FREQUENCY AND LENGTH EFFECTS OF WORDS ON FIXATION DURATIONS IN TURKISH SENTENCE READING

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FREQUENCY AND LENGTH EFFECTS OF WORDS ON FIXATION DURATIONS IN TURKISH SENTENCE READING

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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.

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ABSTRACT

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This thesis mainly examined the effect of frequency and length features of the words on eye movement parameters in reading Turkish sentences. In order to examine these word features, target words were categorized into three; uninflected words, words with short inflectional suffix, *-lEr*; and words with long inflectional suffixes, *-lErdEkilerden*. Whether frequency and length of the uninflected stems of the target words affect the fixation durations in reading across (inflectional) suffixation condition was examined. To investigate the impact of these word features, first fixation durations on the target word, sum of the fixation durations in the first pass reading and total sum of gaze durations were analyzed seperately. The results indicated that both frequency and length of the target words (frequecy and length of the uninflected stems) influenced eye movement parameters while reading Turkish sentences. The eye movement measures of gaze durations in first pass reading and total sum of fixation durations indicated that longer fixation durations were seen on the long and low frequency words than the short and high frequency words. However, the first fixation measure analyses in the groups of words with inflectional suffixes showed opposite results for the effect of word length (length of the uninflected stem) that longer words got shorter fixation durations than the shorter words.

Key Words: Reading Turkish, Eye Movements, Word Frequency, Word Length, Inflectional Suffixes

ÖZ

SÖZCÜKLERIN SIKLIK VE UZUNLUKLARININ TÜRKÇE CÜMLELERİ OKUMADA GÖZ HAREKETLERİ ÜZERİNDEKİ ETKİSİ

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Bu tez temel olarak Türkçe bir metnin okunması esnasında sözcüklerin sıklık ve uzunluk özelliklerinin gözün hareket değişkenleri üzerindeki etkisini incelemiştir. Bu sözcük özelliklerinin etkisini incelemek için hedef kelimeler; çekim eksiz, kısa çekim eki, -*lEr*, almış ve uzun çekim eki, -*lErdEkilerden*, almış olmak üzere üç gruba ayrılmıştır. Bu tezde, okuma esnasında çekim eki alma durumuna göre, hedef sözcüklerin çekimsiz gövdelerinin sıklık ve uzunlarının, gözün bu sözcükler üzerindeki sabitlenme sürelerini etkileyip etkilemediği araştırılmıştır. Kelimelerin bu özelliklerininin etkisini incelemek için hedef sözcük üzerindeki gözün ilk sabitlenme süresi, gözün sözcüğü ilk okuması esnasında sözcük üzerindeki toplam sabitlenme süreleri, ve totaldeki toplam sabitlenme süreleri (dönüşler ve tekrar okumalar dahil) ölçüleri ayrı ayrı analiz edilmiştir. Sonuçlar Türkçe cümlelerin okunması esnasında, hedef sözcüklerin çekimsiz gövdelerinin hem sıklık hem de uzunluk özelliklerinin göz hareket değişkenleri üzerinde etkisi olduğuna işaret etmiştir. Gözün sözcüğü ilk okuması esnasında sözcük üzerindeki toplam sabitlenme süreleri ölçüsü ve totaldeki toplam sabitlenme süreleri ölçüsü, uzun ve düşük sıklığa sahip kelimeler üzerinde daha uzun sabitlenme sürelerinin görüldüğüne işaret etmiştir. Ancak, hedef sözcük üzerindeki gözün ilk sabitlenme süresi ölçüsü analizleri, sözcük uzunluğu etkisine dair (çekimsiz gövdelerinin uzunluğu) diğer ölçülerin karşıtı sonuçlar göstermiştir ki bunlar da daha kısa kelimeler daha uzun sabitlenme süreleri alırken, daha uzun sözcükler daha kısa sabitlenme süreleri almıştır.

Anahtar Kelimeler: Türkçe Okuma, Göz Hareketleri, Kelime Sıklığı, Kelime Uzunluğu, Çekim Ekleri

To the love of my life, Emre Çağrı GEZEN

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CHAPTER 1

INTRODUCTION

1.1. Purpose of the Study

Reading studies have been developed mostly in the framework of the researches in the field of cognitive psychology. Since cognitive science has an interdisciplinary framework including cognitive psychology, computing and also linguistic studies, it provides researchers with a proper research area in which they could do current reading studies with multiple theoretical approaches and methods (Rayner, Pollatsek, Ashby, & Clifton, 2012).

Reading is defined basically as the recognition of the information from written works. This process contains comprehension of this information (meaning) and encoding it in the memory in the following stages. Thus, one of the basic subjects of reading studies is the relation between reading patterns and human information processeses. These cognitive processes are examined, in an indirect way, by observing eye movements, which occur during reading, in the framework of assumptions on human information processeses (Rayner, Pollatsek, Ashby, & Clifton, 2012).

Information extracting from texts and comprehending/interpreting activities are continuing processes. Investigating these processes together has been a general practice in linguistic studies (Rayner, Pollatsek, Ashby, & Clifton, 2012), while comprehension/interpretation stages are not generally investigated in the studies on experimental psychology.

Eye movements are one of the most studied areas under this topic because of its informativeness about data processing in mind (Rayner, 1998; Richardson & Spivey, 2004; Duchowski, 2007; Richardson, Dale & Spivey, 2007).

Eye movement patterning which occurs during reading shows the reading processes arise by successive *saccades* (the continually movement of the eyes) and *fixations* (the time period in which the eyes remain still between saccades in which acquisition of the new information from the visual array is done). Saccades appear in a short time period of about 30-35 ms and fixations occur in a longer time periods of about 200-250 ms. It is assumed that information intake occurs mostly during fixations. The fixation is the stable position of the eyes that enables the eyes to extract the information from the text (Rayner, Pollatsek, Ashby, & Clifton, 2012).

Word-frequency and word-length are among the most researched topics so far. These factors highly affect the eye movement patterning. Predictability is another important factor in reading studies, which shows the relation between the target word and the previous and following words in the sentence. Moreover, frequency, length and predictability (sentential frequency) are the computational characteristics of the words. Thus, when reading studies are investigated with a cognitive science approach, these word features become prominent.

The studies conducted on eye movements searching for the effect of word-length showed that longer words receive more and longer fixations. It is because when people fixate on longer words, their average visual acuity (clearness or sharpness of vision) of the letters in the long words will be lower, compared to short words which leads to more fixation numbers and more fixation durations on this word (Inhoff & Rayner, 1986; as cited in Bicknell & Levy, 2012). Bicknell and Levy (2012) also suggests that uncertainty of the word-length (not knowing the number of the letter in the word) explains why longer words have more fixations and fixation durations.

The effect of word-frequency on eye movement during reading is another factor that is often examined by the researchers in the reading experiments in the literature. It is commonly stated that word frequency affects the eye movements in a way that high frequency words have less fixation durations than low frequency words (Rayner & Duffy, 1986; Rayner, Sereno, & Raney, 1996; Sereno & Rayner, 2000; Staub et al., 2010; as cited in Miellet, Sparrow & Sereno, 2007).

The studies about the effect of both word frequency and word-length on eye movements in a reading task and their interaction indicated that high gaze durations are observed on the words which are long and have low frequency (Kliegl et al, 2004). That's why we chose these two variables in this thesis and intended to see their influence on reading Turkish words in a context.

English is the language which is commonly used in reading experiments, but other languages such as French (Miellet, Sparrow & Sereno, 2007), German (Kliegl et al., 2004) have been also studied up to now. However, Turkish whose morpho-syntactic structure is different than these languages, was not studied in this field before. Since word derivation and inflection are formed by attaching, mainly, suffixes to the roots or stems, length of Turkish words can be controlled with these suffixes.

In this study, frequency and length characteristics of the Turkish words was analyzed. The length was determined by the number of letters, as short words (consisting four letters) and long words (consisting eight letters). The Turkish National Corpus (demo version) (Aksan, et al., 2012) was used to determine the frequency of the words. In addition, since Turkish is an agglutinative language, (inflectional) suffixation was also analyzed; i.e. stems such as 'gece' (night), short inflectional suffixed forms such as 'gece*ler*' (nights) (the plurality suffix -*lEr*) and long inflectional suffixed forms such as 'gece*lerdekilerden*' (those in the night) (with plurality suffix+ locative case suffix+ possessive suffix+ plurality suffix+ ablative case suffix -*lErdEkilerden*). This study examined the effect of inflectional suffixes different from other studies, which investigated mainly the compound words or derivational affixes.

1.2. Research Questions & Hypotheses

In this study, the effect of word-frequency and word-length in Turkish on reading are analyzed experimentally. A number of words are read by the participants in sentences having target words to explore the effect of word features on eye movement parameters in reading Turkish sentences.

Thus the basic research questions are the following:

1. How does word length (length of the uninflected stems) affect fixation durations while reading Turkish sentences?

2. How are the fixation durations affected by the frequency of the words (frequency of the uninflected stems) in reading Turkish sentences?

3. How does (inflectional) suffixation -length of the word stemming from inflections; i.e. condition (1): words without any inflectional suffixes, condition (2): words with a short inflectional suffix, -*lEr* (plural), and condition (3): words with long and five inflectional suffixes, -*lErdEkilerden*- affect fixation durations while reading Turkish sentences?

    3.1. What kind of an impact does the length of the word (length of the uninflected stems) have on the fixation durations for each inflectional suffixation condition?

    3.2. How does the frequency of the word (frequency of the uninflected stems) affect the fixation durations for each suffixation condition?

There are three main hypotheses tested in this study;

1. The first hypothesis is that the word length (length of the uninflected stems) will have an effect on eye movement parameters while reading Turkish; i.e. short words will be fixated shorter, while fixation durations on the long words will be longer.

2. The second hypothesis is that frequency feature of the words (frequency of the uninflected stems) in Turkish will have an impact on eye movement parameters, i.e. high frequency words will have shorter fixation durations than low frequency words.

3. For each (inflectional) suffixation condition, word length and frequency will be expected to indicate similar trend in the results. As the inflectional suffix number increases, the fixation durations are expected to increase in a parallel way, which is the third hypothesis.

In this thesis, a general theoretical framework and state of the art about the eye movement studies in reading is given in chapter 2. In addition, morphological information about word structuring in Turkish is also given briefly. In Chapter 3, the experimental design of the study is given. In chapter 4, the results of the experiments are stated. A general discussion of the results are made in chapter 5. Lastly, a brief summary of the whole study is given, the limitations and suggestions for further studies are stated in chapter 5 under subsections.

CHAPTER 2

EYE MOVEMENTS IN READING

2.1. History of the Development of Eye Movement Studies in Reading

The first era of eye movement researches was between the first experiments of Javal in 1879 until 1920 (Rayner, 1998). Many basic facts and issues about eye movements were discovered during this era such as saccadic suppression (the behavioral observation that people under normal situations do not perceive the motion of the world images across the retina during each saccade (Krekelberg, 2010)), saccade latency (the time which eyes require to encode target's location in visual area and start an eye movement and lasts around 175- 200 ms (Becker &Jürgens, 1979; Rayner, Slowiaczek, Clifton, & Bertera, 1983; see Rayner, 1998; 2009 for a review)) and the size of perceptual span (angular vision of human eyes; i.e. an eye has clear enough vision to read text within this span, and it is the span from which useful information is acquired in reading (Legge, Ahn, Klitz & Luebker, 1997; Rayner, 1986)) (Rayner, 1998). Proffessor Emile Javal, of the University of Paris, was the first who reported eye movement characteristics in reading. In 1897, Professor Emile Javal noticed the eyes do not move smoothly from left to right but rather they make pauses and make quick and short movements, called as *saccades* later, until the end of the line, then pass through the beginning of the line below quickly to start over the same procedure (as cited in Huey, 1908). Before this study, the eye movements while reading were assumed to sweep across a text. The finding of the existence of pauses along a line of a text set ground for the investigation of the role of eye movements in reading, aroused questions of "Where do the eyes stop? For how long? Why do they stop there? Why do they regress at times?" (Paulson & Goodman, 2009). M. Lamare, working with Professor Javal, developed the study by connecting the eye lids with a microphone (i.e. they made sound as the eyes moved), which counted the movements by the sound (as cited in Huey, 1908). M. Landolt, in 1891, was the one who improved the study and contributed with concrete results by observing the eye movements directly and found that participants read 1.55 words on average per saccade. His study showed the first proof that the eyes do not follow a regular and fixed path but change according to the reading type such as foreign language reading, numbers, detached words (as cited in Huey, 1908), which might be seen as a sign for the cognitive processes of perception and comprehension occurring during reading (Paulson & Goodman, 2009).

In his experiments, Huey (1908) developed an apparatus to record the eye movements during reading. It provided the first physical findings by tracing the movements of the eyes. The apparatus included a plaster of a paris cup with a hole in the middle put on the cornea of the eyes similar to a contact lens. The cup was tied to an aluminum pointer which signaled even a tiny eye movement. As the participants read the text, their eye movements were drawn on a separate piece of paper. As a result, he found that eyes moved forward line by line, without leaving the lines much above or below, from left to right with quick movements, *saccades*, and pauses, *fixations*. Also he found that the first fixations were observed frequently after the first word. The last fixation was not placed on the last word of the line. There were fixations anywhere between the first and the last word on a line. These findings showed that reading was not passive, on the contrary it was an active process of word identification because the readers decided where and when to look during reading.

The second era, between the 1950s and 1970s, affected by the behaviorist tendency with experimental psychology, had a more applied focus. However, eye movement research from perspective of cognitive processes was administered little in this era (Rayner, 1998). Despite the classic studies of Tinker (1946) on reading and Buswell (1935), the studies undertaken in this era were much more on the surface aspect of the eye movements (as cited in Rayner, 1998). Even the progress was slow during this time up until the start of the third era of the eye movement studies. This might be because of the Tinker (1958)'s final review saying that no more research was needed because almost everything was learned about reading from eye movements (as cited in Rayner, 1998).

In the third era, beginning in the middle of 1970s, progresses in eye movement recording systems were made, which enabled the measures done more accurately, concretely and easily (Rayner, 1998). Many precious works such as Kliegl & Olson, (1981), Pillalamarri, et al. (1993), and Scinto & Barnette (1986) were held to investigate the methods of analyzing eye movement data (as cited in Rayner, 1998). Also, many studies such as Deubel & Bridgeman (1995a, 1995b), Muller (1993) showed characteristics of various eye tracking systems (as cited in Rayner, 1998). Morover, development of the technology forming the basis for current eye tracking laboratory computers occured in this era. This development provided collection and analyses of huge amounts of data in addition to innovative techniques to be developed. Lastly, eye movement records were used to investigate human information processes es underlyning reading by general language processing theories (Rayner, 1998).

2.2. Basic Characteristics of Eye Movements in Information Processing During Reading

The eye movement measures in reading do not coincide with other measures in different tasks such as scene perception or visual search (Castelhano & Henderson, 2007; Rayner & McConkie, 1976). This might be explained by saying that cognitive

mechanism of different tasks and the connection between the cognitive system and the oculomotor system vary as a function of the task (Rayner, 2009).

Eyes move smoothly across the text while reading. Two basic components of eye movements are *saccade*s and *fixations* (Rayner, 2009; Reichle, Rayner, & Pollatsek, 2003). For a skilled reader, avarage saccades typically last about 20 (a 2-deg saccade)- 40 (a 5-deg saccade) ms (Abramson & Goldinger, 1997; Rayner, 1978; see Rayner 2009)- and span of 7- 9 letters on avarage (Reichle et al., 2003)-, while the mean durations of the fixations last around 200- 250 ms and these fixations might change from minimum around 50-100 ms to maximum about 500 ms. – 15- 20 letters spaces at avarage- for readers of English and other alphabetic writing systems (Staub & Rayner, 2007; Reichle et al., 2003). Despite special situations in which new information is acquired during saccades (see Campbell & Wurtz, 1978; see Rayner, 1998; 2009 for a review) and lexical processing is performed (Yatabe, Pickering, & McDonald, 2009); under normal circumstances, only during fixations is meaningful information acquired since during saccades the retina picks up the vision but not the new information (saccadic suppression) (Matin, 1974; Staub & Rayner, 2007; Rayner, 2009). In the studies of Sereno, Rayner, & Posner (1998), Rayner & Pollatsek, (1989), Schilling, Rayner, & Chumbley (1998), it is assumed that 100- 300 ms time period is needed to be completed for lexical access (as cited in Reichle, Rayner, & Pollatsek, 2003) , thus in most situations cognitive processing does not carry on during saccades (Irwin, 1998; Irwin, Carlson-Radvansky, & Andrews, 1995; see Rayner, 1998; 2009 for a comprehensive review).

The third companent of eye movements in reading are regressions, which are the saccades that move backwards in the text. Regressions appears about 10- 15% of the time. It is observed mostly when lack of comprehension exists or the text is difficult. Regressions might be done generally to the preceding word or it might also go back the earlier words (Rayner, 2009).

In general, difficulty of the text affects eye movements in a way that duration of the fixations gets longer while the saccades get shorter and regression numbers increase (Rayner, 1998; Rayner, 2009). Apart from text difficulty, as Rayner et al., (2006d) and Slattery & Rayner, (2009) stated, typographical variables such as font, or letter size might have similar effects on eye movements, as the difficulty of reading the letters increases, the fixation durations get longer, saccades get shorter and more regressions are made (as cited in Rayner, 2009).

As mentioned above, these variables are for skilled readers, since beginning, dsylexic readers and less skilled readers show different tendencies while reading; i.e. the first two groups, beginning and dyslexic readers have longer fixations, shorter saccades and more regressions than skilled readers (Rayner, 1998; 2009), as do less skilled readers (Rayner, 2009). The study of Ashby, Rayner, & Clifton (2005), in which the effects of word frequency, predictability and font difficulty on reading were examined, showed that age also affect eye movements during reading though fixation time data showed that similar results for both groups (with young and old participants), larger frequency and predictability effects were observed for older

readers. More word skipping and regressions were made by older readers, and lexical processing was slower in older readers.

