The self-organising lexical acquisition and recognition (SOLAR) model of visual word recognition.* Unpublished doctoral dissertation, University of New South Wales.

Davis, C. J. (2010a). SOLAR versus SERIOL revisited. *European Journal of Cognitive Psychology*, *22*(5), 695–724.

Davis, C. J. (2010b). The Spatial Coding Model of Visual Word Identification. *Psychological Review*, *117*(3), 713–758.

Davis, M. H., & Rastle, K. (2010). Form and meaning in early morphological processing: Comment on feldman, O'Connor, and Moscoso del Prado Martín (2009). *Psychonomic Bulletin and Review*, *17*(5), 749–755.

Dehaene, S., Cohen, L., Sigman, M., & Vinckier, F. (2005). The neural code for written words : a proposal. *Trends in Cognitive Sciences*, *9*(7), 335–341.

Diependaele, K., Duñabeitia, J. A., Morris, J., & Keuleers, E. (2011). Fast morphological effects in first and second language word recognition. *Journal of Memory and Language*, *64*(4), 344–358.

Diependaele, K., Morris, J., Serota, R. M., Bertrand, D., & Grainger, J. (2013). Breaking boundaries: Letter transpositions and morphological processing. *Language and Cognitive Processes*, *28*(7), 988–1003.

Diependaele, K., Sandra, D., & Grainger, J. (2005). Masked cross-modal morphological priming: Unravelling morpho-orthographic and morpho-semantic influences in early word recognition. *Language and Cognitive Processes*, *20*(1/2), 75-114.

Diependaele, K., Sandra, D., & Grainger, J. (2009). Semantic transparency and masked morphological priming: The case of prefixed words. *Memory & Cognition*, *37*(6), 895–908.

Duñabeitia, J. A., & Carreiras, M. (2011). The Relative Position Priming Effect Depends on Whether Letters Are Vowels or Consonants. *Journal of Experimental Psychology*, *37*(5), 1143–1163.

Duñabeitia, J. A., Lallier, M., Paz-Alonso, P. M., & Carreiras, M. (2015). The Impact of Literacy on Position Uncertainty. *Psychological Science*, *26*(4), 548-550.

Duñabeitia, J. A., Perea, M., & Carreiras, M. (2007). Do transposed-letter similarity effects occur at a morpheme level? Evidence for morpho-orthographic decomposition. *Cognition*, *105*(3), 691–703.

Duñabeitia, J. A., Perea, M., & Carreiras, M. (2009). There is no clam with coats in the calm coast : Delimiting the transposed-letter priming effect. *The Quarterly Journal of Experimental Psychology*, *62*(10), 1930–1947.

Duñabeitia, J. A., Perea, M., & Carreiras, M. (2014). Revisiting letter transpositions within and across morphemic boundaries. *Psychonomic Bulletin and Review*, *21*, 1557–1575.

Feldman, L. B., & Basnight-Brown, D. M. (2008). *List Context Fosters Semantic Processing: Parallels Between Semantic and Morphological Facilitation When Primes Are Forward Masked*. *34*(3), 680–687.

Feldman, L. B., Kostić, A., Gvozdenović, V., O'Connor, P. A., & Moscoso del Prado Martín, F. (2012). Semantic similarity influences early morphological priming in Serbian: A challenge to form-then-meaning accounts of word recognition. *Psychonomic Bulletin and Review*, *19*(4), 668–676.

Feldman, L. B., Milin, P., Cho, K. W., Moscoso del Prado Martín, F., & O'Connor, P. A. (2015). Must analysis of meaning follow analysis of form? A time course analysis. *Frontiers in Human Neuroscience*, *9*, 1–19.

Feldman, L. B., O'Connor, P. A., & Moscoso del Prado Martín, F. (2009). Early morphological processing is morphosemantic and not simply morpho-orthographic: A violation of form-then-meaning accounts of word recognition. *Psychonomic Bulletin and Review*, *16*(4), 684–691.

Feldman, L. B., & Soltano, E. G. (1999). Morphological Priming: The Role of Prime Duration, Semantic Transparency, and Affix Position. *Brain and Language*, *68*, 33–39.

Forster, K., Davis, C., Schoknecht, C., & Carter, R. (1987). Masked priming with graphemically related forms : Repetition or partial activation? *The Quarterly Journal of Experimental Psychology*, *39*(2), 211–251.

Forster, K., Mohan, K., & Hector, J. (2003). The Mechanics of Masked Priming. In S. Kinoshita & S. Lupker (Eds.), *Masked Priming The State of Art* (pp. 2–21), New York: Psychology Press.

Frost, R., Forster, K. I., & Deutsch, A. (1997). What Can We Learn From the Morphology of Hebrew? A Masked-Priming Investigation of Morphological Representation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *23*(4), 829–856.

Giraudo, H., & Grainger, J. (2000). Effects of prime word frequency and cumulative root frequency in masked morphological priming. *Language and Cognitive Processes*, *15*(4/5), 421–444.

Goldacre, B. (2008). *Bad Science*. London: HarperCollins.

Gómez, P., Ratcliff, R., & Perea, M. (2008). The Overlap Model: A Model of Letter Position Coding. *Psychological Review*, *115*(3), 577–600.

Grainger, J., & Jacobs, A. M. (1996). Orthographic Processing in Visual Word Recognition: A Multiple Read-Out Model. *Psychological Review*, *103*(3), 518–565.

Grainger, J., & van Heuven, W. J. (2003). Modeling letter position coding in printed word perception. In P. Bonin (Ed.), *The mental lexicon* (pp. 1–24). New York, NY: Nova Science.

Grainger, J., & Ziegler, J. C. (2011). A dual-route approach to orthographic processing. *Frontiers in Psychology*, *2*, 54.

Gürel, A. (1999). Decomposition: To what extent? The case of Turkish. *Brain and Language*, *68*(1–2), 218–224.

Heyer, V., & Kornishova, D. (2018). Semantic transparency affects morphological priming . . . eventually. *Quarterly Journal of Experimental Psychology*, *71*(5), 1112–1124.

Hockett, C. D. (1960). The Origin of Speech. *Scientific American*, *203*(3), 88–97.

Kazanina, N. (2011). Decomposition of Prefixed Words in Russian. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *37*(6), 1371–1390.

Kazanina, N., Dukova-Zheleva, G., Geber, D., Kharlamov, V., & Tonciulescu, K. (2008). Decomposition into multiple morphemes during lexical access: A masked priming study of Russian nouns. *Language and Cognitive Processes*, *23*, 800-823.

Lewis, G. (2000). *Turkish Grammar*. Oxford: Oxford University Press.

Longtin, C. M., & Meunier, F. (2005). Morphological decomposition in early visual word processing. *Journal of Memory and Language*, *53*(1), 26–41.

Longtin, C. M., Segui, J., & Hallé, P. A. (2003). Morphological priming without morphological relationship. *Language and Cognitive Processes*, *18*(3), 313–334.

Lupker, S. J., Perea, M., & Davis, C. J. (2008). Transposed-letter effects : Consonants , vowels and letter frequency letter frequency. *Language and Cognitive Processes*, *23*(1), 93–116.

Manelis, L., & Tharp, D. A. (1977). The processing of affixed words. *Memory & Cognition*, *5*(6), 690–695.

Marslen-Wilson, W. D., Bozic, M., & Randall, B. (2008). Early decomposition in visual word recognition: Dissociating morphology, form, and meaning. *Language and Cognitive Processes*, *23*(3), 394–421.

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

McClelland, J. L., & Rumelhart, D. E. (1981). An Interactive Activation Model of

Context Effects in Letter Perception: Part 1. An Account of Basic Findings. *Psychological Review*, *88*(5), 375–407.

McCormick, S. F., Rastle, K., & Davis, M. H. (2008). Is there a "fete" in "fetish"? Effects of orthographic opacity on morpho-orthographic segmentation in visual word recognition. *Journal of Memory and Language*, *58*(2), 307–326.

Meunier, F., & Longtin, C. M. (2007). Morphological decomposition and semantic integration in word processing. *Journal of Memory and Language, 56*, 457–471.

Norris, D., Kinoshita, S., & Casteren, M. Van. (2010). A stimulus sampling theory of letter identity and order. *Journal of Memory and Language*, *62*(3), 254–271.

Özgür, L., Güngör, T., & Gürgen, F. (2004). Adaptive anti-spam filtering for agglutinative languages: A special case for Turkish. *Pattern Recognition Letters*, *25*(16), 1819–1831.

Perea, M., & Carreiras, M. (2006). Do transposed-letter effects occur across lexeme boundaries? *Psychonomic Bulletin and Review, 13*(3), 418–422.

Perea, M., & Lupker, S. J. (2003a). Transposed-letter confusability effects in masked form priming. In S. Kinoshita & S. J. Lupker (Eds.), *Masked Priming The State of Art* (pp. 97–120). New York: Psychology Press.

Perea, M., & Lupker, S. J. (2003b). Does jugde activate COURT? Transposed-letter similarity effects in masked associative priming. *Memory & Cognition*, *31*(6), 829–841.

Perea, M., & Lupker, S. J. (2004). Can CANISO activate CASINO? Transposed-letter similarity effects with nonadjacent letter positions. *Journal of Memory and Language*, *51*(2), 231–246.