2.3. Alternative Measures of Processing Time

Eye movements are good indicators of cognitive processing that occur with every moment during reading (Rayner, 1998; 2009). Therefore, variables such as frequency and length have an impact on fixation times; however, taking the avarage fixation durations (or total sum of all fixation durations on the target word) is insufficient while measuring momet-to-moment processing. In order to make more conrete and valid cognitive observations on eye movements during reading, a number of local measures would give more informative estimates (Rayner, 1998; 2009), since word skipping occurs more on function words than content words (see the following section 2.6. under Chapter 2 for descriptions) ans since an increase in the word length increases the probability of fixation on the word and decreases skipping (Rayner & McConkie, 1976; Rayner, Sereno, & Raney, 1996; Rayner, Slattery, Drieghe & Liversedge, 2011; Brysbaert, Drieghe, & Vitu, 2005; Brysbaert & Vitu, 1998; Schotter, Angele, & Rayner, 2012; see Rayner, 1998, 2009 for a review). Also, longer words are often refixated; i.e. fixation times on the longer words are mostly higher than shorter words (McConkie, Kerr, Reddix, Zola, & Jacobs, 1989; McDonald & Shillcock, 2004; Vergilino & Beauvillain, 2000, 2001; Vergilino-Perez, Collins, & Dore-Mazars, 2004; as cited in Rayner, 2009). The strategy of taking only single fixation durations (the conditions where only one fixation is made on the target) does not give sound results since more than once fixation points occur on some words especially longer and complex words. As a result, alternative measures such as first fixation duration (the first fixation duration landing on the target), gaze duration (or first pass reading which covers the sum of fixation durations before leaving the target and moving to the next word) were developped (see Rayner, 1998, 2009). As stated in Rayner (1998), which measure is best for analyzing the processing time partially depends on what is investigated. Inhoff (1984) claimed that the first fixation duration and first pass reading fixation times measure different processes by demonstrating that word frequency influenced both first fixation and gaze durations, whereas word predictability affected only gaze duration, suggesting that measure of lexical access is the first fixation while gaze duration measures not only lexical access but also text integration processes (as cited in Rayner, 1998). However, Rayner (1998) argued that processing time for a single word is a weak display of cognitive processing; thus using only one single measure strategy while analysing a great quantity of texts limits the measure of on-line processing. Therefore, choosing target words (locations) in texts or sentences and analyzing them by using more than one measures such as first fixation durations, gaze durations, avarage durations were adopted by many researchers.

The reason for not analyzing the data coming from each eye seperately is that it is assumed that there is near-perfect binocular coordination during reading, though some studies such as Heller & Radach (1999) and Liversedge et al. (2006a; 2006b)

demonstrated that the two eyes do not always perfectly match, and they might be on different letters or be crossed (as cited in Rayner, 2009).

2.4. The Control of Eye Movements in Reading

There is no correlation between the eyes' fixation duration (when to move the eyes) and saccade length (how far the eyes move) (Rayner & McConkie, 1976). For the saccade length, mostly low level properties of the eyes determine length of the saccade from the current fixation to the next (where to move the eyes next); however, lexical properties of the text influence the duration of the fixations (when to move the eyes) at most (Rayner, 1998; 2009).

Rayner & Pollatsek (1981) manipulated the physical appearance of the text and found that aspects of available display were reflected by the eye movements. They conducted three experiments; in the first one, they used moving window paradigm and changed window size for each fixation concluding that prior window size influenced saccade length; i.e. when the window was large, saccade size was longer than the time when the window was small. In the other two experiments, visual mask (changing the delay for fixations randomly) was applied on the onset of a fixation and found that the delay determined most of the fixation durations. As a result the present fixation, the earlier fixations and also other possible sources decided on when and where to move the eyes; however, deciding on when and where to move the eyes was found to be somehow independent. They suggested that direct cognitive control was observed in a large percentage of fixations during reading despite preprogrammed some subset of fixations (see also Rayner, 2009).

It has been investigated that there is a relationship between attention and eye movement (Rayner, 1998, 2009). Rayner (2009) said that although attention and eye location could be divided in complex tasks such as reading, scene perception, or visual search; this kind of divison is a part of a processing system. Attention precedes a saccade to a given saccade target position (Deubel & Schneider, 1996; Henderson, 1993; Hoffman & Subramaniam, 1995; Irwin & Gordon, 1998; Irwin & Zelinsky, 2002; Kowler, Anderson, Dosher, & Blaser, 1995; Rayner, McConkie, & Ehrlich, 1978; Shepherd, Findlay, & Hockey, 1986; as cited in Rayner, 2009), which is a feature of human information processing system.

Henderson (2012) said that there was a close connection between attentional process and eye movements especially fixations in reading. He stated that fixation location and durations were the measured reflections of the allocation of (covert) attention infect eye movements were attributed to overt attention (Henderson, 2012). How overt attention was directed in real time through complex visual stimuli and real-world tasks was studied (Henderson, 2012).

2.5. Where to Move the Eyes

As mentioned above, for alphabetical languages, low level characteristics of the text, such as word length or space information influence where to move the eyes. Both the word length of currently fixated word and the word to the right of the fixation affect the saccade length (Inhoff et al., 2003; Juhasz et al., 2008; O'Regan, 1979, 1980; Rayner, 1979; White et al., 2005; see also Rayner 2009). When the word on right of the fixation is medium sized, the following saccade would be shorter than in both cases that the word right to the fixation is long or short (Juhasz et al., 2008; Rayner, 1979; White et al., 2005; see also Rayner, 2009).

Space information, spaces between words, is another property of the text which has an effect on the saccade length. While removing spaces within interwords slows down reading to 30- 50 % (Morris et al., 1990; Pollatsek & Rayner, 1982; Rayner & Pollatsek, 1996; Reichle et al., 1998; Spragins et al., 1976; see also Rayner, 2009), interspacing between words make reading effective and fast even in languages which do not have space in their writing system such as Thai (Kohsom & Gobet, 1997; see also Rayner, 2009) or in the conditions that do not require space such as coumpund words in German (Inhoff et al., 2000; see also Rayner, 2009).

2.6. When to move the eyes

The studies done over the last decade showed that difficulty (assosiacted with processing the fixated word) has a significant impact on when the eyes move (fixation duration) (Liversedge & Findlay, 2000; Rayner, 1998; Yang, 2012). Lots of lexical and linguistic varibles such as frequency (Gollan et al., 2011; Inhoff & Rayner, 1986; Hand et al., 2010; Kliegl et al., 2004; Rayner & Duffy, 1986; Rayner & Pollatsek, 1996; Rayner et al., 2007, 2011; Schilling et al., 1998; Staub & Rayner, 2007; Vitu, 1991; White, 2008; Whitford & Titone, 2014; among others), word predictability (Ashby et al., 2005; Balota, Pollatsek, & Rayner, 1985; Drieghe et al., 2005; Hand et al., 2010; Kliegl et al., 2004; Rayner, 1986; Rayner et al, 2006; Rayner & Well, 1996; Zola, 1984; Reichle et al., 2013; Staub & Rayner, 2007; Whitford & Titone, 2014; among others), number of meanings (Binder & Morris, 1995; Binder & Rayner, 1998; Dopkins et al., 1992; Duffy et al., 1988; Folk & Morris, 2003; Kambe et al.,2001; Rayner et al.,2006a; Rayner & Frazier, 1987; Rayner, 2009; Sereno et al., 2006; among others), acquisition age (Clifton et al., 2007; Juhasz et al., 2003; Juhasz & Rayner, 2006; Rayner, 2009; Staub & Rayner, 2007; Williams & Morris, 2004) phonological word character (Ashby & Clifton, 2005; Ashby, 2006; Folk, 1999; Jared et al., 1999; Miellet & Sparrow, 2004; Rayner et al., 1998; Sereno & Rayner, 2000; Schotter et al., 2012; Slattery et al., 2006; Yang, 2012; among others), meaning associations between the fixated word and preceding word (Carroll & Slowiaczek, 1986; Morris, 1994) and word familarity in the text (Chaffin et al., 2001; Hautala et al., 2012; Greene & Rayner, 2001; White, 2008; Williams & Morris, 2004; see Rayner, 2009 for a review) have an impact on fixation numbers and durations during reading English and other alphabetical languages. In addition to alphabetical languages, non-alphabetical languages such as Chinese

display also the influence of word frequency (Yan et al., 2006) and predictability (Rayner et al., 2005; Wang et al., 2010) on fixations during reading.

Aside from the above-mentioned variables influencing processing time of words, several other variables such as transitional probability (in which the preceding word influences lexical probability of the following word; statistical probability that a word precedes or follows another) between two words affects fixation durations on the words (McDonald & Shillcock, 2003, 2003a), while it was claimed that the target word's predictability was responsible for this difference; i.e. in the conditions that the predictability was controlled, no difference was observed between low and high transitional probability words (Frisson, Rayner, & Pickering, 2005; see Rayner, 2009). On the contrary, the studies of Kwantes & Mewhort (1999) and Lindell et al. (2003) claimed that words with a late uniquness point (OUP; position of the first letter from the left that differentiates the target word from other words) were processed slower than words with early OUP. Lamberts (2005) found that selective evidence was not obtained from OUP results for left-to-right consecutive processing in visual word recognition since random order letter processing might occur. Moroever, Miller, Juhasz, & Rayner (2006) found no difference between early and late OUP with naming and lexical decision data (see Rayner, 2009). As Rayner (2009) said that though these transitional probability and the uniqueness point, which were extralexical variables, did not appear to have an impact on fixation durations, other varibles such as morphological features of words affected fixation times on target words. For instance, frequency of beginning or ending lexemes in a compund word influences fixation times; i.e. highly frequent lexemes (at the beginning or end) are fixated more than low frequent lexemes (Andrews, Miller, & Rayner, 2004; Angele & Rayner, 2013; Bertram & Hyönä, 2003; Hyönä & Pollatsek, 1998; Hyönä, Bertram, & Pollatsek, 2004; Juhasz, Inhoff, & Rayner, 2005; Juhasz et al., 2003; Juhasz, 2007; Pollatsek, Hyönä, & Bertram, 2000; see Rayner, 2009). Hyönä et al. (2004) and Juhasz et al. (2009) found that lexemes consisting of the second half of a compund word showed larger preview benefit (information acquired before the eyes actually land on the target word (Deutsch, Frost, Pelleg, Pollatsek & Rayner, 2003)) than preview benefit which was recorded across words (see Rayner, 2009).

In reading, lexical and semantic information is intaken by the movements of the readers' eyes on different positions of the target words. The fixation landing positions (FLP) of the eyes on the target word are accepted as the center of the word which would be determined by the word length (see Rayner, 2009; for a review). Apart from this low level visual information on the saccade target selection, high level information such as morphological structures of words and word frequency were analyzed in the study of Yan et al. (2014) (in Uyghur language). Two experiments, in which the effects of word length, launch site, morphological complexity and word frequency on fixation-landing-position during reading Uyghur language which requires reading right to left, were carried out in this study. The results parallel with some previous literature (Rayner & Pollatsek, 1996; Rayner, 1979; Rayner, Binder, Ashby, & Pollatsek, 2001) showed that preferred viewing location (PVL) started from word beginning to word center depending on the word length, in which as the word length increases, the FLP shifted from beginning to further away. However, the morphological structure of the words had an opposite

effect on the FLP; the FLP on suffixed words were towards the beginning. Moreover, there was also an effect of morphological complexity on gaze durations on highly frequent long words providing a huge processing difficulty relating to increasing suffix numbers; as the suffix number increased, the gaze durations got longer and re-fixation probabilities increased (Yan et al., 2014). The procedure of analyzing the data was relevant with the findings of this study in which the environment of the target words were stated starting from one character before the first letter of the target word and ending one character after the last letter of the target word. Additionally, this study was one of the studies on reading, analyzing the effect of morphological structure of the words, which shows similarity with this thesis. Although the effect of other suffix types (e.g. derivational suffix) is not taken into account in this thesis, examining the effect of the inflectional suffixes (also the complexity of these inflectional suffixes) is one of the aims of this thesis.

Overall, it is clear that, no matter how much the variables influence eye movements, there is a strong effect of cognitive processing activities on fixation durations (determining when the eyes move) (Rayner, 2009). The eye movements in the experiments where the fixated word is masked after 50-60 ms or disappears showed the strongest evidence that cognitive processing of the fixated word; i.e. when readers were shown the fixated word 50- 60 ms before it diseappeared, they read normally, however this does not show precisely that this 50- 60 ms time period is enough to process and encode the word. (Liversedge et al., 2004; Rayner, 2009; Rayner et al., 2003, 2011; Rayner, Liversedge, & White, 2006; Schad et al., 2014). The cogntive processing linked to a fixated word, such as lexical variables controls eye movements in reading the text (Rayner, 2009). Morover, considerable later effects are observed in higher level linguistic variables; for instance, disambiguating words are fixated more in a syntactic garden path sentence (Frazier & Rayner, 1982; Rayner, Carlson, & Frazier, 1983; Rayner & Frazier, 1987; as cited in Rayner, 2009) or regressions from that words to prior words in the sentence (Frazier & Rayner, 1982; Meseguer, Carreiras, & Clifton, 2002; Mitchell et al., 2008; as cited in Rayner, 2009). The end of clauses or sentences receives longer fixations (Hirotani, Frazier, & Rayner, 2006; Just & Carpenter, 1980; Rayner, Kambe, & Duffy, 2000; Rayner, Sereno, Morris, Schmauder, & Clifton, 1989; as cited in Rayner, 2009) and anamalous words receive immediate and longer fixations (Rayner et al., 2004b; Staub, Rayner, Pollatsek, Hyöna¨, & Majewski, 2007; Warren & McConnell, 2007; as cited in Rayner, 2009); however when there is an implausable but not totally anamalous word, there would be a bit delayed effect observed in later processing measures (Joseph et al., 2008; Rayner et al., 2004b; as cited in Rayner, 2009).

Eye movements are influenced mainly by higher order comprehension processes when other variables are not measured (Clifton et al., 2007; Staub & Rayner, 2007), though it is argued that lexical processing makes the eyes move through the text. The fixations get longer and shorter saccades and more regressions are made (Altmann, Garnham, & Dennis, 1992; Rayner, 2009; Rayner & Sereno, 1994) as readers are gardenpathed (which is a type of ambiguity in which reader puts the sentence in a syntactic structure (parsing) with syntactic ambiguity, then the reader denies this structure and adopts another structure) (Binder, 2001; Boland & Blodgett, 2001;

Clifton et al., 2003; Ferreira & Clifton, 1986; Frazier & Rayner, 1982; MacDonald et al., 1994; Rayner, 2009; Rayner, Garrod, & Perfetti, 1992; Rayner & Frazier, 1987).

2.7. Models of eye movement control in reading

There has been developed a number of eye movement models in reading, for example E-Z reader model (e.g. Pollatsek, Reichle, & Rayner, 2006d; Rayner, Ashby, Pollatsek, & Reichle, 2004a; Rayner, Pollatsek, & Reichle, 2003c; Rayner, Reichle, & Pollatsek, 1998c; Reichle, Pollatsek, Fisher, & Rayner, 1998; Reichle, Pollatsek, & Rayner, 2006; Reichle, Rayner, & Pollatsek, 1999; Reichle et al., 2003; as cited in Rayner, 2009), SWIFT (e.g. Engbert, Longtin, & Kliegl, 2002**;** Engbert et al., 2005), EMMA (e.g. Salvucci, 2001; as cited in Rayner, 2009), SERIF (e.g. McDonald, Carpenter, & Shillcock, 2005, as cited in Rayner, 2009), Mr. Chips (e.g. Legge, Hooven, Klitz, Mansfield, & Tjan, 2002; Legge, Klitz, & Tjan, 1997; as cited in Rayner, 2009), and and the competition/activation model (e.g. S. Yang, 2006; Yang & McConkie, 2001; as cited in Rayner, 2009). Some of these models state that eye movements are deriven by lexical processing; however, in others, they are viewed as being mainly affected by oculomotor constraints. They also say that operating properties of the visual and oculumotor systems mainly derive fixation locations and when the eyes move is primarily determined by fixation locations. Lexical parallel processing of words are allowed in some models, however, in others, lexical processing is serial; i.e. untill the target word (n)'s lexical processing is (nearly) complete, the word to the right of the target word (n + 1) is not accessed (Rayner, 1998, 2009).

Two classes of eye movement control models of reading can be identified depending on the attentional categorization theory that they cover; i.e. the first one is the serial attention shift (SAS) such as E-Z Reader model (e.g. Pollatsek, Reichle, & Rayner, 2006d; Rayner, Ashby, Pollatsek, & Reichle, 2004a; Rayner, Pollatsek, & Reichle, 2003c; Rayner, Reichle, & Pollatsek, 1998c; Reichle, Pollatsek, Fisher, & Rayner, 1998; Reichle, Pollatsek, & Rayner, 2006; Reichle, Rayner, & Pollatsek, 1999; Reichle et al., 2003; as cited in Rayner, 2009) and processing gradient models (PG) such as SWIFT (e.g. Engbert, Longtin, & Kliegl, 2002**;** Engbert et al., 2005) (Schad & Engbert, 2012). SAS proposes that only a single word is focused at a time by attentional spotlight while PG assumes that attention is splitted to an extented region of the text to support processing several words at a time (Schad & Engbert, 2012).

E-Z Reader model is a processing model predicting duration of the fixations of the readers, which words they will skip and refixate (Rayner, 2009). This model is the developped version of (Morrison, 1984) (which was also influenced by Becker and Jürgens (1979) and McConkie (1979) (as cited in Reichle et al., 2003). It is known for its clear predictions even though when it cannot clarify certain data. Its characteristics of making clear predictions provides the model create interesting researches (e.g. Drieghe, 2008; Inhoff, Eiter, & Radach, 2005; Inhoff, Radach, & Eiter, 2006; Miellet, Sparrow, & Sereno, 2007; Pollatsek, Reichle, & Rayner, 2006b, 2006c; Rayner et al., 2004a; Reingold & Rayner, 2006; as cited in Rayner, 2009).

Despite the model's strong properties, it has limitations; for instance, higher level linguistic processing effects are not explained in detail in this model since it was not designed for a deep explanation of language processing (Reichle et al., 2003) but for global aspects of eye movements in reading in addition to more local processing property (Rayner, 2009). However, Reichle et al. (2003) said that these effects appeared when the text was hard to understand causing the readers make regressions to re-understand a garden-path sentence and suggested that this model should be seen as the "'default' reading process" (p. 10). They claimed that eye movement control was involved in higher order processes only when there was a problem, as a result of these higher order processes a signal was sent to cease the eyes going next or to stop moving back (regression). Thus, they viewed E-Z Reader as a monitor of what happens while reading when there was no problem with the higher level linguistic processing (Reichle et al., 2003).

SWIFT, a dynamical model of saccade generation during reading, is another alternative model of eye movements in reading. It grasps three principles: "spatially distributed lexical processing, a separation of saccade timing from saccade target selection, and autonomous (random) generation of saccades with foveal inhibition" (Engbert, Longtin & Kliegl, 2002, p. 621). SWIFT's main goals are to examine the probability of spatially distributing processing and to implement a common control mechanism for fixations, refixations and regressions (Engbert, Nuthmann, Richter & Kliegl, 2005). It shows a good accordance with influences of word frequency on single fixation, first fixation, and total sum of fixation durations and also fixation and word skipping probabilities in first-pass analysis. It also generates regressions and refixations- complex eye movement patterns- inherently because of its fundamental dynamical principle (Engbert, Longtin & Kliegl, 2002).

Schad and Engbert (2012) examined the foveal load hypothesis; i.e. the hypothesis that the difficulty of the fixated word adjusts the perceptual span by analyzing the zoom lens model of attention implemented in the model of SWIFT which was closely related to this hypothesis. They claimed that these important assumptions for cognitive researches had not been examined quantitatively in eye movement models. The motivation behind developing this model for reading was about its prediction on effects of word frequency and word length on fixation durations. They stated that the regulation of the attentional span in a computational model can change or reverse the effects of these word features in reading. By applying the model to reading, they found out the focus of the zoom lens is controlled by the foveal processing and by shuffling the text they controlled the effects of word frequency and word length during reading on perceptual span.

2.8. Background on the Morphological Aspect of the Target Words in this Thesis

The "word" is the basic unit of morphology, however, the exact definition of "word" is problematic since different aspects of different linguistic subsystems define it in different ways (Aronoff & Fudeman, 2011; Bauer, 2003). It can be defined as a

constituent which is in the form between the morpheme and the syntactic level, and has psychological evidence (Bauer, 2004). Syntactically, a word is defined as the smallest unit of syntax or language that can stand alone (this does not explain the word clearly, though). Forms are classified as free or bound, according to their capability to stand alone; words are accepted as free forms which can stand alone while bound forms cannot such as affixes. However, this does not give an accurate definition since for example in English "my" is a word but it cannot stand alone thus it is not in the same category of words (Aronoff & Fudeman, 2011; Bauer, 2003). Another clarification by defining a word by the individual languages' phonological systems is that the word is the domain of stress appointment; i.e. a sequence of sounds behaving as an entity for basic types of phonological courses especially stress or accent (Aronoff & Fudeman, 2011).

Grammatical or morpho-syntactic word, generally synonymous with "word", are different forms of a single word which appear according to different syntactic contexts. For instance *school* (belonging to singular forms) and *schools* (belonging to plural forms) are taken as two different words although they are tokens of the same word (Aronoff & Fudeman, 2011; Bauer, 2003, 2004).

Lexeme is the term to make distinction between phonologically similar words and their meanings; i.e. lexeme is a word which has a distinctive sound and meaning; for instance, the word *house* has a number of meanings such as (1a) means "a building where people live, usually one family or group", and (1b)" a group of people which makes a country's laws, or the place where they meet" (house, n.d.).

(1).

a. "We went to my aunt's house for dinner."
b. "The House voted on the proposals." (house, n.d.).

In the sentences above, the meaning of (1a) and (1b) are related; however, they have specific meanings. Each word is called "lexeme" with a peculiar sound and meaning whose shape may change according to syntactic context while differentiating phonologically similar patterns according to their meanings (Aronoff & Fudeman, 2011).

Types of words as content and function is the other issue concerning word definition. Content words-such as noun, verb, adjective or adverb- have an independent semantic content in the world context within a particular sentence (Aronoff & Fudeman, 2011; content word. (n.d.)), whereas functions words- such as verbs (auxiliary verbs and modal verbs) prepositions, conjunctions, articles, or determiners- have- little identifiable- meaning but in a different way and carry grammatical functions (Aronoff & Fudeman, 2011; function word. (n.d.)).

Inflection and derivation are two distinctions in the formation of word and lexemes. While derivation is about creating one lexeme from another (or more than one: e.g. compound words) for instance *writer* from *write*, inflection is about construction of grammatical forms (tense, mood or aspect, or plurality- singularity, case or

possession) for example *writes, writing* or *written* from the word *write.* (Aronoff & Fudeman, 2011).

Suffixation (creating a new word by attaching an affix (either inflectional or derivational) to the right of a root or stem (a root added suffix (es))) is the main word formation process in Turkish. Almost all suffixes in Turkish have more than one form, shaped according to the consonant and vowels preceding them.

Vowel harmony is a phonological process which determines what vowel comes in the syllables of a word -excluding the first syllable- with respect to given features such as height, rounding, or backness (Aronoff & Fudeman, 2011; Göksel, & Kerslake, 2005). When a suffix is bound to a stem, it harmonizes with the preceding syllable's vowel. In Turkish, the rule of vowel harmony (in native Turkish words) is the following;

Back vowels can only be followed by the same feature

'a' can only be followed by 'a'or 'ı'

'ı' can only be followed by 'a' or 'ı'

'o' can only be followed by 'a' or 'u'

'u' can only be followed by 'a' or 'u'

Front vowels can only be harmonized with front vowels

'e' can only be followed by 'e' or 'i'

'i' can only be followed by 'e' or 'i'

'ö' can only be followed by 'e' or 'ü'

'ü' can only be followed by 'e' or 'ü' (Göksel & Kerslake, 2005)

For example the plural suffix in Turkish has two forms *–ler* (e.g. gece*ler* 'nights' and *–lar* (e.g. bakanlık*lar* 'ministries'*)* in which only –e and –a in the middle of the suffix change according to the last syllable of the attached word, while perfective suffix has eight different forms, -dı, -di, -du, -dü, -tı, -ti, -tu, -tü (e.g. dal*dı 'dived'*). The alterable sounds in suffixes are presented with capital letters in this thesis such as *–lErdEkilerden;* i.e. when the last syllable of the target word has front vowels, such as *–e, -i, ,-ö, -ü* (e.g.*-lerdekilerden*), *-e* is used in the next inflectional suffix while if there is a back vowel such as *–a, -ı, -o, -u* in the last syllabus of the target word *–a* is used in the following nominal inflectional suffixes (e.g. *-lardakilerden*). There are a number of exceptions in Turkish vowel harmony; e.g. the suffix *-ki* optionally undergoes vowel harmony such as *gün* 'day': *günki/günk**ü*** (Göksel & Kerslake, 2005). However, in the target words of this thesis, the suffix *–ki* is not harmonized.

In this study, for target words, morpho-syntactic definition of the "word"- since the target words in the experiments are with or without inflectional suffixes- is used. The target words are content words –which are nouns and could have nominal inflectional suffix(es) in this study.

CHAPTER 3

METHODOLOGY

In this chapter, first of all information about the participants is given. Then, the materials are described in a detailed way. The apparatus is also introduced. Then, the design of the experiments is expressed. Data collection methods are stated in the following section. A brief information about the pilot study is given. Lastly, how the data were analyzed is described in the last section.

3.1. Participants

Seventeen university students at Middle East Technical University whose native language is Turkish participated in the experiment. Eleven of these participants were female and five of them were male and their ages were between 19- 26 (M= 19.94); however, three of these participants (female) whose ages were between 19-20 could not be included in the analysis because of the low data quality (see section 3.7. under Chapter 3 for further information)**.** All the participants participated in the study on voluntary basis.

3.2. Materials

All the study materials were designed in Turkish. There were 12 types of sentences, in the whole experiment. Most of the sentences were retrieved from the Turkish National Corpus (demo version) (Aksan, et al., 2012), which has about 48 million words from 4438 different text samples, 9 domains such as social science or world affairs, and 34 different genres. About 8% of the all sentences were taken from the internet sources while about 33% of all were made up. Approximately 20% of the all sentences were retrieved from Turkish National Corpus but modified to adjust with the guideline of the stimuli preparation of this study. The length of the sentences; i.e. the number of the words in the sentence, were different (6 words-22 words) in each sentence. The sentences were selected on the basis of a guideline including the following criteria:

1) The sentences were formed in a way each sentence would have one target word, which was a noun, and this target word was placed randomly in the sentence from the second word from the beginning to the second from the end of the sentence.

2) No punctuation marks existed in the close environment of the target word in the sentence.
3) No numbers existed in the close environment of the target word in the sentence.
4) Any numbers were avoided as much as possible in the sentences at all.
5) Abbreviations in the sentence such as "GDO" were avoided.
6) Conjunctions that connect two phrases were not used in the environment of the target word, because it makes the target word the first word of the new phrase, which was avoided.
7) Short adjectives such as *bu* 'this' were not used before the target words, because the fixations are affected by the preceding short word.
8) Ambiguous words such as *sıra* (desk, row or time) were avoided.
9) Idioms such as *ayaklar altına alındı* (to trample on sb/sth) were avoided.
10) When re-designing (modifying) the corpus sentences, the target words –noun phrases- were in the same part of speech tag.
11) Only one target word was used to the extent possible in each sentence.
12) The word *bir* "one" or "a" was avoided, as much as possible since it is a determiner and a short function word which affects the attention and eye movements on the words it precedes or follows.

The reason why the affix *–lEr* as short inflectional suffix was used was because first,*–lEr* (plurality suffix) is one of the most frequent inflectional suffixes and; second, it prevents haplology[1]. Since there are no long inflectional suffixes in Turkish, more than one inflectional suffix, *–lErdEkilerden* (plurality suffix (*-lEr*) + locative case suffix (*-dE*) + possessive suffix (*ki*) + plurality suffix (*ler*) + ablative case suffix (*-den*)), was used to compare the inflected word types according to the length of the inflectional suffix. The *–lEr* suffix continues its function of haplology even when more suffixes added to itself. Moreover, the other inflectional suffixes are frequently used suffixes, too.

The target words had a 2x2 design according to their length (short words having 4 letters and long words having 8 letters) and frequency (high frequency vs low frequency). There were 12 sentences in each category which were; short high frequency target word group (short & high frequency), short low frequency target word group (short & low Frequency), long high frequency target word group (long & high frequency); and long and low frequency target word group (long & low frequency). There were 12 categories in the experiment:
(1) short and high frequency words without inflectional suffixes,
(2) short and low frequency words without inflectional suffixes,
(3) long and high frequency words without inflectional suffixes,
(4) long and low frequency words without inflectional suffixes;
(5) short and high frequency words with short inflectional suffix *-lEr*,
(6) short and low frequency words with short inflectional suffix *-lEr*,
(7) long and high frequency words with short inflectional suffix *–lEr*,

[1] Haplology is "the omission of one occurrence of a sound or syllable which is repeated within a word (e.g. in *February* pronounced as /f bri)/." (Haplology (n.d.)).

(8) long and low frequency words with short inflectional suffix *–lEr;*
(9) short and high frequency words with short inflectional suffix *–lErdEkilerden*,
(10) short and low frequency words with short inflectional suffix *–lErdEkilerden*,
(11) long and high frequency words with short inflectional suffix *–lErdEkilerden*,
(12) long and low frequency words with short inflectional suffix *–lErdEkilerden.*

In addition to the four base word categories without inflectional suffixes (see the items of 1, 2, 3, 4 above) such as 'adam' (man), 'etek' (skirt), 'gazeteci' (journalist), 'saltanat'(sultanate) respectively; there were two more inflected word types -short and long inflectional suffixes (see the items of 5, 6, 7, 8, 9, 10, 11, 12 above)- the same words with the bare word group but suffixed as short and long- such as 'adam*lar*' (men), 'etek*ler*' (skirts), 'gazeteci*ler*' (journalists), 'saltanat*lar*'(sultanates); 'adam*lardakilerden*' (than/from those in/on men), 'etek*lerdekilerden*' (than/from those on skirts), 'gazeteci*lerdekilerden*' (than/from those on journalists), 'saltanat*lardakilerden*'(than/from those in sultanates) respectively. In other words, the experimental items involved three categories as base words- words without inflectional suffixes- such as "anne" (mother), words with short inflectional suffix -*lEr* (plural marker) such as "anne*ler*" (mothers), and words with long inflectional suffixes, -*lErdEkilerden* (plurality suffix (-lEr) + locative case suffix (-dE) + possessive suffix (ki) + plurality suffix (ler) + ablative case suffix (-den)) such as "anne*lerdekilerden*" (than/from those of/ on mothers) (See table 1; see Appendix C for all target words in all categories).

Table 1.

Word Categories Across Inflectional Suffixes

	No Inflectional Suffixes	**Short Inflectional Suffix -*lEr***	**Long Inflectional Suffixes -*lErdEkilerden***
Short & High Frequency	e.g. 'adam' (man)	e.g. 'adamlar' (men)	e.g. 'adamlardakilerden' (than/from those in/on men)
Short & Low Frequency	e.g. 'etek' (skirt)	e.g. 'etekler' (skirts)	e.g. 'eteklerdekilerden' (than/from those on skirts)
Long & High Frequency	e.g. 'gazeteci' (journalist)	e.g. 'gazeteciler' (journalists)	e.g. 'gazetecilerdekilerden' (than/from those on journalists)
Long & Low Frequency	e.g. 'saltanat'(sultanate)	e.g. 'saltanatlar' (sultanates)	e.g. 'saltanatlardakilerden'(than/from those in sultanates)

We assumed that frequency information of the target words taken from Turkish National Corpus (Aksan, et al., 2012) is representative for written Turkish language.

Table 2 shows the mean statistics of estimated word frequencies (per million tokens) of the target words (Aksan, et al., 2012). As stated in Table 2, the mean of the estimated frequency information of the short and high frequency words in the Turkish National Corpus 224.78 (N=12, SD= 126.65) is ranging from the minimum value of 67.78 to 443.29. Short and low frequency words' estimated frequency mean is 9.93 (N= 12, SD= 5.02) whose minimum value is 3.38 and maximum value is 20.71. The mean score of the words in the group of long and high frequency is 72.97 (N= 12, SD= 29.49) changing the values from minimum 33.70 to maximum 120.04. Lastly, the words in the long and low frequency category has the mean score of 8.65 (N=12, SD= 6.82) in the range of minimum .08 to maximum 25.46. Overall, the mean score of high frequency words regardless of their length is 148.87 (N=24, SD=118.74) while the mean score of the low frequency words is 9.29 8N=24, SD=5.89).

Table 2.

Descriptive Statistics: The Mean statistics of Estimated Word Frequencies (per million tokens) of the target words in the Turkish National Corpus

	Short & High Frequency PerMillion	Short & Low Frequency QPerMillion	Long & High Frequency PerMillion	Long & Low Frequency PerMillion	High Frequency PerMillion*	Low Frequency PerMillion**
Mean	224.78	9.93	72.97	8.65	148.87	9.29
N	12	12	12	12	24	24
Std. Deviation	126.65	5.02	29.49	6.82	118.74	5.89
Minimum	67.78	3.38	33.70	.08	33.70	.08
Maximum	443.29	20.71	120.04	25.46	443.29	25.46
*High frequency target word group ** Low frequency target word group						

In addition, Table 3 shows the frequency (per million) information list of all the 48 target words (under 4 categories as short & high frequency, long & high frequency, short & low frequency and long & low frequency) in the corpus in detail (Aksan, et al., 2012).

Table 3.

Frequency list of the target words per million (Aksan, et al., 2012)

Short & High Frequency	Frequency Per million		Long & High Frequency	Frequency Per million
Ürün ‘product’	118		davranış 'behavior'	81.72
Ağaç ‘tree’	67.78		fotoğraf 'photograph'	77.48
Okul ‘school’	165.29		gazeteci 'journalist'	52.05
Kişi ‘person’	396.8		sıcaklık 'temperature'	47.26
Saat ‘clock’	317.43		istikrar 'stability'	33.7
Aile ‘family’	232.02		öğretmen 'teacher'	120.04
Ayak ‘foot’	91.98		elektrik 'electricity'	95.88
Adam ‘man’	443.29		politika 'politics'	91.48
Anne ‘mother’	202.2		toplantı 'meeting'	48.08
Halk ‘public’	208.24		belediye 'municipality'	116.14
Akıl ‘mind’	99.79		enflasyon 'inflation'	74.42
Short & Low Frequency	Frequency Per million		Long & Low Frequency	Frequency Per million
ödev 'homework'	10.98		hükümdar 'sovereign'	7.7
reis 'chief'	10.83		bakanlık 'ministry'	25.46
sızı 'ache'	5.16		istasyon 'station'	10.18
kuzu 'lamb'	15.26		aktivite 'activity'	10.33
baca 'chimney'	3.38		orkestra 'orchestra'	10.07
kazı 'excavation'	11.56		potasyum 'potassium'	10.33
etek 'skirt'	9.67		egzersiz 'exercise'	10.83
fert 'individual'	10.87		buhurdan 'censers'	0.42
ayin 'ritual'	4.32		çamurluk 'fender'	0.08
takı 'jewelry'	4.747		külliyat 'corpus'	0.5
kale 'castle'	20.71		saltanat 'sultanate'	7.22

3.3. Apparatus

Eye movements were recorded using a Tobii T120 desktop eye tracker. Reported spatial accuracy was typical 0.5 degrees and resolution accuracy was typical 0.3 degrees.
The sentences were shown on the center line of a 17-inch TFT monitor (1280 x 1024 pixels, 120 Hz frame rate and regular Courier New 14 mono-space font). Because the eye tracker computer gives freedom of head movements to a certain extent, the participants sat in front of the computer and were instructed to read the sentences by controlling all their readings and not to make big movements in order not to lose the control of the eye modeling. The eye tracking information of the participants were recorded by the embedded cameras on the computer.