Perea, M., & Lupker, S. J. (2007). La posición de las letras externas en el reconocimiento visual de palabras. *Psicothema*, *19*(4), 559–564.

Perea, M., Mallouh, R., & Carreiras, M. (2010). The search for an input-coding scheme: Transposed-letter priming in Arabic. *Psychonomic Bulletin and Review*, *17*(3), 375–380.

Rastle, K., & Davis, M. (2008). Morphological decomposition based on the analysis of orthography. *Language and Cognitive Processes*, *23*(7-8), 942–971.

Rastle, K., Davis, M. H., Marslen-Wilson, W., & Tyler, L. K. (2000). Morphological and semantic effects in visual word recognition : A time-course study. *Language and Cognitive Processes*, *15*(4/5), 507–537.

Rastle, K., Davis, M. H., & New, B. (2004). The broth in my brother's brothel: Morpho-orthographic segmentation in visual word recognition, *Psychonomic Bulletin & Review*, *11*(6), 1090–1098.

Rastle, K., Lally, C., & Lee, C. (2019). No flexibility in letter position coding in Korean. *Journal of Experimental Psychology: Human Perception and Performance*, *45*(4), 458–473.

Raveh, M., & Rueckl, J. G. (2000). Equivalent Effects of Inflected and Derived Primes : Long-Term Morphological Priming in Fragment Completion and Lexical Decision. *Journal of Memory and Language*, *42*(1), 103–119.

Rayner, K., White, S. J., Johnson, R. L., & Liversedge, S. P. (2006). Raeding Wrods With Jubmled Lettres: There Is a Cost. *Psychological Science*, *17*(3), 192–193.

Rueckl, J. G., & Aicher, K. (2012). Are CORNER and BROTHER morphologically complex? Not in the long term. *Language and Cognitive Processes*, *23*(7-8), 972-1001.

Rueckl, J. G., & Raveh, M. (1999). The influence of morphological regularities on the dynamics of a connectionist network. *Brain and Language*, *68*(1–2), 110–117.

Rueckl, J. G., & Rimzhim, A. (2011). On the interaction of letter transpositions and morphemic boundaries. *Language and Cognitive Processes*, *26*(4–6), 482–501.

Rumelhart, D. E., & McClelland, J. L. (1986). On learning the past tenses of English verbs. In D. E. Rumelhart (Ed.), *Parallel Distributed Processing: Explorations in the microstructure of cognition.* (pp. 216–271). Cambridge, MA: MIT Press.

Sak, H., Güngör, T., & Saraçlar, M. (2008). Turkish Language Resources: Morphological Parser, Morphological Disambiguator and Web Corpus. *Advances in Natural Language Processing Lecture Notes in Computer Science,* 417–427.

Sánchez-Gutiérrez, C., & Rastle, K. (2013). Letter transpositions within and across morphemic boundaries : Is there a cross-language difference? *Psychonomic Bulletin and Review, 20,* 988–996.

Schneider, E., Eschman, A., & Zuccolotto, A. (2012). E-Prime User's Guide.

Schoonbaert, S., & Grainger, J. (2004). Letter position coding in printed word perception: Effects of repeated and transposed letters Effects of repeated and transposed letters. *Language and Cognitive Processes*, *19*(3), 333–367.

Shillcock, R., Ellison, T. M., & Monaghan, P. (2000). Eye-fixation behavior, lexical storage, and visual word recognition in a split processing model. *Psychological Review, 107,* 824–851.

Topbaş, S. (1997). Phonological acquisition of Turkish children: Implications for phonological disorders. *International Journal of Language and Communication Disorders*, *32*(4), 377–396.

Trask, R. L. (1998). The Typological Position of Basque: Then and Now. *Language Sciences, 20*(3), 313–324.

Tsang, Y., & Chen, H. (2013). Early morphological processing is sensitive to morphemic meanings: Evidence from processing ambiguous morphemes. *Journal of Memory and Language, 68,* 223–239.

Tsang, Y. K., Wong, A. W. K., Huang, J., & Chen, H. C. (2014). Morpho-orthographic and morpho-semantic processing in word recognition and production: Evidence from ambiguous morphemes. *Language, Cognition and Neuroscience*, *29*(5), 543–560.

van Assche, E., & Grainger, J. (2006). A Study of Relative-Position Priming With Superset Primes. *Journal of Experimental Psychology*, *32*(2), 399–415.

Velan, H., & Frost, R. (2009). Letter-transposition effects are not universal: The impact of transposing letters in Hebrew. *Journal of Memory and Language*, *61*(3), 285–302.

Whitney, C. (2001). How the brain encodes the order of letters in a printed word : The SERIOL model and selective literature review. *Psychonomic Bulletin and Review*, *8*(2), 221–243.

Whitney, C. (2008). Comparison of the SERIOL and SOLAR theories of letter-position encoding. *Brain and Language*, *107*(2), 170–178.

Whitney, C., & Cornelissen, P. (2008). SERIOL Reading. *Language and Cognitive Processes*, *23*(1), 143-164.

Yakup, M., Abliz, W., Sereno, J., & Perea, M. (2015). Extending Models of Visual-Word Recognition to Semicursive Scripts : Evidence From Masked Priming in Uyghur. *Journal of Experimental Psychology: Human Perception and Performance*, *41*(6), 1553–1562.

Zargar, E. S., & Witzel, N. (2016). Transposed-Letter Priming Across Inflectional Morpheme Boundaries. *Journal of Psycholinguistic Research*, *46*(1), 125–140.

Zhang, Q., Liang, L., Yao, P., Hu, S., & Chen, B. (2017). Parallel morpho-orthographic and morpho-semantic activation in processing second language morphologically complex words: Evidence from Chinese-English bilinguals. *International Journal of Bilingualism*, *21*(3), 291–305.

APPENDICES

A. FULL ITEM LIST

Targets	Target Type	Intact Primes	TL Primes	RL Primes
ACI	Transparent	acılı	aclıı	acteı
ACİL	Transparent	acilen	acieln	aciakn
ART	Transparent	artım	arıtm	arudm
AŞI	Transparent	aşılı	aşlıı	aşteı
BAT	Transparent	batık	baıtk	baedk
BOYA	Transparent	boyacı	boycaı	boyruı
BÖL	Transparent	bölen	böeln	böakn
ÇEK	Transparent	çekim	çeikm	çeatm
ÇIK	Transparent	çıkış	çııkş	çıulş
ÇİZ	Transparent	çizim	çiizm	çiurm
ÇÖK	Transparent	çökük	çöükk	çöabk
DAVA	Transparent	davacı	davcaı	davnuı
DEFO	Transparent	defolu	deflou	defhıu
DEL	Transparent	delik	deilk	deakk
DİK	Transparent	dikiş	diikş	diatş
DON	Transparent	donuk	dounk	doask
DUR	Transparent	duruş	duurş	duemş
DÜŞ	Transparent	düşük	düüşk	düeçk
EŞYA	Transparent	eşyalı	eşylaı	eşydeı
GER	Transparent	gerim	geirm	georm
GİR	Transparent	giriş	giirş	gienş
GİY	Transparent	giyim	giiym	giapm
GÜL	Transparent	gülüş	güülş	güahş

HİLE	Transparent	hileli	hillei	hildai
İMA	Transparent	imalı	imlaı	imdeı
KARE	Transparent	kareli	karlei	karkai
KAT	Transparent	katık	kaıtk	kaidk
KES	Transparent	kesim	keism	keorm
KİLO	Transparent	kilolu	killou	kilhıu
KİRA	Transparent	kiracı	kircaı	kirnuı
KOK	Transparent	kokan	koakn	koeln
KÖK	Transparent	köklü	kölkü	kötbü
KÜS	Transparent	küsen	küesn	küimn
ODA	Transparent	odacı	odcaı	odruı
SEÇ	Transparent	seçiş	seiçş	seaşş
SİL	Transparent	silik	siilk	siakk
SÜR	Transparent	sürüş	süürş	süimş
ŞİŞ	Transparent	şişik	şiişk	şiaçk
TUT	Transparent	tutuk	tuutk	tuokk
VER	Transparent	verim	veirm	veanm
VUR	Transparent	vuruş	vuurş	vuemş
YAĞ	Transparent	yağış	yaığş	yaeyş
YAK	Transparent	yakım	yaıkm	yaulm
YAR	Transparent	yarık	yaırk	yaunk
YAT	Transparent	yatış	yaıtş	yaudş
YAY	Transparent	yayım	yaıym	yaapm
YIK	Transparent	yıkım	yııkm	yıulm
YÜK	Transparent	yüklü	yülkü	yütbü
ANT	Opaque	anten	anetn	anakn
BANK	Opaque	banket	banekt	banolt
BAS	Opaque	basen	baesn	baamn
BAY	Opaque	bayat	baayt	baişt
BİL	Opaque	bilet	bielt	biakt
BUL	Opaque	bulut	buult	buıkt

BUT	Opaque	butik	buitk	buahk
ÇAM	Opaque	çamur	çaumr	çaevr
ÇAN	Opaque	çanak	çaank	çaerk
ÇAY	Opaque	çayır	çaıyr	çaapr
ÇİL	Opaque	çilek	çielk	çiakk
DEM	Opaque	demet	deemt	deont
DİN	Opaque	dinar	dianr	dierr
FEN	Opaque	fener	feenr	feirr
FİŞ	Opaque	fişek	fieşk	fiuyk
FORM	Opaque	format	foramt	forunt
HALT	Opaque	halter	haletr	halakr
HAM	Opaque	hamur	haumr	haevr
HAS	Opaque	hasat	haast	haort
HAT	Opaque	hatır	haıtr	haodr
HIZ	Opaque	hızar	hıazr	hıurr
KAŞ	Opaque	kaşar	kaaşr	kaiyr
KAY	Opaque	kayıt	kaıyt	kaeşt
KAZ	Opaque	kazak	kaazk	kaurk
KEK	Opaque	kekik	keikk	keatk
KEL	Opaque	kelek	keelk	keakk
KEP	Opaque	kepek	keepk	keüçk
KIL	Opaque	kılık	kıılk	kıatk
KİL	Opaque	kilit	kiilt	kiakt
KOÇ	Opaque	koçan	koaçn	kouyn
KOV	Opaque	kovuk	kouvk	koozk
DAL	Opaque	dalak	daalk	daekk
KURS	Opaque	kursak	kurask	kurork
KUŞ	Opaque	kuşak	kuaşk	kuiyk
MOR	Opaque	moruk	mourk	moımk
ORG	Opaque	organ	oragn	orejn
PARK	Opaque	parkur	paurkr	parihr

SAĞ	Opaque	sağır	saığr	sauyr
SAT	Opaque	saten	saetn	saakn
SAZ	Opaque	sazan	saazn	saurn
SIR	Opaque	sırık	sıırk	sıazk
SİM	Opaque	simit	siimt	siürt
SOY	Opaque	soyut	souyt	soeşt
TANK	Opaque	tanker	tanekr	tanolr
TEZ	Opaque	tezek	teezk	teomk
TUZ	Opaque	tuzak	tuazk	tuurk
YAN	Opaque	yanıt	yaınt	yaert
YEL	Opaque	yelek	yeelk	yeakk
ANTİ	Form Overlap	antika	antkia	anttea
ARA	Form Overlap	araba	arbaa	arkia
ARI	Form Overlap	arıza	arzıa	arroa
ARŞ	Form Overlap	arşiv	arişv	areyv
ASA	Form Overlap	asabi	asbai	astei
ATA	Form Overlap	atari	atrai	atmei
BAL	Form Overlap	balina	bailna	baakna
BAR	Form Overlap	baraj	baarj	bainj
BİT	Form Overlap	bitap	biatp	biedp
BOY	Form Overlap	boyoz	booyz	boipz
CEP	Form Overlap	cephe	cehpe	cekşe
DAR	Form Overlap	darbe	dabre	datve
DEV	Form Overlap	devre	derve	denze
DİZ	Form Overlap	dizayn	diazyn	diüryn
DOL	Form Overlap	dolap	doalp	doekp
DÜZ	Form Overlap	düzine	düizne	düürne
FAL	Form Overlap	falso	faslo	fanko
FES	Form Overlap	fesih	feish	feemh
FİLE	Form Overlap	fileto	filteo	filkio
GAF	Form Overlap	gafil	gaifl	gaebl

GAR	Form Overlap	garaj	gaarj	gainj
GAZ	Form Overlap	gazap	gaazp	gaurp
GÜR	Form Overlap	güruh	güurh	güizh
HAL	Form Overlap	halef	haelf	haakf
HAZ	Form Overlap	hazine	haizne	haürne
KAN	Form Overlap	kanepe	kaenpe	kaarpe
KAR	Form Overlap	kargo	kagro	kayno
KAS	Form Overlap	kasap	kaasp	kaorp
KASA	Form Overlap	kasaba	kasbaa	kaskia
KOL	Form Overlap	kolej	koelj	koakj
KOP	Form Overlap	kopya	koypa	koğşa
KOR	Form Overlap	korna	konra	komza
KÖR	Form Overlap	körpe	köpre	köyze
MONT	Form Overlap	montaj	monatj	monolj
PAS	Form Overlap	pasif	paisf	paemf
PATİ	Form Overlap	patika	patkia	pattea
RED	Form Overlap	redif	reidf	reükf
SAL	Form Overlap	salep	saelp	saakp
SAY	Form Overlap	sayfa	safya	sahşa
SER	Form Overlap	serap	searp	seinp
SEV	Form Overlap	sevap	seavp	seüzp
ŞER	Form Overlap	şeref	şeerf	şeanf
TABU	Form Overlap	tabure	tabrue	tabmie
TAY	Form Overlap	tayfa	tafya	tahşa
TEL	Form Overlap	telif	teilf	teakf
TEN	Form Overlap	tenha	tehna	tetva
TUR	Form Overlap	turna	tunra	tumza
ZAR	Form Overlap	zarif	zairf	zaenf

B. APPROVAL OF METU HUMAN SUBJECTS ETHICS COMMITTEE

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

DUMLUPINAR BULVARI 06800
ÇANKAYA ANKARA/TURKEY
T: +90 312 210 22 91
F: +90 312 210 79 59
ueam@metu.edu.tr

Sayı: 28620816 / 678

19 ARALIK 2018

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Doç.Dr. Bilal KIRKICI

Danışmanlığını yaptığınız Ozan Can ÇAĞLAR'ın **"Türkçe Sözcüklerde Harf Yer Değişikliklerinin Biçimbilimsel İşlemlemeye Etkisi: Ruhdilbilimsel Bir İnceleme"** başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek gerekli onay **2018-EGT-201** protokol numarası ile araştırma yapması onaylanmıştır.

Saygılarımla bilgilerinize sunarım.

Prof. Dr. Tülin GENÇÖZ
Başkan

Prof. Dr. Ayhan SOL
Üye

Prof. Dr. Ayhan Gürbüz DEMİR (4.)
Üye

İZİNLİ
Prof. Dr. Yaşar KONDAKÇI
Üye

Doç. Dr. Emre SELÇUK
Üye

Doç. Dr. Pınar KAYGAN
Üye

Dr. Öğr. Üyesi Ali Emre TURGUT
Üye

C. LANGUAGE BACKGROUND QUESTIONNAIRE

Kişisel Bilgiler		Kod:
Adı:	Soyadı:	Bugünün Tarihi:
Doğum Tarihi/Yeri:	Kadın ( )	Erkek ( )
Bölüm:	E-posta:	
Mezun olduğunuz lise türü nedir? (*Örn: Anadolu Öğretmen Lisesi*)		

Hangi dil(ler)i, hangi sırayla öğrendiniz? (ana diliniz dahil)

Dil	Hangi yaştan itibaren?	Ne kadar süreyle?	Öğrendiğiniz yer? (evde, okulda vb.) (lütfen belirtiniz)
1.			
2.			
3.			

Türkiye dışında bir ülkede yaşadınız mı?	Hangi yaştan itibaren?	Ne kadar süreyle?	Hangi sebeplerden dolayı? (okul, çalışma vb.)
1.			
2.			

İngilizce Yeterlik Öz Değerlendirmesi

Lütfen aşağıdaki soruları cevaplayınız:

1) Nasıl değerlendirirsin…	**çok zayıf**								**çok iyi**
… genel İngilizce yeterliğini?	1	2	3	4	5	6	7	8	9
… İngilizce konuşma becerini?	1	2	3	4	5	6	7	8	9
… İngilizce dinlediğini anlama becerini?	1	2	3	4	5	6	7	8	9
… İngilizce yazma becerini?	1	2	3	4	5	6	7	8	9
… İngilizce okuma becerini?	1	2	3	4	5	6	7	8	9
	oldukça rahatsız								**oldukça rahat**
2) İngilizceyi anlama ve kullanmada kendinizi ne kadar rahat hissediyorsunuz?	1	2	3	4	5	6	7	8	9
3) Hangi yaştan itibaren kendinizi İngilizceyi kullanmada rahat hissetmeye başladınız?									

D. THE INFORMED CONSENT

ARAŞTIRMAYA GÖNÜLLÜ KATILIM FORMU

Bu araştırma, ODTÜ Yüksek Lisans öğrencilerinden Ozan Can Çağlar tarafından yürütülmektedir. Bu form sizi araştırma koşulları hakkında bilgilendirmek için hazırlanmıştır.

Çalışmanın Amacı Nedir?

Bu araştırma, Türkçe anadil konuşucularının bazı Türkçe sözcükleri biçimbilimsel olarak nasıl işlemlediklerini, deneysel bir yöntemle incelemeyi amaçlamaktadır.

Bize Nasıl Yardımcı Olmanızı İsteyeceğiz?

Araştırmaya katılmaya gönüllü olmanız durumunda, yaklaşık 30 dakika sürecek bir sözcüksel karar testini tamamlamanız istenecektir. Sözcüksel karar testi kapsamında, bilgisayar ekranında karşınıza çıkacak sözcüklerin Türkçede bulunan bir sözcük olup olmadığına bilgisayara bağlanmış bir oyun konsolunda tanımlı tuşlara basarak karar vermeniz beklenecektir. Kararlarınızı verirken olabildiğince doğru ve hızlı olmanız önem arz etmektedir.

Sizden Topladığımız Bilgileri Nasıl Kullanacağız?