3.4. Procedure

The experiments were conducted in Human Computer Interaction Research and Application Laboratory at the Middle East Technical University. The participants were placed 60 cm. away from the computer and asked not to move as much as possible during the experiment. They were given brief information about the procedure of the experiment. Standard nine-point grid for both eyes calibration was taken for each participant before starting each group. After beginning each session, the experimenter left the laboratory and watched the experiment behind the one-way glass and the participants were told to inform the experimenter when the session ended.
The participants were presented 144 sentences in total. The study was divided into three sessions, each of which has 48 experimental sentences except the first session which has four extra trial sentences, in order to obtain a more clear calibration. The stimuli were mixed to avoid familiarity effect of similar words in the non-inflected form, and the inflected forms of the same word with both short suffix *-lEr* and long suffixes *-lErdEkilerden*. All the three groups had the same kinds of words (mixed categories), each group consisted of 48 sentences in a mixed order and each sentence was presented to the participants randomly (randomized twice by using "counterbalance" choice of the Tobii computer).
There existed fixation point slides in which a fixation dot stands in the center of the bottom line writing "İşaretin merkezine bakarak bir tuşa basınız" (Press a button by looking at the center of the point) in Turkish. This slide appeared before each sentence. The participants were instructed to read the instructions and move accordingly to the other slides by themselves by pressing any key on the keyboard. They were supposed to read the sentences silently by comprehending them and when they finished reading, by pressing any key on the keyboard while looking at the fixation point; as it was instructed in the same way, they were asked to pass on the other slide which was the other sentence slide. Except the first group of sentences which had a trial session at the beginning, all the groups had the same procedure; when each session ended up, the participants were supposed to inform the experimenter, thus the other session could be started with a new calibration. The participants were told that each session would last 10 minutes and the whole experiment would last about 20- to 30 minutes approximately, at the beginning of the experiment.

Before starting the experiment, the participants were informed partially about the study not to affect the results, and were asked to sign a consent form and fill demographic information about their name, age, educational background, native language and foreign languages. At the end of the experiment, the participants were thanked and informed about the study completely and also told that they could ask any questions about the study and if any, their questions were answered and contact information of the experimenter was given for further questions.

3.5. Data Collection

Three types of word groups according to their inflection conditions were used to measure the effect of word frequency and word length on eye movement parameters. All the target words (the uninflected part of the words- base words) in each inflection condition were the same, only their inflectional suffixes were different. The recorded data were analyzed in these steps:

1) The experimental protocol of each participant was extracted on which fixation numbers and places existed (e.g. see Figure 1).
2) Each target word environment, including 1-2 character left and right of the target words, were marked.
3) The data of each participant was extracted from the eye tracker.
4) Each fixation duration was identified by finding the fixation durations in the data scale by finding media (each sentence were placed on a slide as a picture and they had an order and a definite number) number and matching fixation point numbers in this media and the data information scale on a table.
5) All the data were organized across participants (and stating each media number in a separate column) in the excel table; first into three categories according to word group; then in each group they were categorized into three as first fixation duration, first pass reading gaze durations and total sum of fixation durations.
6) After finishing all the analyses, each fixation values under 50 ms were deleted to avoid noisy data.
7) Lastly, all the data were imported into SPSS program.

This procedure was applied to all the data taken from all the participants one by one.

3.5.1. Uninflected Words

The target words used in this experimental group were bare words, which did not have any suffixes. There were 48 sentences (target words) divided into four categories, containing 12 sentences in each group, according to the frequency and length of the words in this word type (see Table 1 above and Appendix C for further examples);

1) Short & High Frequency such as ‘gece’ (night)
2) Short & Low Frequency such as ‘kıta’ (continent)

3) Long & High Frequency such as ‘otomobil’ (automobile)
4) Long & Low Frequency such as ‘bakanlık’ (ministry)

3.5.2. Words with Short Inflectional Suffix, *-lEr*

In this experimental task, the target words had short inflectional suffix, *-lEr*. In four categories, 48 sentences (target words) existed in total according to the word frequency and length (see Table 1 above and Appendix C for further examples). Each category included 12 contexts for each target word;

1) Short & High Frequency such as ‘geceler’ (nights)
2) Short & Low Frequency such as ‘kıtalar’ (continents)
3) Long & High Frequency such as ‘otomobiller’ (automobiles)
4) Long & Low Frequency such as ‘bakanlıklar’ (ministries)

3.5.3. Words with Long Inflectional Suffixes, *-lErdEkilerden*

The target words contained more than one inflectional suffix, *-lErdEkilerden*. 48 separate sentences in total involved each target word. There were 4 according to these words’ frequency and length (see Table 1 above and Appendix C for further examples);

1) Short & High Frequency such as ‘gecelerdekilerden’ (than/from those in nights)
2) Short & Low Frequency such as ‘kıtalardakilerden’ (than/from those in continents)
3) Long & High Frequency such as ‘otomobillerdekilerden’ (than/from those in automobiles)
4) Long & Low Frequency such as ‘bakanlıklardakilerden’ (than/from those in ministries)

3.6. Pilot Study

A pilot study was conducted with four participants to identify the issues in the initial experimental design. The same procedure as mentioned above in section 3.4., was followed in these experiments. However, there were some differences; the font was 12; the calibration number taken before each session was smaller than the original experiments, which appeared to be an obstacle to get qualified results. Moreover, since that was the first trial of the final experiments, there were some typos, which were edited before the real experiments were conducted.

3.7. Data Analysis

The data of three participants (female, ages of 19-20) were excluded from the study because of the low qualified data- under 80% data in Tobii eye-tracker. Thus the data of fourteen participants were included in the study.

The main research question of this thesis was what were the factors affecting the eye movement parameters during reading, which was examined by controlling the frequency and length characteristics of the words. These eye movement parameters were analyzed under three parts: the first fixation durations on the target words, gaze durations on the target words (the first pass reading) and finally total sum of fixation durations on the target words during whole reading time (see figure 1 for a detailed representation of what are these eye movement measures on the data).

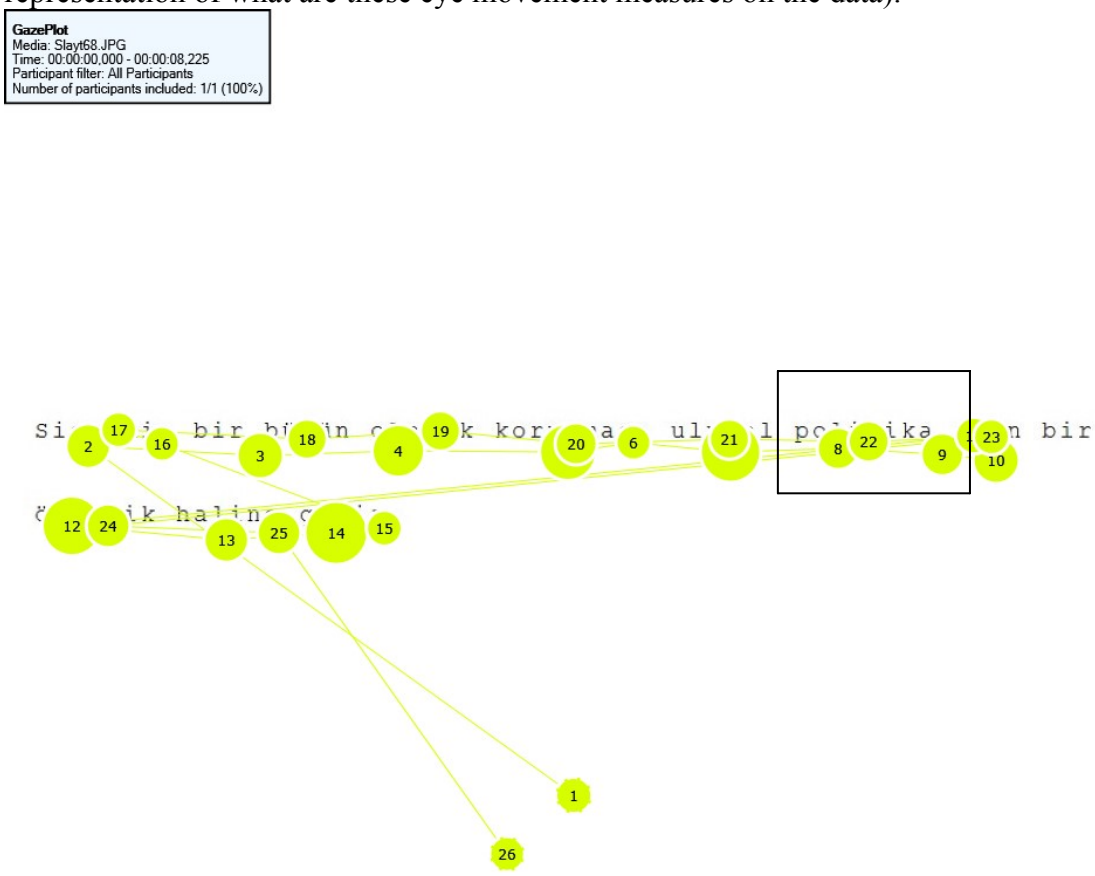

Figure 1. Representation of the eye movement measures
The word 'politika'*(*politics) is the target word in the sentence.
Number 8 is the first fixation point on the target word.
Number 8+9 are the gaze durations on first pass reading.
Number 8+9+22 are the total sum of fixation durations on the whole reading time.

The analyses were handled under three sections; the first section represented the analyses of the word group without inflectional suffixes on the fixation durations; while the second section consisted of the analyses of the word groups with short inflectional suffix *–lEr* and likewise, the third section examined the effect of the

word features in the long inflectional suffixes, *–lErdEkilerden,* word category. Lastly, the fourth section showed the comparison of the effect of the word features in these three groups together including the effect of inflectional suffixes.

All those sections included the analyses of the three types of eye movement measures separately such as

1) First fixation durations: A within-subject analysis was run by using a 2 (short and long) x2 (high frequency and low frequency), length vs frequency, repeated measures ANOVA. Paired samples t-tests were run to do further analysis on the interaction patterns (if any).

2) First pass reading analysis (gaze durations): A within-subject analysis was run by using a 2 (short and long) x2 (high frequency and low frequency), length vs frequency, repeated measures ANOVA. Paired samples t-tests were run to do further analysis on the interaction patterns (if any).

3) Total sum of fixation durations: A within-subject analysis was run by using a 2 (short and long) x2 (high frequency and low frequency), length vs frequency, repeated measures ANOVA. Paired samples t-tests were run to do further analysis on the interaction patterns (if any).

Under each of these eye movement measures, the effect of the variables, which were word frequency and word length, were investigated for each section. The first feature of the target words was the length. It was determined by the length of the base words such as the words consisting four-letter words (excepting any inflectional suffixes) are short words. For instance, 'gece' (night) was the base word of the 'gece', 'gece*ler*' (nights) or 'gece*lerdekilerden*' (than/from those in nights), or 'ürün' (product) was the base word of 'ürün', 'ürün*ler*' (products) or 'ürün*lerderkilerden*' (than/from those in/on products). They were accepted as short words, while the words having eight letters were long words e.g. 'öğretmen' (teacher) was the base word of the 'öğretmen', 'öğretmen*ler*' (teachers) and 'öğretmen*lerdekilerden*' (than/from those in nights) and they were regarded as long words. The second feature of the target words was the frequency of the base words. The frequency feature belongs to only the base word forms which did not have any inflectional suffixes in all word groups. The inflected versions of the words were not taken into consideration; for example, low frequency information came from the uninflected stem 'reis' (chief) in the three word groups (1) 'reis' (chief) in the uninflected word group, (2) 'reis*ler*' (chiefs) in the group of words with short inflectional suffix and (3) 'reis*lerdekilerden*' (than/from those in nights) in the group of words with long inflectional suffixes. However, in the last section the effect of (inflectional) suffixation was examined; i.e. the effect of the inflectional suffixes was compared by analyzing the uninflected words ('gece' (night), short inflectional suffixed words with the *–lEr* suffix ('gece*ler*' (nights)), and long suffixed words with the *–lErdEkilerden* suffix ('gece*lerdekilerden*' (than/from those in nights)). The two variables frequency and length were investigated across inflectional suffix types in ths section. On the other hand, both frequency and length features belonged to only the uninflected stems of all words; in other words, for example only the frequency of,

the uninflected stem, ‘gece’ (night) was taken into account in the forms of, inflected word groups, ‘gece*ler*’ or ‘gece*lerdekilerden*’; i.e. the frequency and length of the whole stem ‘gece*ler*’ or ‘gece*lerdekilerden*’ is not taken into consideration.

For examining the effect of the word features on the eye movement parameters comparing the inflection (suffixation) features, a within-subject analysis was run by using a 3 (root, short suffixed and long suffixed) x2 (short and long) x2 (high frequency and low frequency) repeated measures ANOVA for each eye movement measures. Further paired samples t-tests were run to see the interaction patterns (if any).

For each eye movement measurements under the three word groups of (inflectional) suffixation, 9 within-subject analysis were done to test the word length and word frequency by using a 2 (short and long) x2 (high frequency and low frequency repeated measures ANOVA. Moreover, another three within-subject analysis was run by using a 3 (root, short suffixed and long suffixed) x2 (short and long) x2 (high frequency and low frequency) repeated measures ANOVA for each eye movement measure to test the effect of inflectional suffixes. For the interaction results, a number of paired samples t-tests were run to investigate the interaction statistically (see section IV).

CHAPTER 4

RESULTS

In this chapter, the results of the each experiment are stated separately under 4 sections. Each section contains the analyses of 3 types of eye movement measures, first fixation duration, gaze duration and total sum of fixation durations. The variables, word length, frequency and interaction between these two, are analyzed under these three eye movement measures. However, in the section 4, there is an additional variable, i.e. suffixation and its interaction with other variables. The first section includes the statistics of the word category without inflectional suffixes. There are the analyses of the words with short inflectional suffix, *-lEr,* under section 2. In the third section, there exist the results of the words with long inflectional suffixes, *-lErdEkilerden.* Lastly, in the section 4 there are the comparison of these three types of word groups to analyze the effect of inflectional suffixes.

4.1. Section I: Type 1 (Words without Inflectional Suffixes)

In this section, three types of eye movement measures; i.e. first fixation durations, gaze durations and total sum of fixation durations are analyzed. In the first part of each subsection a descriptive statistics exist, then the results of the analyses of word length and frequency variables are stated. Lastly, a discussion part is given to cover all the results in this section.

4.1.1. First Fixation Durations

Table 4 shows the descriptive statistics of frequency and length of the words without any inflectional suffixes in first fixation point analysis.

Table 4.

Descriptive Statistics: Mean Scores of the First Fixation Durations by Frequency and Length of the non-inflected target words

Word groups without inflectional suffixes	Mean	Std. Deviation	N
Short & High Frequency e.g. 'gece' (night)	217	49.9	14
Short & Low Frequency e.g. 'kıta' (continent)	227.5	48. 1	14
Long & High Frequency e.g. 'otomobil' (automobile)	227. 4	55	14
Long & Low Frequency e.g. 'bakanlık' (ministry)	257. 6	76. 2	14

Word length

There was no significant main effect of word length on the first fixation durations of the uninflected word groups (F(1,13)= 2.76 p= .120).

Word frequency

There was a significant main effect of word frequency on the first fixation durations on the target words without inflectional suffixes (F(1,13)= 5.71 p= .033). The first fixation durations on the high frequency words (M= 222.25 SD= 12.53) were shorter than the low frequency words (M= 242.53, SD= 14.1).

Frequency and length interaction

There was no two way significant interaction between the frequency and length of the words on the mean scores of first fixation durations (F(1,13)= .836 p= .377).

4.1.2. First Pass Reading Analysis (Gaze Durations)

Table 5 shows the descriptive statistics of frequency and length of the uninflected words in first pass reading analysis.

Table 5.

Descriptive Statistics: Mean Scores of the Gaze Durations on the First Pass Reading *by Frequency and Length of the target words*

Word groups without inflectional suffixes	Mean (ms)	Std. Deviation
Short & High Frequency e.g. 'gece' (night)	313.9	96.5
Short & Low Frequency e.g. 'kıta' (continent)	329.4	79.5
Long & High Frequency e.g. 'otomobil' (automobile)	331.2	96.4
Long & Low Frequency e.g. 'bakanlık' (ministry)	389.5	222.7

Word length

No significant main effect of the word length was observed on gaze durations ($F(1,13)= 2.059$ $p= .175$).

Word frequency

There was a significant main effect of word frequency of the target words without inflectional suffixes in first pass reading ($F(1,13)= 6.362$ $p= .025$). The gaze durations on the high frequency words ($M= 322.57$, $SD= 24.31$) were lower than the low frequency words ($M= 359.51$, $SD= 37.27$.

Frequency and length interaction

There was no significant interaction between frequency and length of the words in the uninflected word group on the mean scores of gaze durations ($F(1.13)= .719$ $p= .412$).

4.1.3. Total Sum of Fixation Durations

The descriptive statistics of frequency and length of the word categories in analysis of the total fixation durations is displayed in Table 6.

Table 6.

Descriptive Statistics: Mean Scores of the Total Sum Of Fixation Points *by Frequency and Length of the uninflected target words*

Word groups without inflectional suffixes	Mean	Std. Deviation
Short & High Frequency e.g. 'gece' (night)	322.9	108.6
Short & Low Frequency e.g. 'kıta' (continent)	371. 4	73
Long & High Frequency e.g. 'otomobil' (automobile)	391. 8	130.9
Long & Low Frequency e.g. 'bakanlık' (ministry)	450. 3	282

Word length

There was no significant main effect of word length on the total sum of fixation durations (F(1,13)= 3.718 p= .076) of the uninflected word groups.

Word frequency

There was a significant main effect of word frequency on the total sum of fixation durations on the target words without inflectional suffixes (F(1,13)= 8.14 p= .014). The total sum of fixation durations on the high frequency words (M= 357.37, SD= f29.8) were lower than the low frequency words (M= 410.9, SD= 45.17).

Frequency and length interaction

There was no significant interaction between frequency and length of the words on the mean scores of total sum of fixation durations (F(1,13)= .031 p= .862).

4.1.4. Discussion

The analyses of uninflected word groups showed that only frequency of the words had an effect on the eye movements. In all three types of eye movement measures used in this study, first fixation time, first pass reading time and total gaze time, the mean scores of high frequency words were lower than low frequency words, which was relevant with the literature on the eye movements in reading (see Rayner, 1998, 2009; Staub and Rayner, 2007; for a review). As the frequency of the words increased, the fixation durations and the fixation numbers (even skipping) on these words decreased. However, there were no effect of word length and no interaction between word frequency and length (see table 7). The reason of this might be that the difference between the number of characters of the short and long words might not be large enough to show significant difference.

Table 7.

Summary Table of Section 1: Type 1 (Words Without Inflectional Suffixes)

	First-fixation Time (FF)	**First-pass Time (FP)**	**Total Gaze Time (TG)**
Main effect of Length	No Effect	No Effect	No Effect
Main effect of Frequency	(F(1,13)= 5.71 p= .033); fixation duration on high frequency < low frequency	(F(1,13)= 6.362 p= .025); fixation duration on high frequency < low frequency	(F(1,13)= 8.14 p= .014); fixation duration on high frequency <low frequency
Length & Frequency interaction	No Effect	No Effect	No Effect

4.2. Section II: Type 2 (*-lEr* Form)

Analyses of first fixation durations, gaze durations and total sum of fixation durations are stated under this section. Each subsection starts with a descriptive statistics, then word length and frequency analyses results follow. The section ends with a discussion of all the results.

First Fixation Durations

Table 8 exhibits the descriptive statistics of frequency and length of the word categories with short inflectional suffix of the first fixation point analysis.

Table 8.

Descriptive Statistics: Mean Scores of the First Fixation Durations of the word with short inflectional suffix by Frequency and Length of the target words

Word groups with *–lEr* suffix	Mean	Std. Deviation	N
Short & High Frequency e.g. 'gece*ler*' (nights)	248.3	59.1	14
Short & Low Frequency e.g. 'kıta*lar*' (continents)	237.5	55.7	14
Long & High Frequency e.g. '*otomobiller*' (automobiles)	218.9	39.7	14
Long & Low Frequency e.g. 'bakanlık*lar*' (ministries)	212.7	58.9	14

Word length

There was a significant main effect of word length on the first fixation durations (F(1,13)= 10.035 p= .007).
Further examination, the LSD post-hoc test, showed that the first fixation on the short words (M= 242.9, SD= 14, 8) was lower than the long words (M= 215.8, SD= 12.2).

Word frequency

No significant main effect of word frequency was observed on the first fixation durations (F(1,13)= 1.567 p= .233).

Frequency and length interaction

There was no significant interaction between frequency and length of the words on the mean scores of first fixation durations (F(1,13)= .122 p= .733).

4.2.2. First Pass Reading Analysis

Table 9 shows the descriptive statistics of frequency and length of the words in first pass reading analysis.

Table 9.

Descriptive Statistics: Mean Scores of Gaze Durations on First Pass Reading *by Frequency and Length of the Words with Short Inflectional Suffix*

Word groups with *–lEr* suffix	Mean	Std. Deviation
Short & High Frequency e.g 'gece*ler*' (nights)	332.1	89.6
Short & Low Frequency e.g. 'kıta*lar*' (continents)	399.8	127.1
Long & High Frequency e.g. '*otomobiller*' (automobiles)	467.1	219.9
Long & Low Frequency e.g. 'bakanlık*lar*' (ministries)	524.8	242.3

Word length

There was a significant main effect of word length in first pass reading (F(1,13)= 11.754 p= .004).
The LSD post-hoc test results showed that the gaze durations on the short words (M= 365.9, SD= 27.65) was lower than the long words (M= 495.9, SD= 59.4).

Word frequency

There was a significant main effect of word frequency on the gaze durations on the target words (F(1,13)= 8.422 p= .012). The gaze durations in first pass reading on the high frequency words (M= 399.6, SD= 38) were lower than the low frequency words (M= 462.3, SD= 48.6).

Frequency and length interaction

There was no significant interaction between and length in first pass reading (F(1,13)= .082 p= .779).

4.2.3. Total Sum of Fixation Durations

The descriptive statistics of frequency and length of the words with short inflectional suffix in total sum of fixation duration analysis is displayed in Table 10.

Table 10.

Descriptive Statistics: Mean Scores of the Total Sum Of Fixation Durations *by Frequency and Length of the Target Words with Short Inflectional Suffix*

Word groups with *–lEr* suffix	Mean	Std. Deviation
Short & High Frequency e.g 'gece*ler*' (nights)	368.3	94.25
Short & Low Frequency e.g. 'kıta*lar*' (continents)	428.1	147.3
Long & High Frequency e.g. '*otomobiller'* (automobiles)	530.2	276.5
Long & Low Frequency e.g. 'bakanlık*lar*' (ministries)	658.7	311.9

Word length

There was a significant main effect of word length on the sum of total fixation durations (F(1,13)= 16.269 p= .001). According to the LSD post-hoc tests, the total sum of fixation durations on the short words (M= 398.1, SD= 31.21) was lower than the long words (M= 594.49, SD= 74.71).

Word frequency

There was a significant main effect of word frequency on the total sum of fixation durations on the words with short inflectional suffix (F(1,13)= 10.323 p= .007). The

total sum of fixation durations on the high frequency words (M= 449.17, SD= 47.42) were lower than the low frequency words (M= 543.42, SD= 59.60).

Frequency and length interaction

There was no significant interaction between frequency and length on the mean scores of total sum of fixation (F(1,13)= 1.876 p= .194).

4.2.4. Discussion

When the plurality suffix *–lEr* was attached to the target words, length effect was observed in all eye movement measures; i.e. fixation durations on short words were lower than the long words in the gaze duration and total gaze time in which -mostly- more than one fixation durations occur and show all the lexical processing time, as relevant with the literature; while first fixation time measure showed the opposite effect; i.e. the first fixation durations on the short words were longer than the long words. This might be due to the fact that fixation landing position shifts towards the beginning of the target word (Yan et al., 2014) and as the length of the word increases, the fixation duration numbers tend to be longer to process the word and fixation durations are moved to and shared with the upcoming fixation points.
An impact of frequency was seen in the analyses of the first pas time and total gaze time measures, parallel with the literature; in other words, as the frequency of the words decreased, the fixation durations on these words increased. The reason why no effect of frequency on the first fixation time analysis seen, might be because cognitive processing got slow at the beginning of the word and needed other fixations to have lexical access to the word as the length of the target word and thus complexity of the word increase (see Rayner 1998, 2009).
Lastly no interaction between the word frequency and length was observed (see table 11.)

Table 11.

Summary Table of Section 2:Type 2 (Words With Short Inflectional Suffix -lEr)

	First-fixation Time (FF)	**First-pass Time (FP)**	**Total Gaze Time (TG)**
Main effect of **Length**	**(**F(1,13)= 10.035 p= .007); fixation duration on short words > long words	**(**F(1,13)=11.754 p= .004); fixation duration on short words < long words	**(**F(1,13)= 16.26 p= .001); fixation duration on short words < long words
Main effect of **Frequency**	No Effect	(F(1,13)= 8.422 p= .012); fixation duration on high frequency < low frequency	(F(1,13)= 10.323 p= .007); fixation duration on high frequency < low frequency
Length & Frequency interaction	No Effect	No Effect	No Effect

4.3. Section III: Type 3 (*-lErdEkilerden* Form)

This section contains the results of the analyses of first fixation durations, gaze durations and total sum of fixation durations and a discussion part. Each eye movement measure analysis begins with a descriptive statistics, then results of word length and frequency analyses are presented.

4.3.1. First Fixation Durations

Table 12 shows the descriptive statistics of frequency and length of the words with long inflectional suffixes in first fixation point analysis.

Table 12.

Descriptive Statistics: Mean Scores of the First Fixation Durations by Frequency and Length of the Words with Long Inflectional Suffixes

Word groups with *–lErdEkilerden* suffix	Mean	Std. Deviation
Short & High Frequency e.g. 'gece*lerdekilerden*' (than/from those in nights)	215.4	63.2
Short & Low Frequency e.g. 'kıta*lardakilerden*' (than/from those in continents)	228.9	72.9
Long & High Frequency e.g. 'otomobil*lerdekilerden*' (than/from those in automobiles)	190.6	52.2
Long & Low Frequency e.g. 'bakanlık*lardakilerden*' (than/from those in ministries)	203	52.8

Word length

There was a significant main effect of word length on the first fixation durations ($F(1,13)= 10.576$ $p= .006$). The LSD post-hoc test, indicated that the first fixation durations on the short words ($M= 222.2$, $SD= 16.8$) was higher than the long words ($M= 196.8$, $SD= 13.5$).

Word frequency

Frequency of the words showed no significant main effect on the first fixation durations in the word category with long inflectional suffixes ($F(1,13)= 2.496$ $p= .138$).

Frequency and length interaction

There was no significant interaction between frequency and length of the words on the mean scores of first fixation durations $F(1,13)= .006$ $p= .941$).

4.3.2. First Pass Reading Analysis

Table 13 shows the descriptive statistics of frequency and length of the word categories in first pass reading analysis.

Table 13.

Descriptive Statistics: Mean Scores of the Gaze Durations on First Pass Reading *by Frequency and Length of the Words with Short Inflectional Suffix*

Word groups with *–lErdEkilerden* suffix	Mean	Std. Deviation
Short & High Frequency e.g. 'gece*lerdekilerden*' (than/from those in nights)	742.3	438.7
Short & Low Frequency e.g. 'kıta*lardakilerden*' (than/from those in continents)	705.6	394.8
Long & High Frequency e.g. 'otomobil*lerdekilerden*' (than/from those in automobiles)	780.9	489
Long & Low Frequency e.g. 'bakanlık*lardakilerden*' (than/from those in ministries)	844.7	441.6

Word length

There was a significant main effect of word length in first pass reading (F(1,13)= 10.576 p= .006). Further LSD post-hoc tests showed that the gaze durations on the short words (M=724, SD= 108.8) was lower than the long words (M= 812.8, SD= 121.4).

Word frequency

No significant main effect of word frequency was seen on the gaze durations on the words with long inflectional suffix (F(1,13)= 2.496 p= .138).

Frequency and length interaction

There was not an interaction between frequency and length of the words on the mean scores of gaze durations (F(1,13)= .006 p= .941).

4.3.3. Total Sum of Fixation Durations

In table 14, the descriptive statistics of frequency and length of the words with long inflectional suffixes in total sum of fixation durations analysis is displayed.

Table 14.

Descriptive Statistics: Mean Scores of the Total Sum Of Fixation Durations by Frequency and Length of the Words Long Suffixation

Word groups with *–lErdEkilerden* suffix	Mean	Std. Deviation
Short & High Frequency e.g. 'gece*lerdekilerden*' (than/from those in nights)	869.5	539. 1
Short & Low Frequency e.g. 'kıta*lardakilerden*' (than/from those in continents)	845.7	453.5
Long & High Frequency e.g. 'otomobil*lerdekilerden*' (than/from those in automobiles)	946.7	638.2
Long & Low Frequency e.g. 'bakanlık*lardakilerden*' (than/from those in ministries)	963.6	523

Word length

The statistics showed no significant main effect of word length on the total sum of fixation durations (F(1,13)= 3.138 p= .100).

Word frequency

There was no significant main effect of word frequency on the total sum of fixation durations (F(1,13)= .008 p= .929).

Frequency and length interaction

There was no significant interaction between frequency and length of the words on the mean scores of total sum of fixation durations (F(1,13)= .154 p= .701).

4.3.4. Discussion

In this section, the target words which were presented with five inflectional suffixes, such as *-lErdEkilerden,* were analyzed. This long inflectional suffixes attached to the target words increased the complexity of the words by making them too long. The results showed an influence of word length on the first fixation duration measure and gaze duration measures, which was most probably related to the lexical access to the word. Word length did not have an influence on the total gaze time measure. This might be because only the length of the uninflected stem of the target words were taken into account but when the words got longer and the suffix number attached to the target words increased, refixations and regression numbers increased, too (see Rayner, 1998, 2009; Staub and Rayner, 2007;for a review). This causes so many fixation numbers and durations on the target words and prevents discriminating the effects of word length on this eye movement measure type.

Secondly, there were no impact of frequency and no interaction between length and frequency on all those three types of eye movement measures. This might be because the frequency feature of the words with long inflectional suffixes was not taken into account. The words taking such long inflectional suffixes were all low frequency, which was the reason for not seeing the influence of frequency in all eye movement measures. For the frequency of the uninflected stems, as the letter numbers increased with the suffixation, access to the lexical information of the uninflected stems of those words cognitively got probably hindered (see table 15.).

4.4. Section IV: Type 4 Mixed (Suffixation x Length x Frequency)

This section covers all three word groups mentioned above and compares the effect of inflectional suffix types. As in the three sections above, there are analyses of three types of eye movement measures; i.e. first fixation durations, gaze durations and total sum of fixation durations. Each subsection gives descriptive statistics first, then the results of the analyses of (inflectional) suffixation, word length and frequency are given. In the last subsection, the results of these three eye movement analyses are discussed

4.4.1. First Fixation Durations

The descriptive statistics of the variables, word frequency and length in the first fixation duration analysis across their suffixation feature were stated in section 1, 2 and 3 (see table 4, 8 and 12).

Suffixation

The main effect of suffixation on the first fixation durations was significant (F (2,26) = 4.63 p = .019). The LSD post-hoc test revealed that the first fixation durations on the long (inflectional) suffixed words such as 'gece*lerdekilerden*' (than/from those in nights) (M= 209.5, SD= 14.7) were significantly lower than those of uninflected words (without inflectional suffixes) such as 'gece' (night)) (M= 232.4, SD= 12.6) and lower than those with words with short inflectional suffix such as 'gece*ler*' (nights) (M= 229.3, SD= 12.9) ($p<.05$ in both cases). However, no significant differences were found between the mean scores of the first fixation durations on the uninflected words and word forms with short inflectional suffix ($p>.05$). The first fixation durations on the uninflected word forms were higher than the short suffixed word forms.

Word length

No statistical effect of word length was seen on the first fixation durations in all three types of word groups (F(1,13)= 3.075 p= .103).

Word frequency

Word frequency did not have an effect on the first fixation durations (F(1,13)= 2.352 p= .149).

Suffixation and length interaction

There was a significant interaction between the (inflectional) suffixation condition and length of the words on the scores of first fixation durations F(2,26)= 8.518 p= .001) (See figure 2).

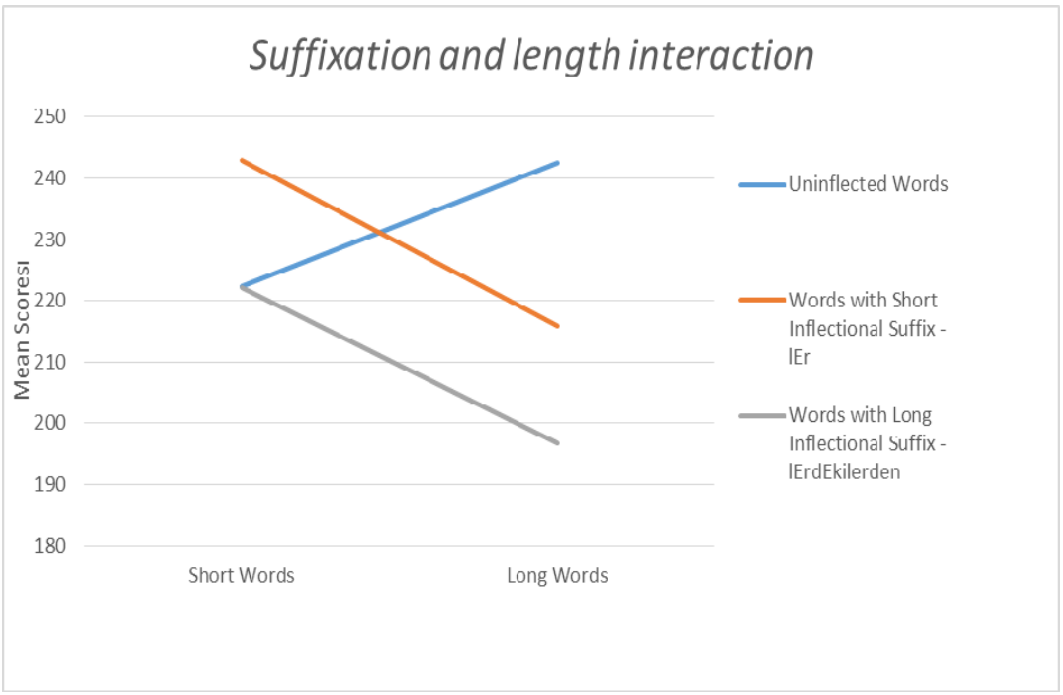

Figure 2. Interaction between the length and suffixation in the analysis of first fixation duration measure

Six paired- samples t-tests were conducted to make post hoc comparisons between the conditions to compare long and short target word categories across (inflectional) suffixation condition. Half of those six pairs showed significant differences, while the other three did not. The mean scores of the long words which do not have any inflectional suffixes showed a significant difference from long words with long inflectional suffixes (t (13) =5.10, p = .000). In the same trend, the mean scores of the long words without inflections and short (inflectional) suffixed form showed significant difference (t (13) =3.27, p = .006). The last pair showing a significant difference in the mean scores of the first fixation durations was on the short suffixed

long words and long suffixed long words (t (13) =2.88, p = .013). The remaining three paired samples t-tests (among the six paired-sample t-tests administered to see the interaction) showed that there were no significant differences in the mean scores of the first fixation durations between the base formed short words, and short suffixed short words (t (13) = -1.75, p >.05) ; suffixless short words and long suffixed short words (t (13) = .01 p >.05); short suffixed short words and long suffixed short words (t (13) =1.79, p >.05).