Araştırmaya katılımınız tamamen gönüllülük temelinde olmalıdır. Deneyde sizden kimlik belirleyici hiçbir bilgi istenmemektedir. Cevaplarınız tamamıyla gizli tutulacak, sadece araştırmacı tarafından değerlendirilecektir. Katılımcılardan elde edilecek bilgiler toplu halde değerlendirilecek ve bilimsel yayımlarda kullanılacaktır. Sağladığınız veriler gönüllü katılım formlarında toplanan kimlik bilgileri ile eşleştirilmeyecektir.

Katılımınızla ilgili bilmeniz gerekenler:

Çalışma, genel olarak kişisel rahatsızlık verecek sorular içermemektedir. Ancak, katılım sırasında sorulardan ya da herhangi başka bir nedenden ötürü kendinizi rahatsız hissederseniz cevaplama işini yarıda bırakıp çıkmakta serbestsiniz. Böyle bir durumda çalışmayı uygulayan kişiye, çalışmadan çıkmak istediğinizi söylemek yeterli olacaktır.

Araştırmayla ilgili daha fazla bilgi almak isterseniz:

Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için ODTÜ yüksek lisans öğrencisi Ozan Can Çağlar (E-posta: caglar.ozan@metu.edu.tr) ya da öğretim üyesi Doç. Dr. Bilal Kırkıcı (E-posta: bkirkici@metu.edu.tr) ile iletişim kurabilirsiniz.

Yukarıdaki bilgileri okudum ve bu çalışmaya tamamen gönüllü olarak katılıyorum.

(Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

İsim Soyad Tarih İmza

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E. DEFINITION TASK

Aşağıda sıralanmış sözcüklerin anlamlarını yanlarına yazınız. Eğer anlamlarını ifade etmekte zorlanıyorsanız, bu sözcükleri çağrıştıran yapılardan faydalanabilir veya sözcükleri tümce içerisinde kullanabilirsiniz.

Örnek

Devre: Belirlenmiş zaman dilimi / ilk devre, son devre / Son devrede yaşanan olaylar herkesi üzdü.

Banket:

Gazap:

Falso:

Kelek:

Atari:

Basen:

Hızar:

Redif:

Kovuk:

Boyoz:

Parkur:

Halef:

Kursak:

Güruh:

F. TURKISH SUMMARY / TÜRKÇE ÖZET

1. Çalışmanın Arka Planı

1.1. Karmaşık Sözcüklerin Erken İşlemlenmesi Aşamasında Anlamsal Bilginin Rolü

Ruhdilbilimsel çalışmaların odaklandığı en temel konulardan biri, *enjoyed* gibi biçimbilimsel olarak karmaşık yapıda olan sözcüklerin insan beyninde nasıl işlemlendiğini araştırmak olmuştur. Bu bağlamda, yürütülen çalışmaların bazıları, bu tür karmaşık sözcüklerin zihinsel sözlükte bütünsel olarak listelendiğini ve bu sözcüklerin zihinsel sözlükten geri çağırılmasının yalnızca bütünsel temsilleri aracılığıyla gerçekleştiğini ileri sürmüştür (Bybee, 1995; Manelis & Tharp, 1977; Rumelhart & McClelland, 1986). Diğer yandan, bütünsel listeleme görüşünün aksine, günümüzde araştırmacıların, karmaşık yapıların görsel sözcük tanıma sistemi tarafından ayrıştırılabilir birimler olarak değerlendirildiği fikrini benimseme eğiliminde oldukları görülmektedir (Beyersmann, Castles, & Coltheart, 2011; Diependaele, Duñabeitia, Morris, & Keuleers, 2011; Feldman, Kostić, Gvozdenović, O'Connor, & Moscoso del Prado Martín, 2012; Longtin & Meunier, 2005; Rastle, Davis, & New, 2004). Daha açık ifade etmek gerekirse, karmaşık yapıdaki sözcüklerin biçimbirim bileşenlerine ayrıştırıldığı ve yapılara bu bileşenler aracılığıyla erişildiği düşünülmektedir (enjoyed: *enjoy* + *-ed*). Karmaşık sözcüklerin ayrıştırılarak işlemlendiği görüşünün deneysel kanıtları, çoğunlukla maskelenmiş hazırlama paradigması kullanan çalışmalar tarafından ortaya konulmuştur.

Maskelenmiş hazırlama paradigması, temelde bir hazırlayıcı sözcüğün bir hedef sözcükten önce oldukça kısa bir süreliğine (Örn. 50 milisaniye) gösterilmesini kapsar. Hazırlayıcı sözcükler genellikle bu kısa zaman aralığında bilinçli olarak algılanamamaktadır. Maskeleme ise genelde hazırlayıcı sözcüğün gösterilmesinden hemen önce bir dizi alfasayısal karakter (Örn., #####) sunularak gerçekleştirilir. Hazırlayıcı sözcük ve hedef sözcüğün gösterilmeye başlanması arasındaki süre farkı uyaran başlangıcı uyumsuzluğu (İng., stimulus-onset asynchrony, SOA) olarak adlandırılmaktadır. Katılımcılardan, bilinçdışı olarak algılanan hazırlayıcı sözcüklere maruz kaldıktan sonra, kendilerine sunulan hedef sözcüğün deneyde test edilen dilde var olan bir sözcük olup olmadığına, belirli tuşlara basarak karar vermesi beklenmektedir. Katılımcıların her bir deneme için tepki gecikmeleri ölçülür ve hazırlayıcı sözcüklerin hedef sözcükleri tanımayı hızlandırıp hızlandırmadığı incelenir (daha kapsamlı bir açıklama için, bkz. Forster, Mohan, & Hector, 2003). Farklı türden hazırlayıcı sözcüklerin katılımcıların tepki süreleri üzerinde farklı etkileri olup olmadığını görmek adına, çoğu kez hazırlayıcı ve hedef sözcük arasındaki ilişki üzerinde eyletim uygulanmaktadır.

Biçimbilimsel olarak ilintili ve tümüyle ilintisiz olmak üzere iki farklı hazırlayıcı sözcüğün etkilerini inceleyen çalışmalar, biçimbilimsel olarak bağıntılı hazırlayıcı-hedef sözcük çiftlerinin (teacher-TEACH), tümüyle ilintisiz hazırlayıcı-hedef sözcük çiflerine (sheep-TEACH) göre anlamlı bir şekilde daha hızlı tepki süreleri ortaya koyduğunu rapor etmiştir. Bu sonuç, hazırlayıcı sözcük ve hedef sözcük arasında biçimbilimsel bir ilinti bulunması durumunda hedef sözcükleri tanımanın hızlandığını göstermiştir (Diependaele, Morris, Serota, Bertrand, & Grainger, 2013; Rastle vd., 2004). Bu hızlandırıcı etkinin, hazırlayıcı sözcüğün (teacher) gösterilmesi yoluyla, sözcük kökünün (TEACH) bireysel olarak hedef sözcük gösterilmeden önce etkinleştirildiğine kanıt olduğu öne sürülmüştür. Sözcük kökünün bu şekilde önceden etkinleştirilebilmesinin ise ancak karmaşık yapıdaki sözcüğün bileşenlerine ayrıştırılmasıyla mümkün olabileceği düşünülmüştür (Rastle vd., 2004). Diğer bir deyişle, örneğin karmaşık yapıdaki *teach* sözcüğünün ayrıştırılması vasıtasıyla okuyucu, sözcük kökü olan *teach* sözcüğüne erişim sağlar ve bu sözcüğü etkinleştirir. Dolayısıyla, önceden etkinleştirdiği *teach* sözcüğünü hedef sözcük olarak tekrardan gören okuyucu, bu sözcüğü daha hızlı tanıyarak bir hazırlama etkisi gösterir.

Alanyazında, karmaşık yapıdaki sözcüklerin ayrıştırılarak işlemlendiğine dair bir fikir birliğine ulaşılmış gibi görünse de, bahsi geçen bu ayrıştırmanın nasıl meydana geldiği konusundaki görüşler birbiriyle çelişmektedir. Önce-biçim görüşü, okuyucuların görsel sözcük tanımanın ilk aşamalarında, karmaşık yapıdaki bir sözcüğün ayrıştırılması esnasında yalnızca biçim temelli bir çözümleme yaptığını savunur. Bu doğrultuda, sözcük anlamının işlemlemede önemli bir rol oynadığı düşünülse de, sözcük tanıma sisteminin öncelikli olarak anlamsal bilginin dahil olmadığı bir çözümleme yaptığı ve anlamsal bilginin ancak biçim çözümlemesi tamamlandıktan sonra devreye girdiği varsayılmaktadır (Örn., Heyer & Kornishova, 2018; Longtin, Segui, & Hallé, 2003; Rastle, Davis, Marslen-Wilson, & Tyler, 2000). Önce-biçim görüşüne göre anlamsal bilgi, erken işlemlemede sözcük tanıma sistemi tarafından o kadar göz ardı edilir ki yalnızca yüzeysel bir karmaşıklık bile biçimbilimsel ayrıştırma için yeterli olmaktadır. Başka bir deyişle, okuyucular *corner* gibi sözde karmaşık yapıya sahip sözcüklerle karşılaştıklarında, bu tür sözcükleri kök *corn* ve sözde sonek *-er* olarak kendiliğinden ayrıştırdıkları düşünülmektedir. Bu iddiayı destekleyen deneysel kanıtlar, hazırlayıcı sözcüklerin anlamsal geçirimliliği üzerinde eyletim uygulayan maskelenmiş hazırlama çalışmaları tarafından ortaya konulmuştur. Birçok çalışma, hem anlamsal olarak geçirimli (ilgili hedef sözcükler ile gerçek bir anlambilimsel ve biçimbilimsel bağıntı gösteren hazırlayıcı sözcükler: walker-WALK) hem de anlamsal olarak geçirimsiz (ilgili hedef sözcükler ile anlambilimsel bir bağıntısı bulunmayan, bu sözcüklerle yalnızca sözde bir biçimbilimsel bağıntıya sahip hazırlayıcı sözcükler: number-NUMB) hazırlayıcı sözcüklerin, anlamlı bir şekilde hedef sözcüklerin tanınmasını hızlandırdıkları sonucuna ulaşmıştır. Daha da önemlisi, bu iki çeşit hazırlayıcı sözcükten elde edilen hazırlama etkilerinin büyüklüğünün, istatistiksel olarak farksız olduğu rapor edilmiştir (Beyersmann, Ziegler, Castles, Coltheart, Kezilas, & Grainger, 2016; Davis & Rastle, 2010; Kazanina, Dukova-Zheleva, Geber, Kharlamov, & Tonciulescu, 2008; Marslen-Wilson, Bozic, & Randall, 2008; Rastle vd., 2004; Rastle & Davis, 2008).