Suffixation and frequency interaction

There was a significant interaction between suffixation and frequency of the words on the scores of first fixation durations across (inflectional) suffixation condition (F(2,26)= 4.533 p= .020) (See figure 3).

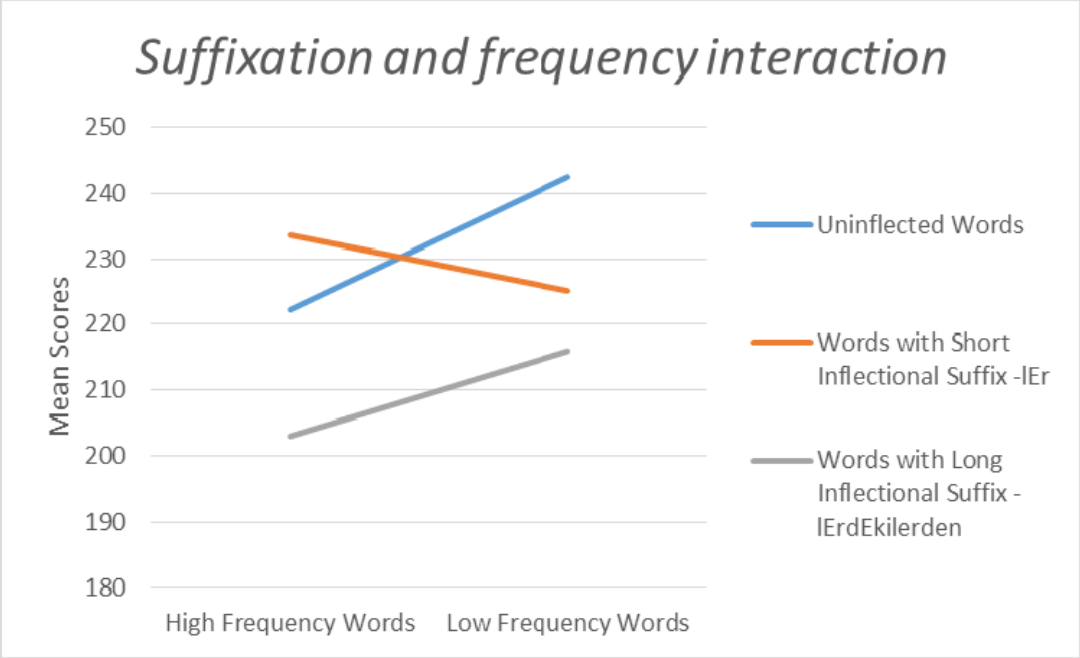

Figure 3.Interaction between the frequency and suffixation in the analysis of first fixation duration measure

Six paired samples t-tests were run to examine further between the inflectional conditions to compare high frequency and low frequency target word categories across inflection types. While four of the pairs were significantly different, the other two were not. The mean scores of the (inflectional) suffixless and high frequency words; and high frequency and inflected with long suffixes words showed significant difference (t (13) =2.40, p = .032). Likewise, the mean scores of low frequency words without inflectional suffixes displayed significant differences between the word groups of low frequency and suffixed with the short inflectional suffix *–lEr* (t (13) =2.19, p = .047); and low frequency words with long inflectional suffix -

lErdEkilerden (t (13) =2.77, p = .016). Moreover, the mean scores of high frequency word groups with short inflectional suffix -*lEr* and high frequency words with long inflectional suffixes -*lErdEkilerden* were significantly different (t (13) =3.58, p = .003). The remaining two paired samples t-tests showed that there were no significant differences between the mean scores of the high frequency words without suffixes and high frequency words with –*lEr,* short inflectional suffix, (t (13) = -1.37, p >.05) ; low frequency words with -*lEr* suffix and low frequency words with –*lErdEkilerden,* long inflectional suffix, (t (13) =1.19, p >.05).

Frequency and length interaction

There was no significant interaction between frequency and length of the words across (inflectional) suffixation condition on the mean scores of first fixation durations (F (1,13) = 0.52 p = .483).

Suffixation, length and frequency interaction
There was no significant three-way interaction between suffixation, frequency and length of the words on the scores of the first fixation duration (F (2,26) =.518 p = .602).

4.4.2. First Pass Reading Analysis

The descriptive statistics of the variables, frequency and length, of each word categories in first pass reading analysis were given in table 5, 9 and 13 above.

Suffixation

The main effect of suffixation in the first pass reading was significant (F (1,13) = 22.016 p= .000). The LSD post-hoc test revealed that the first pass reading scores on the long suffixed words (M= 768.4, SD= 113.7) were significantly higher than those of uninflected formed (M= 341, , SD= 30, 6) and short suffixed words (M= 430.9, SD= 42.3) (p<.05 in both cases). Similarly, there were significant differences between the mean scores of the gaze durations on the words without inflectional suffixes and short (inflectional) suffixed word forms (p< .05).

Word length

Word length affected significantly the gaze durations across (inflectional) suffixation conditions (F(1,13)= 11.545 p= .005). Further examination, the LSD post-hoc test, indicated that the gaze durations on the short words (M= 470.5, SD= 50.5) was lower than the long words in all word types (according to their inflection condition) (M= 556.4, SD= 71.6).

Word frequency

Word frequency had a statistically significant impact on the gaze durations on the target word in all word types (F(1,13)= 9, 012 p= ,010). The fixation durations in

first pass reading on the high frequency words (M= 494, 6, SD= 59) were lower than the low frequency words' (M= 532, 3, SD= 62, 8)

Suffixation and length interaction

There was no significant interaction between suffixation condition and length of the words on the scores of gaze durations (F (1,16) = 2. 488 p= .128).

Frequency and length interaction

No significant interaction between frequency and length of the words were observed on the mean scores of gaze durations (F (1,13) =1.065 p= .321).

Suffixation and frequency interaction

Frequency and (inflectional) suffixation condition of the words did not show a significant interaction on the scores of gaze durations (F(2,26)= 1.210 p= .314).

Suffixation, length and frequency interaction

There was no significant three-way interaction between (inflectional) suffixation condition, frequency and length of the words on the scores of the gaze durations (F(2,26)= 1.008 p= .379).

4.4.3. Total Sum of Fixation Durations

Table 6, 10 and 14 above show the descriptive statistics of frequency and length of the word categories in total sum of fixation durations analysis across inflection condition of the words.

Suffixation

Suffixation condition (inflectional) showed a statistical impact on the total sum of fixation durations (F(1,13)= 21.876 p= .000). According to the LSD post-hoc test results, the total sum of fixation durations on the words with long inflectional suffixes (M= 906.4, SD= 138.6) were significantly higher than those of uninflected word groups (M= 384.1, SD= 37.1) and words with short inflectional suffix (M= 496.2, SD= 51.8) ($p<.05$ in both cases). Similarly, there were significant differences between the mean scores of the total sum of fixation durations on the word groups without inflectional suffixes and word forms with short inflectional suffix ($p< .05$).

Word length

There was a significant main effect of word length on the total sum of fixation durations (F(1,13)= 10.242 p= .007). Further investigation, the LSD post-hoc test, indicated that the total sum of fixation durations on the short words in all types of words (M= 534.3, SD= 58.4) was lower than the long words (M= 656.9, SD= 90.7).

Word frequency

A significant main effect of word frequency was seen on the total sum of fixation durations on the target words in all (inflectional) suffixation conditions (F(1,13)= 14.740 p= .003). The total sum of fixation durations on the high frequency words (M= 571.5, SD= 74.2) was lower than the low frequency words (M= 619.6, SD= 7).

Suffixation and length interaction

There was no significant interaction between suffixation and length of the words on the scores of first fixation durations (F(1,18)=3.421 p= .68).

Frequency and length interaction

There was no significant interaction between frequency and length of the words on the mean scores of total sum of fixation durations (F(1,13)= .758 p= .400).

Suffixation and frequency interaction

There was no interaction between frequency and (inflectional) suffixation of the words on the scores of total sum of fixation duration (F(2,26)=2 .217 p= .129).

Suffixation, length and frequency interaction

There was no significant three-way interaction between (inflectional) suffixation, frequency and length of the words on the scores of the total sum of fixation durations (F(2,26)= .166 p= .848).

4.4.4. Discussion

This section enabled us to see the overall results that were stated in the previous sections comparing them under the suffixation type. First of all, significant main effect of (inflectional) suffixation condition was observed; i.e. fixation durations of the long inflectional suffixed words were significantly lower than both the uninflected words and words with short inflectional suffix on the first fixation measure. This was because the first fixation analysis mostly measures the lexical access; i.e. the longer the words are formed especially with (inflectional) suffixation, the more fixation points (durations) they require to acquire the word (see Rayner 1998, 2009). However, the results of the gaze durations and total sum of fixation durations showed that as the words got longer, the refixations on them increased by enhancing the fixation durations. We obtained significant differences between the words with long inflectional suffixes, uninflected words and words with short inflectional suffix.

Apart from the influence of (inflectional) suffixation condition of the target words on eye movements, both length and frequency (length and frequency of the uninflected stem of the whole word) effect was observed in all the three experiments mentioned above. Short words were fixated shorter than the long word in the gaze duration and total sum of fixation duration analyses. However, there existed no influence of the word length on the first fixation duration, which might be because only the frequency of the uninflected stem was focused but the frequency of the whole word with inflections was not examined; i.e. in the first fixation point, perception of the morphological information of the target word was not probably complete.

Similarly, as parallel with the literature, frequency had an effect on the analyses of eye movements on the first pass reading time and total gaze time; i.e. low frequency words were fixated longer than the high frequency words. The reason why there was no impact of word frequency on the first fixation measure might be because only the frequency information of the uninflected stem of the whole target word was studied. Lastly, there were no interaction between the variables of word frequency and length.

Finally, there were only two two-way interactions with respect to the first fixation measure; which were the interactions between the suffixation and word length and also (inflectional) suffixation and word frequency on the first fixation analyses. For the first interaction, the further examinations showed that uninflected long words were fixated significantly longer than the inflected words with long inflectional suffixes and also words with short inflectional suffix. In addition, the participants fixated significantly more on the long words with short inflectional suffix than long words with long inflectional suffixes. Secondly, the analyses for the interaction between the inflectional condition and word frequency showed that uninflected high frequency words were fixated longer than high frequency words with long inflectional suffixes. Moreover, the first fixation durations on low frequency words with the short inflectional suffix were shorter than both the low frequency words without inflectional suffixes and low frequency words with long inflectional suffix. Lastly, *t*he mean scores of high frequency words with short inflectional suffix were longer than high frequency words with long inflectional suffixes (see table 16).

Table 16.

Summary Table of Section 4:Mix Type (Across (Inflectional) Suffixation Condition)

Type 4 Mixed (Suffixation x Length x Frequency)	**First-fixation Time (FF)**	**First-pass Time (FG)**	**Total Gaze Time (TG)**
Main effect of **Suffixation**	(F(2,26)= 6. 855 p= .004); fixation duration on words without inflectional suffixes >words with -lErdEkilerden suffixes ; words with -lEr suffixes > words with -lErdEkilerden suffixes	(F(1, 13)= 22.016 p= .000); fixation duration on words without inflectional suffixes < words with -lEr suffixes; fixation duration on words without suffixes < words with -lErdEkilerden suffixes ; words with -lEr suffixes < words with -lErdEkilerden suffixes	(F(1,13)= 21.876 p= .000); fixation duration on words without inflectional suffixes < words with -lEr suffixes; fixation duration on words without suffixes < words with -lErdEkilerden suffixes; words with -lEr suffixes < words with -lErdEkilerden suffixes
Main effect of **Length**	No Effect	(F(1,13)= 11.545 p= .005); fixation duration on short words < long words	(F(1,13)= 10.242 p= .007); fixation duration on short words < long words
Main effect of **Frequency**	No Effect	(F(1,13)= 9.012 p= .010); fixation duration on high frequency < low frequency	(F(1,13)= 14.740 p= .003); fixation duration on high frequency < low frequency
Length & Frequency Interaction	No Effect	No Effect	No Effect
Suffixation & Length Interaction	(F(2,26)= 8. 518 p= .001); uninflected long words> inflected words with long inflectional suffixes; uninflected long words> short inflectional suffix; long words with short inflectional suffix > long words with long inflectional suffixes	No Effect	No Effect

Table 16 (cont.)

Type 4 Mixed (Suffixation x Length x Frequency)	**First-fixation Time (FF)**	**First-pass Time (FG)**	**Total Gaze Time (TG)**
(Inflectional) Suffixation Condition & Frequency Interaction	(F(2,26)= 4.533 p= .020); uninflected high frequency words > high frequency words with long inflectional suffixes; low frequency words with the short inflectional suffix < the low frequency words without inflectional suffixes; low frequency words with the short inflectional suffix < low frequency words with long inflectional suffix –lErdEkilerden; high frequency words with short inflectional suffix –lEr > high frequency words with long inflectional suffixes –lErdEkilerden	No Effect	No Effect
(Inflectional) Suffixation & Length & Frequency Interaction	No Effect	No Effect	No Effect

CHAPTER 5

GENERAL DISCUSSION

This thesis was focused on the factors that have an impact on eye movement parameters in reading. The variables word-length and word-frequency were chosen. The first reason for analyzing these features was that they have been the most studied variables in the literature about eye movement studies in reading. The second and the most prominent reason was that as doing reading studies with a cognitive science approach, these computational characteristics of the words (including predictability (sentential frequency)) become notable.

The target words were presented in a context to the participants. There were three types of word groups; the first one included the uninflected words, the second one covered the words with a short inflectional suffix, *-lEr*, and the last groups consisted of the words with long inflectional suffixes, *-lErdEkilerden*. However, the frequency and length information came from the uninflected stem of the whole target word in each of these word groups. In other words, for example the frequency or length information belonged to the uninflected stem 'kıta' in the two inflected groups 'kıta*lar*' (continents) and 'kıta*lardakilerden*' (than/from those in/on continents); i.e. the frequency or length information of the whole stem of 'kıta*lar*' or 'kıta*lardakilerden*' was not taken into account.

In order to examine the eye movements to interpret the human information processes in a more clear way in reading, fixation durations were analyzed. The analyses of first fixation durations, gaze durations in the first pass reading, and total sum of fixation durations were chosen as the eye movement measures in this thesis. Although both word length and frequency were assumed to have an effect on the fixation durations, its impact might change according to different eye movement measures; i.e. first fixation durations had a different role than the other two eye movement measures; first pass reading gaze durations and total sum of fixation durations, which might include more than one fixation. For instance, word length might show the opposite results on the first fixation duration than first pass reading gaze durations. The first fixation durations on the long target words might be shorter than the fixation durations on the short words. This would be an opposite result of the gaze durations, where the fixation durations on the long words would be longer than the short words.

The hypothesis one, that longer words would be fixated longer than the shorter words was partially confirmed in the analyses of all the three word types excluding the first fixation durations. When each word category was examined separately, first pass reading time analyses of the words with short and long inflectional suffixes and also total sum of fixation duration analyses of word types with short inflectional suffix

showed similar results with the analysis of all word groups together that fixation durations on longer words were longer than the shorter words. On the other hand, the reason why there were no significant main differences of length on the words with long inflectional suffixes might be that we did not taken into consideration the length of the whole stem with long inflectional suffixes. There was a tendency to have several fixation points and rereading of the long inflected words. As the words became longer (4+13 letters or 8 + 13 letters), the fixations increased by closing the gap between the short and long stemmed word too much to make a difference. Secondly, the uninflected words did not show significant main difference, which might be because the difference between the word-length as short words (4 letters) and long words (8 letters) was not large enough to make a significant difference. On the other hand, for the first fixation durations, these results were the opposite of the other eye movement measures such as gaze durations and total sum of fixation durations, i.e. the shorter words were fixated longer than the longer words in the word groups with short and long inflectional suffixes. The reason behind this might be that the longer words need second and further fixations because of the cognitive processing to perceive the words (lexical processing) while the shorter ones might need less further fixation points (and durations). Thus the longer the words became, the more fixation points occur on that word; so because there would be more fixation points, the first fixation durations become shorter. However, the durations of the first fixations on the short words were longer, because there were not many further fixation durations on the short words and cognitive processing for these words would occur starting from the first fixation.

The hypothesis two was that as the word-frequency got higher, the fixation times would be shorter, which was partially confirmed by the results of the analyses of first pass reading time and total sum of all fixation duration. The results of the uninflected word type and groups of words with short inflectional suffix analyses indicated that the fixation durations on the low frequency words were higher than the high frequency words in the three types of eye movement measures. However, there were no significant main differences of word-frequency in the first fixation durations. This might be because of the fact that as the words took inflectional suffixes, the focus might shift to the inflections, which might prevent the effect of frequency of the uninflected stem. Another explanation might be that the frequency feature of the inflected words as total might have a role rather than the frequency of the uninflected stem of the inflected words for example in the 'gece*ler'*, only the frequency of 'gece' was taken into consideration in this thesis but not 'gece*ler*' as a whole, but some words might be used more in their suffixed forms than in their non-suffixed forms in written Turkish language. In addittion, as we did not take into account the frequency and length effect of whole stem in the word groups with inflectional suffixes by considering only the frequency and length of the uninflected stems of all the words; long inflectional suffixes by creating such long words such as 'gazeteci*lerdekilerden'* (than/from those in/on journalists), most probably removed the frequency effect of the uninflected stem, e.g. 'gazeteci' (journalist), of the long words (with long inflectional suffixes).