Bu bulgular temel alındığında, araştırmacılar, erken işlemleme esnasında anlam temelli bir çözümleme olmadığını iddia etmektedir. Çünkü geçirimli sözcüklerde, biçimbilimsel ilintililiğin yanı sıra anlamsal da bir bağıntı bulunmasına rağmen, bu sözcükler geçirimsiz hazırlayıcı sözcüklerden daha büyük bir hazırlama etkisi ortaya koymayı başaramamıştır. Alanyazındaki çalışmaların deney desenine, geçirimli ve geçirimsiz hazırlayıcı sözcüklerin dışında ayrıca hedef sözcüklerle sadece yazımsal olarak ilintili olan kontrol sözcükler (örtüşük yazımlı) de dahil ettikleri görülmektedir. Bu kontrol koşulunun test edilmesinin temel nedeni, geçirimli ve geçirimsiz hazırlayıcı sözcüklerden elde edilen hazırlama etkilerinin yazımsal örtüşme kaynaklı olmadığından emin olmaktır. Beklenildiği gibi, örtüşük yazımlı hazırlayıcı sözcüklerin herhangi bir hazırlama etkisi göstermediği saptanmıştır. Dolayısıyla, gözlemlenen hazırlama etkilerinin kaynağının, hazırlayıcı ve hedef sözcükler arasındaki paylaşılan biçimbilimsel ilinti olduğu öne sürülmüştür. Dahası, önce-biçim görüşü her ne kadar işlemlemenin erken aşamalarında anlamsal bilginin dahil olmadığı biçim-yazımsal bir çözümleme önerse de, işlemlemenin ilerleyen aşamalarında anlamsal bilginin de devreye girdiğini savunmaktadır. Bununla bağlantılı olarak, birçok çalışma, hazırlayıcı sözcükler daha uzun süre gösterildiğinde (Örn., 100 ms) anlamsal geçirimliliğin etkilerini gözlemlemiştir. Bu etkinin ortaya çıkmasının sebebi, okuyucuların hazırlayıcı sözcüklere, biçim-anlamsal bilgiye ulaşabilecekleri kadar uzun süre maruz kaldıklarına bağlanmıştır (Rastle vd., 2000).

Önce-biçim görüşünün tam aksine, hem anlam hem biçim görüşü, görsel sözcük tanımanın erken aşamalarında anlamsal bilginin de rolü olduğunu ileri sürmektedir. Bu görüşü destekleyen çalışmalar, anlamsal olarak geçirimli hazırlayıcı sözcüklerin aslında geçirimsiz hazırlayıcı sözcüklerden anlamlı bir şekilde daha fazla hazırlayıcı etki ortaya koyduğunu göstermiştir (Diependaele, Sandra, & Grainger, 2009; Diependaele vd., 2011; Diependaele vd., 2013; Feldman, O'Connor, & Moscoso del Prado Martín, 2009; Feldman vd., 2012). Daha doğrusu, geçirimsiz sözcüklerin ya hiç etki göstermedikleri ya da geçirimli sözcüklere oranla nispeten daha zayıf etki gösterdikleri saptanmıştır. Bu sebeple, bu çalışmalar, karmaşık sözcüklerin erken işlemleme sürecine anlamsal bilginin dahil olmadığı görüşüne karşı çıkmaktadır. Buna karşılık, araştırmacılar biçim-anlamsal bilginin, biçim-yazımsal bilgi kadar erken aşamada işlemlemeye dahil olduğu görüşünü desteklemiştir. Bu bulgular ışığında araştırmacılar, gözlemlenen hazırlama etkisi örüntülerini açıklamak amacıyla bazı modeller geliştirmiştir. Örneğin, Diependaele vd. (2013) tarafından geliştirilen ikil-yollu biçimbilimsel işlemleme modeli, karmaşık yapıdaki sözcüklerin iki farklı işlemlemeden (biçim-yazımsal ve biçim-anlamsal) eş zamanlı geçtiğini belirtmektedir.

Yani model, görsel olarak karmaşık yapıdaki bir sözcükle karşılaşıldığında, bu sözcüğün hem bileşenlerinin hem de bütünsel temsillerinin etkinleştirildiğini savunmaktadır. Dolayısıyla, geçirimsiz sözcük çiftlerinde kaybolduğu veya zayıfladığı gözlemlenen hazırlama etkilerinin sebebi, bu sözcük çiftlerinde, hedef sözcüklerin yalnızca bileşenler aracılığıyla (biçim-yazımsal işlemleme aracılığıyla) etkinleştirildiğine bağlanmıştır. Geçirimsiz sözcüklerden farklı olarak, geçirimli sözcük çiftlerinde ise hem bileşenler hem de bütünsel temsiller aracılığıyla hedef sözcüklerin etkinleştirildiği varsayılmaktadır. Bu tür sözcüklerde gözlemlenen anlamlı şekilde daha güçlü hazırlama etkilerinin ise, bu ikil-yollu etkinleştirmenin sonucu olduğu düşünülmektedir. Biçimbirimlerin anlam yüklü en temel birimler olduğu iddiası düşünüldüğünde (Raveh & Rueckl, 2000), karmaşık sözcüklerin işlemlenmesi üzerine oldukça önemli bilgiler açığa çıkarabileceğinden, anlamsal bilginin erken işlemlemedeki rolü hususundaki çelişkili sonuçları çözüme kavuşturmak büyük önem arz etmektedir.

1.2. Harf Düzenekleme ve Harf Yer Değişikliği Hazırlama Etkisi

Çoğu zaman herhangi bir anlam taşımamaları, harflerin, beynimizde inşa ettiğimiz dilin önemli bir parçası olduğu gerçeğini değiştirmemektedir. Alfabetik bir dilin konuşucularının, sözcükleri bireysel olarak harfler aracılığıyla işlemledikleri savı düşünüldüğünde (Duñabeitia, Perea, & Carreiras, 2009), harflerin sözcük içerisindeki tam konumu hakkında bilgi sahibi olmak, *expect* ve *except* gibi çevrik sözcükleri ayırt edebilmemiz açısından büyük önem arz etmektedir. Örneğin, konuma özgü harf düzenekleme modelleri (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; McClelland & Rumelhart, 1981), harflerin sözcük içerisindeki konumlarının konuma özgü bir şekilde kodlandığını varsaymaktadır. Dolayısıyla, bu modellere göre, *expect* sözcüğündeki *p* harfi ile *except* sözcüğündeki *p* harfi, yazımsal olarak aynı olmalarına rağmen birbirinden farklı harfler olarak kabul edilir. Bu sebeple, konuma özgü harf düzenekleme modellleri, bahsi geçen çevrik sözcükleri başarılı bir şekilde ayırt edebilmektedir. Fakat bu modeller, alanyazında belirgin bir şekilde rapor edilmekte olan harf yer değişikliği etkisini (İng., transposed-letter effect) açıklayamamaktadır. Harf yer değişikliği etkisi, var olan bir sözcüğün iki harfinin değiştirilmesiyle oluşan anlamsız sözcüklerle, bu sözcüklerin asıl biçiminin, okuyucular tarafından karıştırılması durumuna işaret eder (*jugde-judge*) (Andrews, 1996; Perea & Lupker, 2003a). Diğer bir deyişle, okuyucular, *jugde* anlamsız sözcüğündeki harf konumu bozukluğunu tespit edemeyip bu sözcüğü *judge* olarak çözümler. Bunun yanı sıra, hazırlayıcı sözcük olarak sunulduklarında, harf yer değişikliği gösteren anlamsız sözcüklerin, asıl biçimlerinin tanınmasını anlamlı bir şekilde hızlandırdıkları saptanmıştır. Daha da önemlisi, bu hazırlama etkisinin, yeri değiştirilmiş harflerin kimliğinin de değiştirilmesiyle oluşturulan anlamsız sözcüklerden (harf kimliği değişimine uğramış hazırlayıcı sözcükler: jupbe-judge) elde edilen hazırlama etkisinden anlamlı bir şekilde daha güçlü olduğu ortaya çıkmıştır (Perea & Lupker, 2003a; 2003b; Perea & Lupker, 2004; Schoonbaert & Grainger, 2004). Gözlemlenen bu hazırlama etkisi farkı, *jugde* and *jupbe* sözcüklerinin asıl biçim olan *judge* sözcüğüne eşit derecede benzediğini ileri süren konuma özgü harf düzenekleme modellerinin öngörüleriyle örtüşmemektedir.

Harf yer değişikliğine uğramış ve harf kimliği değişimine uğramış sözcüklerde gözlemlenen hazırlama etkisi farkı, konuma özgü harf düzenekleme modelleri ile açıklanamasa da, konumdan bağımsız harf düzenekleme modelleri (Davis, 1999; 2010b) bu etkiye açıklık getirebilmektedir. Bu modellere göre, asıl birimle tümüyle aynı harf grubundan oluştukları için ve bu harfler konumdan bağımsız bir şekilde kodlandığı için, harf yer değişikliğine uğramış sözcükler asıl birime, harf kimliği değişimine uğramış sözcüklerden daha fazla benzemektedir. Harf yer değişikliği hazırlama etkisi yaygın olarak kabul gören bir etki olmasına rağmen, bu etkinin kısıtlandığı ve ortaya çıkmadığı durumlar da alanyazında rapor edilmiştir. Örneğin, çalışmalar, harf yer değişiklikleri sözcüğün ilk veya son harfini içerdiğinde (Örn., ujdge-judge), anlamlı bir harf yer değişikliği hazırlama etkisi ortaya koymamıştır (Rayner, White, Johnson, & Liversedge, 2006; Perea & Lupker, 2007).

Mevcut çalışma düşünüldüğünde, harf yer değişikliği etkisinin ortadan kalktığının rapor edildiği en göze çarpan durumun, biçimbirim sınırında uygulanan harf yer değişiklikleri olduğu söylenebilir. Tıpkı erken işlemlemede anlamsal bilginin rolü konusunda olduğu gibi, biçimbirim sınırında uygulanan harf yer değişikliklerinin etkileri konusunda da alanyazındaki çalışmaların birbiriyle çeliştiği görülmektedir. Örnek vermek gerekirse, birçok çalışma biçimbirim sınırında harf yer değişikliğine uğramış sözcüklerin (ediotr-editor), asıl biçimleri hedef sözcük olarak gösterildiğinde, yine de anlamlı hazırlama etkisi gösterdikleri tespit edilmiştir (Beyersmann, McCormick, & Rastle, 2013; Perea & Carreiras, 2006; Rueckl & Rimzhim, 2011; Sánchez-Gutiérrez & Rastle, 2013; Zargar & Witzel, 2016). Bu sonucun aksine, bazı çalışmalar ise biçimbirim sınırında harf yer değişikliğine uğramış sözcüklerin, kontrol koşulu olan harf kimliği değişimine uğramış sözcüklerle istatistiksel olarak aynı büyüklükte hazırlama etkisi gösterdiğini saptamıştır (Christianson, Johnson, & Rayner, 2005; Duñabeitia, Perea, & Carreiras, 2007; Duñabeitia, Perea, & Carreiras, 2014). Hazırlama etkisinin kaybolduğu bu durum 'sınır etkisi' olarak adlandırılmıştır (Rueckl & Rimzhim, 2011). Elde dilen çelişkili sonuçlar, biçim-yazımsal işlemleme süreçleri ve anlamsal bilginin erken işlemlemedeki rolü konusunda önemli bilgiler vermektedir. Örneğin, sınır etkisinin gözlemlendiği durumlar, harf düzenekleme ve biçim-yazımsal ayrıştırma süreçlerinin eş zamanlı meydana geldiğine kanıt olarak gösterilmiştir. Dolayısıyla, sınır etkisi, biçimbirim sınırındaki harf konumu bozukluklarının, halihazırda belirlenmiş biçimbirim sınırları üzerinde hasar verici etkisi olmasına bağlanmıştır. Biçimbirim sınırındaki harf yer değişikliğine rağmen hazırlama etkisinin yine de gözlemlendiği durumlara ise iki farklı açıklama getirilmiştir. Bir taraftan, bu sonuç, harf düzeneklemenin biçim-yazımsal işlemlemeden daha önce gerçekleştiği ve bu yüzden biçimbirim sınırlarının uygulanan harf yer değişikliği eyletiminden olumsuz bir şekilde etkilenmediği şeklinde yorumlanmıştır. Diğer taraftan ise, bu sonucun, biçim-anlamsal bilginin, biçim-yazımsal bilgi kadar erken işlemlendiğine kanıt olduğu ileri sürülmüştür. Bu iddia temel alındığında, aslında biçimbirim sınırındaki harf yer değişikliklerinin biçim-yazımsal ayrıştırmaya zarar verdiği kabul görmektedir. Fakat biçimbirim sınırında harf yer değişikliği uygulansa da, biçim-yazımsal ayrıştırmanın yanı sıra bütünsel temsillerin de etkinleştirilmesi hazırlama etkisinin kaybolmasına engel olmaktadır. Yine de, bu bulguların anlamsal bilginin erken işlemlemede bir rolü olduğuna işaret ettiğinden emin olmak adına gerçek ekli sözcüklerin yanında sözde ekli sözcüklerin de biçimbirim sınırında harf değişikliği uygulanarak test edilmesi gerekmektedir.

Buna rağmen, sözde ekli yapıların böyle bir desenle test edildiği çalışma sayısı oldukça azdır. Bu çalışmalardan en göze çarpanı, hem gerçek ekli hem de sözde ekli sözcüklere biçimbirim sınırında harf yer değişikliği eyletimi uygulayan Diependaele vd. (2013) tarafından yürütülmüştür. Araştırmacılar, kendi geliştirdikleri ikil-yollu biçimbilimsel işlemleme modelinden ve alanyazında, biçimbirim sınırındaki harf yer değişikliklerine rağmen hazırlama etkisine ulaşan çalışmalardan yola çıkarak, biçimbirim sınırında uyguladıkları harf yer değişikliği sonucu geçirimli sözcüklerde (walker: walekr-WALK) hazırlama etkisi gözlemleneceğini, fakat geçirimsiz sözcüklerde (corner: corenr-CORN) bir sınır etkisinin ortaya çıkacağını beklemişlerdir. Sonuçlar ise açık bir şekilde bu öngörüleri desteklemiştir. Yalnızca geçirimli sözcüklerin biçimbirim sınırındaki harf yer değişikliklerinden etkilenmemesi, Diependaele vd. (2013) tarafından biçim-anlamsal bilginin de erken işlemlemede bir rolü olduğuna kanıt olarak gösterilmiştir. Biçim-yazımsal işlemleme, bahsi geçen harf yer değişikliklerinden olumsuz etkilense de, geçirimli hazırlayıcı sözcükler yine de ilgili hedef sözcükleri bütünsel temsiller aracılığıyla etkinleştirmeyi başarmıştır. Geçirimsiz hazırlayıcı sözcükler için hazırlama etkisinin tek kaynağı biçim-yazımsal işlemleme olduğundan (geçirimsiz hazırlayıcı-hedef sözcükler arasında anlamsal bağıntı bulunmadığından), bu sözcükler sınır etkisine takılmıştır. Çünkü biçim-yazımsal etkinleştirme kanalı harf yer değişiklikleriyle etkisiz hale getirilmiştir. Sonuç olarak, Diependaele vd. (2013) tarafından yürütülmüş bu çalışma, biçimbirim sınırında uygulanan harf yer değişiklikleri konusunu da çalışma desenine dahil ederek, anlamsal bilginin erken işlemlemedeki rolünü inceleme adına alternatif ve etkili bir deney deseni sunmuştur. Fakat hem anlamsal bilginin rolü hem de biçimbirim sınırındaki harf yer değişikliklerinin etkileri konusundaki çelişkili sonuçlar göz önünde bulundurulduğunda, bu çelişkilerin çözüme kavuşturulması için iyi tasarlanmış birçok çalışmaya ihtiyaç duyulmaktadır. Mevcut çalışmanın amacı da, bahsi geçen bu tartışmalara anlamlı katkılar sağlamaktır.

2. Çalışmanın Önemi

Türkçe de Bask dili gibi zengin ve üretken bir biçimbilime sahip sondan eklemeli bir dildir (Gürel, 1999; Özgür, Güngör, & Gürgen, 2004). Bu sebeple alanyazında, Türkçe ve Bask dili gibi dillerin konuşucularının karmaşık yapılı sözcükleri işlemlerken, İngilizce ve Fransızca gibi sondan eklemeli olmayan dillerin konuşucularına oranla daha fazla bilişsel kaynaktan faydalanması gerekebileceğinden bahsedilmektedir (Zargar & Witzel, 2016). Bu doğrultuda, mevcut çalışmanın, Türkçe anadil konuşucularının işlemlemelerine odaklanması sebebiyle alanyazındaki tartışmalara önemli katkılar sağlaması mümkündür.