The last hypothesis, that the fixation durations would be parallel with the length of the inflectional suffixes, was partially supported with the results for the first pass reading analysis and total sum of all fixation duration analyses by showing that longer fixation durations were observed on the words taking longer inflectional suffixes. On the other hand, the results of the first fixation time analysis did not

indicate the same results with these two measures; i.e. the first fixation durations were from longest to shortest on the uninflected words, inflected words with short inflectional suffix and inflected words with long suffixes, respectively. This might be explained with that as the word length increased, which was because of the inflectional suffixes, the fixation point number increased and the durations of the first fixations decreased; since the process would be completed with more than one fixation points and needed for other upcoming fixations on the target words. There were also two interactions between the word length and inflectional suffixation and word frequency and inflectional suffixation in the first fixation duration analyses. Word length and inflectional suffixation results showed that as the length of the whole stem increased, the first fixation duration landing on the target word decreased, since it needed more fixations to process the word. The interaction between the word frequency and inflectional suffixation showed the tendency that as the words took inflectional suffixes, the frequency information of the uninflected stem of this word disappeared; e.g. the fixation durations on the uninflected high frequency words were shorter than high frequency words with long inflectional suffixes or uninflected low frequency words were significantly lower than the low frequency words with long inflectional suffixes. However, if the (estimated) frequency information of the whole stems including all the suffixes were taken into account and also controlled, an effect of frequency might be seen on these word groups.

Eye movement modelling was beyond the scope of this thesis. However, Turkish has a potential to provide appropriate data to review the basic assumptions of the models and provide generalizability to other languages. The primary reason was that taking into account only the characteristics of the uninflected stems of the whole words taking a large number of inflectional suffixes made it hard to reach the uninflected stem of the word by parsing the words and process this word. The attention was assumed to be at first on the whole word as a complete stem and then it shifted to the inflectional suffixes. On the other hand, the findings of this thesis exhibited that first fixation measure of eye movement analysis on word length displayed contradictory results from other measures such as gaze durations in the first pass reading and total sum of fixation durations; i.e. the first fixation duration on the longer words were shorter than the shorter words in the analyses of inflected word groups in reading Turkish sentences. Since the effect of word length was not investigated in detail in the eye movement models in the literature, this thesis, specific to Turkish, has a potential to contribute to this gap.

This study might help eye movement models to be reviewed and developed that they investigate the process of word identification by measuring and modeling attention as an overt process, particularly eye movement control. Since Bicknell and Levy (2012a) said that major reading models of eye movement control did not model word identification from visual input clearly, the results showing that word frequency and word length of the uninflected stems had an effect on when to move the eyes might make contributions to the computational field of reading studies in cognitive science. Length and frequency characteristics of the words might determine the difficulty of the text by raising the attentional process. The findings of this thesis in the analyses of gaze duration and total sum of fixation durations showed that these models of eye movements in reading such as SWIFT and E-Z Reader model, could implement their mechanisms for eye movements in reading Turkish. Although Turkish language has

a different morpho-syntactic structure (and also control of word frequency and word length was determined by the uninflected stem of the target words), the results showed parallel findings with the literature about reading up to now; i.e. Turkish words' complexity increased as the frequency of the uninflected stem decreased and length of the uninflected stem increased. As Henderson (2012) said that the allocation of attention was reflected (measured) by fixation locations and duration, the fixation durations on the target words in this study exhibited that frequency and length influenced the attentional process during reading.

5.1. Conclusion

To sum up, this thesis explored whether the word features frequency and length affect eye movement parameters during reading. Length feature had two types in this study which were the length of the bare stem (uninflected part of the whole word) which was called "length" and length of the inflectional suffix(es). Length of the words because of the inflectional suffix(es) was analyzed under the 'suffixation' effect, and it had an impact on eye movements in reading. The eye movements were investigated under three parts (measures) as first fixation durations, in which on the first fixations on the environment of the target words while reading, gaze durations in the first pass reading, which included all the fixation durations recorded starting from the first fixation until the eyes left the environment of the target word, and total sum of al fixation durations which cover all the fixation durations landing on the environment of the target word including re-reading times. The length and frequency information of the target word in all word groups belonged to only the uninflected stem of the whole word; i.e. the frequency and length of the inflected words were not taken into consideration. As conclusion, as in the literature, this study showed an impact of certain word features such as word frequency and length on eye movements in reading Turkish sentences, however these effects were not observed clearly in the inflected (especially the words with long inflectional suffixes) word groups since effects of these word features of the uninflected stems disappeared as the words were attached suffixes. The first fixation durations had adverse influence on the word length from the measures of first pass reading gaze durations and total sum of fixation durations. First fixation durations on the short words were longer than the long words while sum of fixation durations on the longer words were longer than the shorter words.

5.2. Limitations and Recommendations for Future Studies

Although this thesis showed some expected results on fixation durations in reading Turkish sentences which were parallel with the literature in other languages, it had some limitations which may lead interested and eager researchers to do further investigations about the factors affecting eye movements in reading in Turkish. First of all, we did these studies with a 120 Hz eye tracker, its analyses was manual and difficult. We think that this study need to be replicated with an apparatus which has a higher sampling frequency.

Another limitation concerns the materials used in the experiments. Firstly, there were words with derivational suffixes among the target words. The stems of the words

were not controlled for instance, derived words (e.g. ‘bakanlık’ (ministry) were not excluded or some words were domain specific terms (e.g. ‘potasyum’ (potassium)). Including these words with derivational suffixes was adopted as a working assumption. These assumptions should be addressed in future researches. Thus, more homogenous materials should be used in the next step; i.e. all the target words should have the same characteristics e.g. target words with no derivational suffixes. In addition, frequency information of the whole stem with all suffixes should be considered and controlled to see the effect of word frequency. Then, when controlling the length of the words, besides character number; numbers of syllables or morphemes might also be taken into account and controlled. Since there was not an average percentage between the short inflectional suffix (3 letters) and long inflectional suffixes (13 letters). Lastly, these character numbers of the inflectional suffixes might be controlled in further researches.

The predictability (sentential frequency) feature of the words was not taken into account and controlled, which would be one of the preliminary steps for further studies.

In addition, interrogative and interjective sentences were included among the experimental items, too; i.e. there were no restrictions on the sentence formation type.

Another limitation might be the number of the participants. Since the analyses of the data took too much time for the experimenter, not many participants could be included in the study.

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APPENDICES

Appendix A: Gönüllü Katılım Formu

Bu deney, Yrd. Doç. Dr. Cengiz Acartürk danışmanlığında, Orta Doğu Teknik Üniversitesi Enformatik Enstitüsü Bilişsel Bilimler ABD yüksek lisans tezi kapsamında Emine EREN tarafından yürütülen Türk dili üzerine bir çalışmadır. Çalışmanın amacı okumada bilişsel süreçlerin incelenmesi adına göz hareketleri kontrol modellemesi için Türkçe okuma örüntüleri derlemi oluşturmaktır. Çalışmaya katılım tamimiyle gönüllülük temelinde olmalıdır. Çalışmada, sizden kimlik belirleyici hiçbir bilgi istenmemektedir. Cevaplarınız tamamıyla gizli tutulacak ve sadece araştırmacılar tarafından değerlendirilecektir; elde edilecek bilgiler bilimsel yayımlarda kullanılacaktır.

Deney, genel olarak kişisel rahatsızlık verecek ögeler içermemektedir. Ancak, katılım sırasında okuduğunuz cümlelerden ya da herhangi başka bir nedenden ötürü kendinizi rahatsız hissederseniz deneyi yarıda bırakıp çıkmakta serbestsiniz. Böyle bir durumda deneyi uygulayan kişiye, çalışmayı tamamlamadığınızı söylemek yeterli olacaktır. Deney sonunda, bu çalışmayla ilgili sorularınız cevaplanacaktır. Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için İngiliz Dili Öğretimi bölümü araştırma görevlisi Emine EREN (Oda: B14; Tel: 05372387360 ; E-posta: emineeren89@gmail.com) ile iletişim kurabilirsiniz.

Bu çalışmaya tamamen gönüllü olarak katılıyorum ve istediğim zaman yarıda kesip çıkabileceğimi biliyorum. Verdiğim bilgilerin bilimsel amaçlı yayımlarda kullanılmasını kabul ediyorum. (Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

İsim Soyad Tarih İmza

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APPENDİX B: DEMOGRAFİK VERİ FORMU

Adınız- Soyadınız:

Yaşınız:

Medeni Durumunuz:

Eğitim durumunuz:

Anadiliniz:

Bildiğiniz Yabancı Diller:

Mesleğiniz:

Öğrenciyseniz;

Kurumunuz/Okulunuz/Üniversiteniz:

Bölümünüz/Branşınız:

Sınıfınız:

İmza:

Appendix C.

Appendix C. *Word Category List Across Inflections*				
Short & High Frequency				
Base Word (Words Without Inflectional Words)		Words with short inflectional Suffix, *-lEr*		Words with long inflectional Suffix, *-lErdEkilerden*
gece 'night '		gece*ler 'nights'*		gece*lerdekilerden 'than/from those in/on nights'*
ürün 'product'		ürün*ler 'products'*		ürün*lerdekilerden 'than/from those in/on products'*
ağaç 'tree'		ağaç*lar 'trees'*		ağaç*lardakilerden 'than/from those in/on trees'*
okul 'school'		okul*lar 'schools'*		okul*lardakilerden 'than/from those in/on schools'*
kişi 'person'		kişi*ler 'persons'*		kişi*lerdekilerden 'than/from those in/on persons'*
saat 'clock'		saat*ler'clocks'*		saat*lerdekilerden 'than/from those in/on clocks'*
aile 'family'		aile*ler 'families'*		aile*lerdekilerden 'than/from those in/on families'*
ayak 'foot'		ayak*lar 'feet'*		ayak*lardakilerden 'than/from those in/on feet'*
adam 'man'		adam*lar 'men'*		adam*lardakilerden 'than/from those in/on men'*
anne 'mother'		anne*ler 'mothers'*		anne*lerdekilerden 'than/from those in/on mothers'*
halk 'public'		halk*lar 'publics'*		halk*lardakilerden 'than/from those in/on publics'*
akıl 'mind'		akıl*lar 'minds'*		akıl*lardakilerden 'than/from those in/on minds'*

Appendix C.(cont.)

Short & Low Frequency

Base Word (Words Without Inflectional Words)	Words with short inflectional Suffix, *-lEr*	Words with long inflectional Suffix, *-lErdEkilerden*
kıta 'continent'	kıta*lar 'continents'*	kıta*lardakilerden 'than/from those in/on continents'*
ödev 'homework'	ödev*ler 'homework'*	ödev*lerdekilerden 'than/from those in/on homework'*
reis 'chief'	reis*ler 'chiefs'*	reis*lerdekilerden 'than/from those in/on chiefs'*
sızı 'ache'	sızı*lar 'aches'*	sızı*lardakilerden 'than/from those in/on aches'*
kuzu 'lamb'	kuzu*lar 'lambs'*	kuzu*lardakilerden 'than/from those in/on lambs'*
baca 'chimney'	baca*lar 'chimneys'*	baca*lardakilerden 'than/from those in/on chimneys'*
kazı 'excavation'	kazı*lar 'excavations'*	kazı*lardakilerden 'than/from those in/on excavations'*
etek 'skirt'	etek*ler 'skirts'*	etek*lerdekilerden 'than/from those in/on skirts'*
fert 'individual'	fert*ler 'individuals'*	fert*lerdekilerden 'than/from those in/on individuals'*
ayin 'ritual'	ayin*ler 'rituals'*	ayin*lerdekilerden 'than/from those in/on rituals'*
takı 'jewelry'	takı*lar 'jewelries'*	takı*lardakilerden 'than/from those in/on jewelries'*
kale 'castle'	kale*ler 'castles'*	kale*lerdekilerden 'than/from those in/on castles'*

Appendix C. (cont.)

Long & High Frequency

Base Word (Words Without Inflectional Words)	Words with short inflectional Suffix, *-lEr*	Words with long inflectional Suffix, *-lErdEkilerden*
otomobil 'automobile'	otomobil*ler* *'automobiles'*	otomobil*lerdekilerden 'than/from those in/on automobiles'*
davranış 'behavior'	davranış*lar* *'behaviors'*	davranış*lardakilerden 'than/from those in/on behaviors'*
fotoğraf 'photograph'	fotoğraf*lar* *'photographs'*	fotoğraf*lardakilerden 'than/from those in/on photographs'*
gazeteci 'journalist'	gazeteci*ler* *'journalists'*	gazeteci*lerdekilerden 'than/from those in/on journalists'*
sıcaklık 'temperature'	sıcaklık*lart* *'emperatures'*	sıcaklık*lardakilerden 'than/from those in/on temperatures'*
istikrar 'stability'	istikrar*lar* *'stabilities'*	istikrar*lardakilerden 'than/from those in/on stabilities'*
öğretmen 'teacher'	öğretmen*ler* *'teachers'*	öğretmen*lerdekilerden 'than/from those in/on teachers'*
elektrik 'electricity'	elektrik*ler* *'electricities'*	elektrik*lerdekilerden 'than/from those in/on electricities'*
politika 'politics'	politika*lar* *'politics'*	politika*lardakilerden 'than/from those in/on politics'*
toplantı 'meeting'	toplantı*lar* *'meetings'*	toplantı*lardakilerden 'than/from those in/on meetings'*
belediye 'municipality'	belediye*ler* *'municipalities'*	belediye*lerdekilerden 'than/from those in/on municipalities'*
enflasyon 'inflation'	enflasyon*lar* *'inflations'*	enflasyon*lardakilerden 'than/from those in/on inflations'*

Appendix C.(cont.)

Long & Low Frequency				
Base Word (Words Without Inflectional Words)		Words with short inflectional Suffix, *-lEr*		Words with long inflectional Suffix, *-lErdEkilerden*
canlılık 'vividness'		canlılık*lar 'vividnesses'*		canlılık*lardakilerden 'than/from those in/on vividnesses'*
hükümdar 'sovereign'		hükümdar*lar 'sovereigns'*		hükümdar*lardakilerden 'than/from those in/on sovereigns'*
bakanlık 'ministry'		bakanlık*lar 'ministries'*		bakanlık*lardakilerden 'than/from those in/on ministries'*
istasyon 'station'		istasyon*lar 'stations'*		istasyon*lardakilerden 'than/from those in/on stations'*
aktivite 'activity'		aktivite*ler 'activities'*		aktivite*lerdekilerden 'than/from those in/on activities'*
orkestra 'orchestra'		orkestra*lar 'orchestras'*		orkestra*lardakilerden 'than/from those in/on orchestras'*
potasyum 'potassium'		potasyum*lar 'potassiums'*		potasyum*lardakilerden 'than/from those in/on potassiums'*
egzersiz 'exercise'		egzersiz*ler 'exercises'*		egzersiz*lerdekilerden 'than/from those in/on exercises'*
buhurdan 'censers'		buhurdan*lar 'censers'*		buhurdan*lardakilerden 'than/from those in/on censers'*
çamurluk 'fender'		çamurluk*lar 'fenders'*		çamurluk*lardakilerden 'than/from those in/on fenders'*
külliyat 'corpus'		külliyat*lar 'corpora'*		külliyat*lardakilerden 'than/from those in/on corpora'*
saltanat 'sultanate'		saltanat*lar 'sultanates'*		saltanat*lardakilerden 'than/from those in/on sultanates'*

APPENDIX D.

STIMULI OF READING STUDY IN TURKISH

Short & High Frequency Word Group

1) **Kişi**

Çünkü her gün birkaç kişi radyoyu arayıp bunu soruyormuş

Özgüveni yetersiz kişiler kendilerine güvenmedikleri için sorumluluk almaktan çekinirler

Bu virüs ile enfekte insanlarda mide kanseri ihtimali, enfekte olmayan kişilerdekilerden daha düşük.

2) **Adam**

Yol çok uzundur, nice dağlar, ovalar aşarlar ve bir noktaya geldiklerinde adam burnuna çok güzel yemek kokuları geldiğini fark eder.

Bu kez kuklalara saldıran çocuğa çevreden gelen adamlar saldırır ve dayak atarlar.

Arkadaşının filmdeki adamlardakilerden bile çok kasları olduğunu söyledi.

3) **Anne**

Neden ne olursa olsun anne doğumu takip eden birkaç yıl boyunca tam gün çalışma isteyen bir yerde çalışmamalıdır.

Şimdi biz büyük bir apartmanda oturduğumuz için bu çevrede yaşayan bütün anneler anlaşmış gibiyiz.

Bebeklerdeki tüm plazma düzeyleri annelerdekilerden çok daha düşüktür.

4) Saat

Yemek sonrası özellikle akşamları yarım saat düz yolda yürüyüş yapılmalı.

Uzun süren ameliyattan saatler sonra narkozun etkisi altında gözümü açtığımda ilk işim, elimi sol bacağıma götürmek oldu.

Bildiğin Alkazar'a gidip planımı yapardım; filmlere bakıp, uygun saatlerdekilerden birini seçer ve seyrederdim.

5) Gece

Kocasının işi gereği her gece geç gelmesine alışıktı, anlaşılan bugün de aynısı olacaktı.

Sabaha yakın yatağa girdiğimde çoğu geceler elime yemek kitapları alır, onlarla oyalanırken uykuya dalarım.

Bu gündüz uykularının rüyalarının gecelerdekilerden bir farkı var mı acaba?

6) ürün

Bu bitki türü düşük ışık ve ısı koşullarında çiçek açtığından özellikle tek ürün yetiştiriciliği için önerilmektedir.

Tescilli markası olan ve olmayan ürünler arasında süre gelen problem, İngiltere için oldukça hassas bir konumdadır.

Genetiğiyle oynanmış yiyeceklerin üzerindeki mikro gözenekler muadili ürünlerdekilerden çok fazla olduğundan tercih edilmemeli.

7) aile

O günün ortamında azınlıklar arasında karışmamış aile bulmak hemen hemen olanaksızdı.

Yan proleter durumda bulunan aileler sefalet yüzünden dağıldığı zaman, devlet ya da toplum bunlara hiçbir zaman yardımcı olmaz

Akrabalar arasındaki benzerlik, aralarında herhangi bir akrabalık bağı olmayan ailelerdekilerden daha çok dağılım gösterir.

8) Halk

Tanzimat yönetimi geniş halk kesimlerinin hayatında kayda değer bir iyileştirme sağlayamamıştır.

Tarihsel gelişimi içinde ezilen halklar kendi meşru şiddetlerini uygulamaya başladılar.

Onların kurtuluş hikâyesi öbür halklardakilerden göz dolduracak seviyede daha trajiktir.

9) akıl

Bu sebepten kendi başına gaye olarak akıl sahibi bir varlık kavramı, en yüksek pratik bir prensip veya kanun için temel olur

Kendi özlerindeki yeti içinde doğal olarak gelişen ve varlığını ortaya koyabilen akıllar toplumda istenen sinerjinin, yaratıcı gücün kaynağı olurlar.

Sözü geçen hastanede kullanılan kan alma yöntemleri çok daha steril akıllardakilerden çok farklı.

10) Ayak

Köye doğru, biçilmiş ekin tarlalarının içinde ayak sesleri duydum.

O kadar zamandır yol kat-eden yorgun ayaklar bedenlerini taşıyabilecek durumda değildiler.

Ellerde bulunan tırnaklar ayaklardakilerden daha hızlı uzar.

11) ağaç

Ömrü hayatında bir tane bile ağaç dikmemiş olanları mı, çocuklarını ısrarla okutmayan, istemedikleri kişilerle evlenmeye zorlayanları mı anlatmalıyım bilmiyorum.

Genellikle sahillere peyzaj amaçlı dikilen ağaçlar kuvvetli bir fırtına ile karşı karşıya kaldığında kolayca devrilebilmektedir.

Genç yaşlardakilerin kozalakları yaşlı ağaçlardakilerden daha büyüktür ve tohumları daha çoktur.

12) okul

Ertesi sabah bütün okul benim başıma toplanmıştı.

Bu zamana kadar parça parça kurulmuş olan ve kurulması düşünülen okullar eğitim sistemi çerçevesinde tamamen teşkilatlandırılıyordu.

Buradaki talebeleri diğer okullardakilerden ayıran özelliklerden biri, bütün çocukların elinde beyaz bastonlar olmasıydı.

Short & Low Frequency Word Group

1) **Kazı**

Eserleri bana gösterdiğinde kazı sırasında çekilen resimleri de vermişti.

Bugün çeşitli vesilelerle yapılan kazılar yıllar önce yapılan bu vahşeti gözler önüne sermiştir.

Asit kuyularında başlatılan kazılardakilerden kemik çıkmasının ardından bölgede geniş bir tarama başlatıldı.

2) **Etek**

Gerçekten benim etek giymem seni rahatsız ediyorsa, burada oldukça derin bir sorunumuz var.

Tekerlekler dönerken etekler uçuşmayınca, pedallara basmak hiç gelmiyor içimden.

Bugün taktığı kemer diğer eteklerdekilerden daha ışıltılı ve renkliydi.

3) **Kıta**

Bu bağlamda, Afrika'nın küreselleşme olgusunun en fazla dışında kalan kıta oluşu da üzerinde düşünmeye değer.

Hindistan'ın zenginliği ve görkemiyle gözleri kamaşan bu büyük kral, bu topraklara ulaşmak için ordusuyla kıtalar aşmayı göze almıştı.

Güneydeki hayvanların diğer kıtalardakilerden bağımsız bir şekilde evrimleşebildikleri bir dönemde yaşıyordu.

4) Fert

Anatomik ve fizyolojik yönden farklı olan fert grupları cemiyette bu farklı yapılarına uygun değişik görevler yapmaktadırlar.

İster geleneksel isterse modern olsun fertler arası ilişkileri idare eden bu kurallar bireyi etkisi altında bulundururlar.

Diyabetlilerin yaşam süresinin sağlıklı fertlerdekilerden daha kısa olduğunu gösteriyor.

5) Kale

Mermer portalının işlenmiş taşlarından birçoğu kale kapısının duvarlarında kullanılmıştır.

Türkler Anadolu'ya geldiklerinde yeni kaleler kurdukları gibi eskilerini de onararak kullanımlı hale getirmişlerdir.

Selâhaddîn Eyyûbî'nin affına sığınarak kalelerdekilerden her erkek için on, her kadın için beş altın vermek şartıyla anahtarları sultana teslim etti.

6) Ayin

Çok eskilerden kalma bu handa kapının bezeme dağarı, yapının mekânsal dili ve içindeki vecdî ayin birbirini bütünlemektedir.

Sanat yaratmanın miktarı ve hatta kalite seviyesi bile esas olarak dini ayinler için sanata gösterilen talebe bağlı görünmektedir.

Birkaç kişiden oluşan grubuyla her ay düzenlediği bu toplanmalarının başka ayinlerdekilerden daha samimi olduğunu iddia ediyorlar.

7) Ödev

Bu tip hatalar ortaokul ve lise düzeyindeki öğrencilerin yıllık ödev yaparken düştükleri bir hata cinsidir.

Bu ilişki taraflara bazı ödevler yüklediği gibi bazı yetkiler de vermektedir.

Soruları gördüğünde matematikten verilen ödevlerdekilerden daha kolay olduğunu gördü.

8) Reis

Feriköy'de kendisine hiç yüz vermeyen reis şimdi evindeydi ve gösterdiği yerde oturuyordu.

Gelen bu heyetle aşiretlere kumanda eden reisler hep birlikte bir harp meclisi halinde toplandı.

Padişahlık döneminde vezirlerde reislerdekilerden daha fazla tevazuya düşkünlük hali nasıl güzel görülmesin?

9) Sızı

Yalnızlığın insanda yarattığı derin sızı yok olur, yerini paylaşmanın doyulmaz hazzına bırakırdı.

Ben herkese ayrımsız şefkat gösterebilirim fakat bana davranılmadığında içimdeki eski sızılar yeniden acımaya başlar.

İşte o an içimde onca yıl birikmiş emirlerden ve onların yarattığı sızılardakilerden bile çok eski bir yere bu yas gelip yerleşti.

10) Takı

Türkiye ise, yatırımcılardan çok takı alıcılarının etkili olduğu altın piyasasındaki bu gelişimden en çok nasiplenen ülkeler arasında.

Ancak erkek tarafı kız tarafının istediklerini ağır bulursa, aracılarında yardımıyla listedeki takılar azaltılmaya çalışılır.

Düğününde gelen takılardakilerden birkaçını bozdurup eşinin çok istediği televizyonu alabilmişti.

11) Kuzu

Bu kız, babasına da yardım eder, analarından ayrı olarak otlatılan kuzu sürüsünün başında gidermiş.

Yemyeşil çayırlardan ve tarlalardan geçen kuzular gibi şendiler.

Bölgede yapılan araştırmalar, tek doğanların yaşama olasılığının ikiz doğan kuzulardakilerden daha düşük olduğunu gösteriyor.

12) Baca

Büyük şehirlerde sanayi baca gazlarına maruz kalmış ve doğası bozulmuş bitkilerin kullanılmaması gerekir.

Bursa'da çıkan lodos ters yönden estiği için bacalar duman çekmedi birçok kişi kömür dumanından zehirlendi.

İnce uzun olanlardakilerin rüzgarlı havalarda dumanı çekme gücü kısa bacalardakilerden daha yüksektir.

Long & High Frequency Word Group

1) **otomobil**

Her işçi bir parça eklerken, büyük bir hızla otomobil imal edilmiş olacak.

O zaman kentin sokaklarında koca koca otomobiller kaldırımlarda park eder, yayalar nereden yürüyeceklerini şaşırırlarmış.

Uçaktaki frenlerin sayısı bile otomobillerdekilerden kat kat fazladır.

2) **Davranış**

Memelilerde doğuştan getirilen davranış örüntülerinin mevcut olup olmadığı pek çok araştırmaya konu olmuştur.

Bu teoriler toplumların sapmış davranışlar göstermelerindeki farklılıkların nedenini sosyo-kültürel farklılıklar çerçevesinde sosyal bütünleşme kavramı üzerine odaklamaktadırlar.

Dergilerde yönetim konularındaki makaleler daha yaygın olduğu için örgütsel davranışlardakilerden daha fazla yer bulmaktadır.

3) **Fotoğraf**

Cumartesileri tasarlamadan fotoğraf çektiğimi düşünüyordum.

Herhangi bir mekânda çekilen fotoğraflar ait oldukları o zamanın gerçeklikleri olarak yer alırlar.

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4) **Öğretmen**

Kitap okuyan ve kendini geliştiren öğretmen sayısı meslekleriyle bağdaşmayacak derecede düşüktür.

Başarılı deneyimler yaşayan öğretmenler kendi yetenek ve becerileriyle ilgili olarak daha fazla kendine güven duygusu geliştirirler.

Çalışmadaki anketler, müdürlerde gözlemlenen kuruma bağlılığın öğretmenlerdekilerden daha yüksek olması gerektiğini göstermiştir.

5) **Elektrik**

Giriş gücü ya da kapasitör boşalmasının yol açtığı elektrik şoku ve yanıklar ciddi yaralanmalara ya da ölüme yol açabilir.

İlkokul öncesi elektrikler kesildiğinde korktuğumu hatırlıyorum.

Haberlere göre, hava şartlarına bağlı olarak suda yapılan kesintiler elektriklerdekilerden daha kısa sürecekmiş.

6) **belediye**

Büyükşehir statüsündeki il merkezlerimizin belediye hizmet alanları bir daireyle sınırlanmaktadır.

Dolayısıyla diyebiliriz ki, bu alanda yapılacak olan bu tür düzenlemelerle belediyeler önemli bir gelir kaynağına kavuşturulabilir.

Belde olarak şanslıyız mesela bizim işçilerin maaşları diğer illerde yönetilen belediyelerdekilerden epeyce fazla görünüyor.

7) **Politika**

Sistemin bir bütün olarak korunması ulusal politika için bir öncelik haline gelir.

Bu durumda ana konulardan birisi politikalar oluşturma düzlemi ile ara kurumların bağımsızlık düzeyi arasında uyum sağlanmasıdır.

Oysa dışardaki değişiklikler ülkenin geleceği üzerinde etkili iç politikalardakilerden çok ama çok daha önemlidir.

8) **Enflasyon**

Vergi sisteminde vergiye tabi kurumların kazançlarının belirlenmesinde enflasyon muhasebesi uygulanmamaktadır

Büyük değerlerde mizahi enflasyonlar yaşayıp az gelişmişliğine karşın, iktisadi büyüme bir yana, habire küçülen Türkiye'de değişen ne?

Borsada sağlam durabilmek için parasal büyüklüklerdeki dalgalanmaların diğer enflasyonlardakilerden daha önce gerçekleşmiş olması gerekir.

9) **Toplantı**

Tatsız konuların konuşulduğu toplantı bittiğinde odasına gitti.

Bu amaçla zaman zaman ortak toplantılar yapılabileceği gibi, kısa süreli görev değişikliklerine de gidilebilir.

Diğer illerde yapılan toplantılardakilerden daha fazla insan konuşma yapmak için davet edilmişti.

10) Gazeteci

Özel yaşamımda alışveriş ettiğim yerlerde fiyat sormaktan çekinirken gazeteci olarak sorulması en zor soruları sormaktan kaçınmam.

Medyatik bir olay meydana geldiğinde gazeteciler olay yerinde kamu çıkarının gerektirdiğinden fazla kalmamalıdırlar.

Düşüncelerini ifade ederken en radikal ifadeleri kullanmış gazetecilerdekilerden daha keskin ifadeler kullanmasıyla tanınırdı.

11) Bakanlık

Kamu hizmet reform programı son zamanlarda bakanlık dışı sivil hizmetler de uygulanmaya başlanmıştır.

Bu karar doğrultusunda bakanlıklar kendi kadro ihtiyaçlarını Başbakanlık'a iletmeye başladı.

Bu yıl alınan birçok memurdan biriydi dairede fakat sayıları diğer bakanlıklardakilerden daha fazla değil.

12) Sıcaklık

Karanfil yetiştirirken ani sıcaklık değişmelerinden kaçınılmalıdır.

Aynı zamanda çiçeklenme devresinde çok düşük sıcaklıklar çiçek tozlarının olgunlaşmasını durdurur.

Düşük ısıdaki metalik malzemelerin özellikleri yüksek sıcaklıklardakilerden daha farklıdır.

Long & Low Frequency Word Group

1) **İstasyon**

Issız ve adeta terk edilen istasyon gideni artık tutamamakta, ona yetmemektedir.

Petrol boru hattını olası saldırılara karşı korumak amacıyla ilgili istasyonlar uyarılırken boru hattının da karartılması talimatı verildi.

Her zaman benzin almak için aynı yere çalışanları diğer istasyonlardakilerden daha cana yakın olduğu için gidiyordu.

2) **Aktivite**

Bu kısımdan alınan manyetik aktivite elektrodun altında bulunan milyonlarca beyin hücresinin çalışması sonucudur.

Fakat otizmli bir çocuğun dil gelişimini ve sosyal uyumunu destekleyen aktiviteler eğitim seanslarına katılabilir.

Tempolu yürümenin yaktığı kalori, spor amaçlı yapılan diğer aktivitelerdekilerden daha fazladır.

3) **Orkestra**

Hele arkada eşlik eden orkestra sesleri nasıl bir derinlik kazandırıyordu mekana, sözcüklerle anlatamam.

Genç kızlar ve erkekler, bizim havalara çok benzer havalar çalan orkestralar eşliğinde dans ediyorlar...

Onurun çaldığının benzer orkestralardakilerden ayrıldığı nokta her kesime hitap edebilmeleridir.

4) **İstikrar**

Ekonomik faktörlerin yanı sıra yabancı yatırımcıların, ülkede siyasi istikrar aradığı dikkatleri çekmektedir.

İşsizlik örneği gibi krizin sonuçlarını yansıtan değişkenlerde istikrarlar böylesi gözlemlenmiyor.

Hükumet siyasetinin milli sınırların ötesinde güç kazanması bölgesel istikrarlardakilerden daha az önemli değildir.

5) **Potasyum**

Kurak bölge topraklarının değişebilir potasyum kapsamlarının belirlenebilmesi için suda çözünebilir miktarların bilinmesi zorunludur.

Toprak tekrar su alırsa, kil tabakalarının açılır böylece sıkışan potasyumlar faydalı duruma geçer.

Killi toprakta diğer türdeki potasyumlardakilerden daha zengin bir mineral çeşitliliği vardır.

6) **Egzersiz**

Tedavilerden sonra hastaların verilen egzersiz programlarını aksatmadan yapmaları gerekir.

Özellikle açık havada yapılan egzersizler direncinizi artırır.

Pilateste harcanan kalorinin diğer egzersizlerdekilerden daha fazla olduğu bilinmektedir.

7) Canlılık

İnşaat sektöründeki canlılık ekonomik büyümeyi de yukarıya doğru çekiyor.

Tabiat bize eşi görülmemiş canlılıklar vererek yaşadığımızı hissettirir.

İçsel hareketliliğin ve coşkunluğun verdiği motivasyon ve enerji mekândaki canlılıklardakilerden daha yüksektir.

8) Buhurdan

Artık iyice loşlaşan mutfak buhurdan gibi tütüyor ve Melih, burada yediği yemekleri, içinde gittikçe ağdalaşan lezzetleriyle hatırlıyordu.

Onun gökkuşağı gibi rengârenk atmosferinde, gönüller her zaman buhurdanlar gibi tüter; her seher bir şehrâyin gibi tüllenir; her koyda yüzlerce bülbül öter.

Günümüzde sadece özel törenlerde ve bayramlarda yakılanlar, geçmişte yaygın olarak kullanılan buhurdanlardakilerden daha az çeşitliliğe sahip.

9) Çamurluk

Arabanızı tamire götürdüğünüzde kaportacı usta duvar dibine konmuş çiçek saksılarından birini biraz çekiçleyip düzelterek arabanıza çamurluk haline getirebiliyordu.

Otomobilde bulunan çamurluklar gibi uzuvlar sacdan üretilecekti.

Arkadakiler ön lastikte bulunan çamurluklardakilerden daha dayanıklı olmak zorunda.

10) Külliyat

Karşımızda bulunan bu devasa külliyat tarihsel olguları gizlici perspektiften değerlendirmektedir.

Ben de yıllardır Türk müziğine ilişkin konulardaki külliyatlar nedir ne değildir bilirim.

Arabanızı tamire götürdüğünüzde kaportacı usta duvar dibine konmuş çiçek saksılarından birini biraz çekiçleyip düzelterek arabanıza çamurluk haline getirebiliyordu.

11) Saltanat

Şeytanın tarih içindeki en büyük saltanat dönemi olan engizisyon devrinin temel özelliklerinden biri de İncil'in milletin bildiği dillere tercümesinin yasaklanmasıdır.

Sen ünlemlerle takıl, ben soru işareti olup saltanatlar kurarım zihninde.

Onun evinde gördüğü ilgi, sevgi ve ikram öyle büyüktü ki sultanların sürdüğü saltanatlardakilerden bile kat be kat fazlaydı.

12) Hükümdar

Emirler, barış zamanlarında hükümdar adına eyaletlerde yöneticilik yapıyorlardı.

Bir müddet meydanda yatan ölüleri içi acıyarak ama gururla, uzun uzun seyreden hükümdarlar tekrar dönüp ağır hareketlerle uykuya dalarlar.

Kanuni'nin adalet uygulaması diğer hükümdarlardakilerden bir adım önde olmuş ve tebaasının güvenini kazanabilmişti.

Appendix E.

TEZ FOTOKOPİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü	
Sosyal Bilimler Enstitüsü	
Uygulamalı Matematik Enstitüsü	
Enformatik Enstitüsü	X
Deniz Bilimleri Enstitüsü	

YAZARIN
Soyadı : EREN

Adı : Emine

Bölümü : Bilişsel Bilimler

TEZİN ADI (İngilizce) : FREQUENCY AND LENGTH EFFECTS OF WORDS ON FIXATION DURATIONS IN TURKISH SENTENCE READING

TEZİN TÜRÜ : Yüksek Lisans [X] **Doktora** [ ]

1. Tezimin tamamı dünya çapında erişime açılsın ve kaynak gösterilmek şartıyla tezimin bir kısmı veya tamamının fotokopisi alınsın. [X]

2. Tezimin tamamı yalnızca Orta Doğu Teknik Üniversitesi kullancılarının erişimine açılsın. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) [ ]

3. Tezim bir (1) yıl süreyle erişime kapalı olsun. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) [ ]

Yazarın imzası Tarih