Daha önce bahsedildiği gibi, anlamsal bilginin görsel sözcük tanımanın erken aşamalarında bir rolü olup olmadığı ve biçimbirim sınırındaki harf yer değişikliklerinin biçim-yazımsal işlemlemeye hasar verip vermediği üzerine tartışmalar devam etmektedir. Fakat ilgili alanyazın incelendiğinde, test edilen dillerin ağırlıklı olarak İngilizce, Fransızca ve İspanyolca gibi Hint-Avrupa olduğu görülmektedir. Bu nedenle, farklı yapısal özelliklere sahip dillerin farklı sonuçlar ortaya koyup koymayacağını test etmek büyük önem arz etmektedir. Birçok çalışmada belirtildiği gibi, elde edilen çelişkili sonuçların sebeplerinden bir tanesi de diller arası farklılıklar olabilir (Duñabeitia vd., 2007; Sánchez-Gutiérrez & Rastle, 2013; Zargar & Witzel, 2016). Bazı Sami dillerinde (Perea, Mallouh, & Carreiras, 2010; Velan & Frost, 2009) ve Korece'de (Rastle, Lally, & Lee, 2019) harf yer değişikliği hazırlama etkisinin gözlemlenememiş olduğu düşünüldüğünde, diller arası farklılıkların gerçekten de sonuçları etkileyebileceği ihtimalini göz önünde bulundurmak mantık dışı değildir. Bu doğrultuda, bilindiği kadarıyla, Türkçede hiçbir çalışma bugüne dek anlamsal bilginin erken işlemlemedeki rolünü, biçimbirim sınırında harf yer değişikliği uygulayarak test etmemiştir. Bu sebeple, mevcut çalışma, Türkçede anlamsal bilginin erken işlemlemede bir rolü olup olmadığını ve harf yer değişikliklerinin bu tartışmayı nasıl bilgilendirdiğini test etmeyi planlayan gelecek çalışmalar için bir temel olarak değerlendirilebilir.

3. Araştırma Soruları ve Öngörüler

Mevcut çalışma, Türkçede karmaşık sözcüklerin bileşenlerine nasıl ayrıştırıldığını incelemektedir. Diğer bir deyişle, bu çalışma temelde, görsel sözcük tanımanın erken aşamalarında, karmaşık sözcüklerin ayrıştırılmasının yalnızca biçim-yazımsal bir işlemleme yoluyla mı, yoksa eş zamanlı biçim-yazımsal ve biçim-anlamsal işlemlemeler aracılığıyla mı gerçekleştiğini sorgulamaktadır. Fakat anlamsal bilginin erken işlemlemedeki rolünü test etmek adına, mevcut çalışma biçimbirim sınırında harf yer değişikliği eyletiminden de faydalanmıştır. Dolayısıyla, çalışma kapsamında, ayrıca, biçimbirim sınırındaki harf yer değişikliklerinin gerçek ekli ve sözde ekli sözcüklerin işlemlenmesini nasıl etkilediği de araştırılmıştır. Buna bağlı olarak, mevcut çalışma yanıt aradığı sorular şu şekildedir: (a) Görsel sözcük tanımanın erken aşamalarında, biçim-anlamsal bilgi de biçim-yazımsal bilgi kadar erken işlemlenmekte midir? (b) Biçimbirim sınırında uygulanan harf yer değişiklikleri, karmaşık sözcüklerin erken işlemlenmesini nasıl etkilemektedir?

İkil-yollu biçimbilimsel işlemleme modeli (Diependaele vd., 2013) temel alındığında, hem geçirimli hem de geçirimsiz hazırlayıcı sözcüklerin hazırlama etkisi göstereceği beklenmektedir. Örtüşük yazımlı hazırlayıcı sözcüklerin ise herhangi bir hazırlama etkisi göstermesi öngörülmemektedir. Geçirimsiz sözcüklerin yalnızca biçim-yazımsal, geçirimli sözcüklerin ise hem biçim-yazımsal hem de biçim-anlamsal kanal aracılığıyla etkinleştirildiği düşünüldüğünde, geçirimli hazırlayıcı sözcüklerin geçirimsiz sözcüklere oranla daha güçlü hazırlama etkisi göstermesi beklenebilir. Dahası, biçimbirim sınırındaki harf yer değişikliklerinin biçim-yazımsal işlemleme üzerinde olumsuz etkileri olduğu iddiası göz önünde bulundurulduğunda, harf yer değişikliği eyletimi sonucu geçirimsiz sözcüklerde gözlemlenen hazırlayıcı etkinin ortadan kalkacağı öngörülebilir. Diğer yandan, alternatif olarak biçim-anlamsal kanaldan da etkileştirme desteği alan geçirimli sözcüklerin, harf yer değişikliği eyletimine rağmen yine de hazırlama etkisi göstereceği düşünülmektedir. Önce-biçim görüşünün geçerli olduğu varsayıldığında ise, uygulanan biçimbirim sınırındaki harf yer değişikliklerinin, hem geçirimli hem de geçirimsiz sözcüklerden elde edilecek hazırlama etkisini ortadan kaldırması öngörülmektedir. Çünkü bu durumda, her iki hazırlayıcı sözcük türü için de alternatif bir etkinleştirme kaynağı söz konusu olmayacaktır.

4. Katılımcılar

Çalışma kapsamında uygulan iki ayrı deneye de, ana dili Türkçe olan Orta Doğu Teknik Üniversitesi Yabancı Diller Eğitimi Bölümü'nde lisans, yüksek lisans veya doktora öğrencisi 42 kişi katılmıştır (34 kadın, Ort. Yaş= 21.4, Stand. Sapma= 2.4). Çalışma için ODTÜ İnsan Araştırmaları Etik Kurulu onayı alınmıştır.

5. Materyaller ve Deneysel Yöntem

5.1. Deney 1

Bu deneyde, hedef sözcük olarak 96 adet üç ya da dört harften oluşan tek biçimbirimli Türkçe kök kullanılmıştır. Bu kökler ad (hız), sıfat (kel) ya da eylem (bul) köklerinden oluşmaktadır. 96 hedef sözcüğün yarısından önce, bu hedef sözcüklerle herhangi bir anlamsal bağıntı göstermeyen, fakat bir kök ile sahte bir ekin birleşimi şeklinde çözümlenebilecek yapısı korunmuş hazırlayıcı sözcükler (Örn., tuzak-TUZ) gösterilmiştir. Anlamsal olarak geçirimsiz hazırlayıcı sözcüklerde sahte ek olarak kullanılan yapım ekleri şu şekildedir: -Ar (yaz**ar**), -An (böl**en**), -Ak (kaç**ak**), -Et (yön**et**-), -Ik (kes**ik**), ve -It (yak**ıt**). Hedef sözcüklerin diğer yarısından önce ise örtüşük yazımlı ya da bir diğer deyişle, hedef sözcüklerle yine herhangi bir anlamsal ilinti göstermeyen, fakat Türkçede var olan bir kök ile ek işlevi olmayan bir sözcük sonu biriminin birleşimi şeklinde çözümlenebilecek yapısı korunmuş hazırlayıcı sözcükler (kasap-KAS) kullanılmıştır. Hedef sözcüklerin hiçbiri aynı deney listesi içinde ya da deney listeleri arasında birden çok kez kullanılmamıştır. Beyersmann vd. (2016) tarafından önerildiği gibi, bu çalışmada, anlamsal olarak geçirimsiz durumda kullanılan hazırlayıcı-hedef sözcük ikililerinin, etimolojik olarak ilintisiz olmasına ve kullanılan sahte eklerin asıl anlam ve işlevlerini korumuyor olmasına dikkat edilmiştir.

Anlamsal olarak geçirimsiz ve örtüşük yazımlı hedef sözcükler için yapısı korunmuş hazırlayıcı sözcüklere (tuzak-TUZ) ek olarak, sözcük kökünün son harfi ile (sözde) ekin/sözcük sonunun ilk harfi yer değiştirilerek elde edilen harf yer değişikliğine uğramış hazırlayıcı sözcükler (tuazk-TUZ) kullanılmıştır. Ayrıca, kontrol koşulu olarak da, yer değişikliğine uğramış iki harfin tamamen farklı iki harf ile değiştirilmesiyle elde edilen harf kimliği değişimine uğramış sözcükler oluşturulmuştur (tuurk-TUZ). Anlamsal olarak geçirimsiz ve örtüşük yazımlı sözcükler çeşitli ruhdilbilimsel ölçütler bakımından liste bazında eşitlenmiştir. Kök sıklığı ve tüm sözcük sıklığı verileri Türkçe Ulusal Derlemi'nden (Aksan, Mersinli, Yaldır, & Demirhan, 2012), iki harf sıklığı verileri ise BOUN Derlemi'nden elde edilmiştir (Sak, Güngör, & Saraçlar, 2008).

Sözcüksel karar testindeki evet ve hayır cevaplarının sayısını dengelemek adına, 96 adet fonotaktik ve yazımsal olarak yasal anlamsız sözcük, dolgu sözcüğü olarak deneysel listelere dahil edilmiştir. Çalışma kapsamında üç farklı deneysel liste hazırlanmıştır. Her listede, aynı hedef sözcük farklı tür bir hazırlayıcı sözcük ile birlikte sunulmuştur. Yorgunluk etkisini önlemek amacıyla bu üç listedeki uyaranların sırası tersine çevrilerek üç liste daha oluşturulmuştur. Uyaran sunumu ve tepki süresi ölçümü için E-prime yazılımından ve katılımcıların evet/hayır yanıtlarının kaydedilmesi için Logitech F310 oyun kolundan faydalanılmıştır.

Katılımcılar, 'Gönüllü Katılım Formu' ve 'Dilsel Artalan Formu' doldurduktan sonra maskelenmiş hazırlama deneyine katılmıştır. Bu deneyde katılımcılardan, ekranda gördükleri harf topluluklarının Türkçe bir sözcük olup olmadığına, oyun kolundaki önceden belirlenmiş bazı tuşlara basarak karar vermeleri istenmiştir. Evet yanıtı daima katılımcıların baskın eli ile kontrol edilmiştir. Her bir deneme, 500 ms süreyle yansıtılan boş bir siyah ekran ile başlamış, bu boş ekranı yine 500 ms ekranda kalan maske (######) takip etmiştir. Maskeden hemen sonra, küçük harflerle yansıtılmış hazırlayıcı sözcük, yalnızca 50 ms süreyle katılımcılara gösterilmiştir. Hazırlayıcı sözcüğün hemen ardından da büyük harflerle yansıtılmış hedef sözcük ekrana gelmiş, katılımcılar yanıt verene kadar veya 2000 ms dolana kadar ekranda kalmaya devam etmiştir. Son olarak, bir sonraki denemeden önce 500 ms süreyle yine boş bir siyah ekran katılımcılara gösterilmiştir. Aynı türden hazırlayıcı-hedef sözcük çiftlerinin art arda gelmesini önlemek amacıyla, uyaran sunum sırası Latin kare deseni kullanılarak belirlenmiştir. Deneye dokuz adet alıştırma denemesi ve iki adet ara eklenmiştir. Katılımcıların deneyi tamamlaması yaklaşık 15 dakika sürmüştür. Deneyden sonra katılımcılardan, bir sözcük tanımlama görevini yerine getirmeleri istenmiştir. Bu görevde katılımcılardan, derlemde sıklık değeri milyonda 1'in altında olan 14 adet hazırlayıcı sözcüğü tanımlamaları beklenmiştir. Bu görevin amacı, bütünsel biçiminin anlamı katılımcılar tarafından bilinmeyen sözcükleri tespit edip analizlerden çıkarmaktır.

5.2. Deney 2

Bu deneyde kullanılacak materyallerin aslında ilk deneyde geçirimsiz ve örtüşük yazımlı sözcüklerle beraber sunulması planlanmıştır. Fakat aynı ek grubunu hem geçirimli hem de geçirimsiz sözcük listelerinde kullanmak, her bir liste için yeterince sözcük bulunamamasına ve ruhdilbilimsel ölçütlerin eşitlenmesi açısından ciddi sorunlara yol açtığından, geçirimli sözcükler çoğunlukla farklı bir ek grubuyla ayrı bir deneyde test edilmiştir. Ayrıca, aynı deney içerisinde yüksek oranda biçimbilimsel olarak bağıntılı hazırlayıcı-hedef sözcük çifti kullanmanın, katılımcıların sözcükleri ayrıştırması yönünde bir strateji geliştirebileceği ve bu sebeple normalde ayrıştırmayacakları sahte ekli bir sözcüğü bileşenlerine ayrıştırabilecekleri iddiasına dayanarak (Beyersmann vd., 2013), geçirimli ve geçirimsiz sözcükler, en az iki hafta arayla farklı günlerde gerçekleştirilen iki farklı deneyle test edilmiştir.

Geçirimli sözcüklerin test edildiği bu deneyde, hedef sözcük olarak, 48 adet üç veya dört harften oluşan tek biçimbirimli ad (kira), sıfat (acil) ya da eylem (seç) kökü kullanılmıştır. Yapısı korunmuş hazırlayıcı sözcükler, hedef sözcükler ile anlamsal olarak ilintili ve bir kök ile gerçek bir ekin birleşimi olarak çözümlenebilecek sözcüklerden (çizim-ÇİZ) seçilmiştir. Deneyde kullanılan yapım ekleri şu şekildedir: -Iş (gör**üş**), -Im (öl**üm**), -lI (tuz**lu**), -CI (av**cı**), -Ik (aç**ık**), ve -An (dur**an**). Yapısı korunmuş hazırlayıcı sözcüklere ek olarak, harf yer değişikliğine uğramış (çiizm-ÇİZ) ve harf kimlik değişimine uğramış sözcükler (çiurm-ÇİZ) de hazırlayıcı sözcük olarak sunulmuştur. Anlamsal olarak geçirimli sözcük listesi de, geçirimsiz ve örtüşük yazımlı listeler ile çeşitli ruhdilbilimsel ölçütler bakımından eşitlenmiştir. Anlamsız dolgu sözcüklerinin üretilmesi, sözcük listelerinin oluşturulması ve izlenen yöntem ilk deneydekiyle birebir aynıdır. Yalnızca, farklı olarak bu deney toplamda 96 adet denemeden oluştuğu için yaklaşık 7 dakika sürmüş ve katılımcılar deney süresince sadece bir kez verebilmiştir.

6. Genel Sonuçlar

Çalışma sonucunda, yalnızca yapısı korunmuş hazırlayıcı sözcüklerden elde edilen veriler incelendiğinde, hem geçirimli hem de geçirimsiz hazırlayıcı sözcüklerin anlamlı bir hazırlama etkisi gösterdiği saptanmıştır. Örtüşük yazımlı hazırlayıcı sözcükler ise ilgili hedef sözcüklerin tanınmasını anlamlı bir şekilde hızlandıramamıştır. Bu sonuç, alanyazında, her iki türden hazırlayıcı sözcüğün de anlamlı hazırlama etkileri göstereceğini öngören önce-biçim görüşüyle uyumlu gibi görünmektedir. Fakat bu konuda erken bir yargıya varılmamalıdır. Çünkü mevcut desen, geçirimli ve geçirimsiz hazırlayıcı sözcüklerden elde edilen hazırlama etkilerinin büyüklüklerinin birbiriyle karşılaştırmaya müsait değildir. Ayrıca, detaylı bir inceleme yapıldığında, geçirimli hazırlayıcı sözcüklerin, geçirimsiz sözcüklere göre sayısal olarak daha büyük bir hazırlama etkisi (13 ms daha fazla) göstermiş olabileceği söz konusudur.

Anlamsal geçirimliliğin herhangi bir etkisi olup olmadığını daha net tespit etmek için, biçimbirim sınırında uygulanan harf yer değişikliği eyletiminin geçirimli ve geçirimsiz hazırlayıcı sözcüklerin işlemlenmesini nasıl etkilediğine bakılmıştır. Sonuç olarak, biçimbirim sınırında harf yer değişikliğine uğramış geçirimsiz sözcüklerde hazırlama etkisinin ortadan kalktığı gözlemlenmiştir. Fakat geçirimli sözcüklerde, bu tür harf yer değişiklikleri hazırlama etkisinin ortaya çıkmasına engel olamamıştır. Diğer bir deyişle, geçirimsiz sözcüklerde bir sınır etkisi söz konusu iken, geçirimli sözcükler, biçimbirim sınırındaki harf yer değişikliklerine rağmen hedef sözcüklerin tanınmasını anlamlı bir şekilde hızlandırabilmiştir. Bu sonuç, desen olarak mevcut çalışmayla oldukça benzerlik gösteren Diependaele vd. (2013) ile yine bu araştırmacılar tarafından geliştirilen ikil-yollu biçimbilimsel işlemleme modelinin öngörüleriyle birebir örtüşmektedir. Yani, harf yer değişikliğine rağmen geçirimli sözcüklerde hazırlama etkisinin kaybolmamasının sebebi, bu sözcüklerin ilgili hedef sözcükleri, alternatif kaynak olarak biçim-anlamsal işlemleme yoluyla da etkinleştirebilmeleri olabilir. Geçirimsiz sözcükler için hazırlama etkisinin tek kaynağı biçim-yazımsal işlemleme olduğundan ve bu işlemleme de biçimbirim sınırındaki harf yer değişikliklerinden olumsuz etkilendiğinden, bahsi geçen eyletim sonucu geçirimsiz sözcüklerin hazırlama etkisinin kaybolması olağandır. Sonuç olarak, bu bulgular, Türkçede anlamsal bilginin, karmaşık sözcüklerin erken işlemlenmesinde biçim-yazımsal bilgi kadar erken sürece dahil olduğunu destekler niteliktedir. Ayrıca, bu çalışma biçimbirim sınırındaki harf yer değişikliklerinin gerçekten de biçim-yazımsal işlemleme zarar verdiğini destekleyen sonuçlar ortaya koymuştur. Bu tür harf değişikliklerine rağmen hazırlama etkisinin gözlemlenmesi, yalnızca hazırlama etkisinin ortaya çıkabilmesi için gerekli alternatif bir etkinleştirme desteğine (biçim-anlamsal işlemlemeye) sahip geçirimli sözcüklerde meydana gelmiştir.

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YAZARIN / AUTHOR

Soyadı / Surname : ÇAĞLAR
Adı / Name : OZAN CAN
Bölümü / Department : İngiliz Dili Öğretimi

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