Dolgunsöz, E. (2018). Word familiarity effects in EFL reading: An eye tracking study. *International Online Journal of Education and Teaching (IOJET),* 5(2), 252-265.
http://iojet.org/index.php/IOJET/article/view/383/233

Received: 01.02.2018
Received in revised form: 12.02.2018
Accepted: 13.02.2018

WORD FAMILIARITY EFFECTS IN EFL READING: AN EYE TRACKING STUDY

Emrah Dolgunsöz

Bayburt University, Dept. of ELT

edolgunsoz@gmail.com

Emrah Dolgunsöz is an assistant professor at Bayburt University, Department of ELT. He is also head of Foreign Languages Education Department of Bayburt University, Faculty of Education. He received his MA and PhD from Hacettepe University. His main research areas are psycholinguistics and eye-tracking.

WORD FAMILIARITY EFFECTS IN EFL READING: AN EYE TRACKING STUDY

Emrah Dolgunsöz

edolgunsoz@gmail.com

Abstract

Do you know what happens in mind when we encounter a novel word while reading a newspaper, a paragraph or a short story? Via eye tracking technique, this study aimed to gather clues about how our mind reacts to an unknown word while we read in another language by examining word familiarity effects on eye movements during EFL reading. After a vocabulary test, eye movements of 60 EFL learners at intermediate level were recorded while they read identical sentence pairs including words with different length and frequency. The results showed that (1) total time spent on words and reanalysis times were predicted by vocabulary knowledge, (2) initial word processing was not predicted by vocabulary size (3) unfamiliar words attended more attention and required more cognitive effort than familiar words, (4) familiar words are processed in similar time spans for English as L1 and L2 but unfamiliar words cause more cognitive load in EFL. The results were discussed in comparison to L1 eye movement research in reading and were evaluated regarding EFL reading in terms of noticing hypothesis, incidental vocabulary acquisition and EFL reading instruction.

Keywords: EFL reading, eye movements, word familiarity, word processing

1. Introduction

As a commonly known, the number of words known in a language highly predicts reading comprehension success. There is a causal relationship between vocabulary knowledge and reading; larger vocabulary size improves reading performance and improved reading leads to higher amounts of vocabulary growth (Stanovich, 2009). Knowing a word is a multifaceted process involving numerous components such as orthography, spelling, pronunciation and meaning (Nation, 2013). Not only reader oriented components exist to recognize a word, linguistic characteristics also greatly influences how readers process words during text processing. When a reader encounters a word while reading, he processes the word depending on several linguistic factors such as word frequency, length, contextual constraints and familiarity. Being the foci of this study, word familiarity refers to how well known a word is and can simply be explained by "reader's lexical access to the word". In English, a two years old baby starts with 300 words and reaches up to approximately 12000 words at the age of 12 by accumulatively increasing this capacity depending on academic and social factors in the upcoming years (Crystal, 2002). For a university graduate, vocabulary size may easily reach over 20000 words (Goulden, Nation, & Read, 1990). Some related research even argues that a high school graduate in USA knows 40000 words in average (Anderson, 1996; Cunningham, 2005; Stahl, 2005). For English language learners, the scenario is quite different as they already have another language in their linguistic rucksack and prone to cross-linguistic effects as they start to learn English at a quite a late age. As a rule of thumb, 15000 words would be an optimal number for a text coverage of nearly 98% (Kucera, 1982). According to Hirsh and Nation (1992), although it may not provide successful guessing of words from context, a learner with a vocabulary size of 2000 words may know every 1 word

out of 5 in a text. For reasonable successful inferences, at least 95% coverage is needed (Laufer, 1989). For Nation (2006), 10000 words are required for reading instructionally. In this respect, a learner should know primarily 3000 words which are mostly highly frequent ones in a rough estimate. After this threshold, low frequency words should be added in time to enlarge vocabulary size (Nation, 1990). As the vocabulary size enlarges, reading performance improves and boosts vocabulary growth, however, the learning process gets complicated: New words are acquired but there is no guarantee; the acquired linguistic input may be lost while trying to learn a new one. This enlargement period involves dense cognitive processes. Hence, it is crucial to know how learners of EFL process new vocabulary when compared to the ones that they already know to evaluate EFL vocabulary size expansion. By using eye tracking technique, the main aim of this study is to reveal how EFL learners process familiar and novel words and to examine the predictive power of vocabulary size on word processing times by controlling length and frequency effects.

2. Literature Review

2.1. Word Processing and Familiarity in L1 Reading: An Eye Movement Perspective

How readers process words during L1 reading has long been examined both by lexical decision tasks and eye tracking technique (Balota, Pilotti, & Corteze, 2001; Chaffin, Morris, & Seely, 2001; Connine, Mullenix, Shernoff, & Yelen, 1990; Ferraro & Sturgill, 1998; Gordon, 1985; Juhazs & Rayner, 2003; Whalen & Zziga, 1994; Williams & Morris, 2004). The general findings for all previous research showed that if a reader is familiar with the word encountered in text, it is processed much faster than unfamiliar ones. The level of familiarity with the words directly predicts the time needed to process that word.

Two studies in L1 context is significant to mention as the current research has a number of similarities with them. Chaffin et al. (2001) recorded readers' eye movements as they read pairs of sentences containing a target word from one of three subjective familiarity conditions: high familiar, low familiar, or novel. The novel words were pseudowords which were pronounceable but totally unknown for the readers. Their results showed that readers spent more time on novel words than they did on high familiar or low familiar ones. However, the initial processing times (first fixation and gaze duration) did not significantly differ. In a similar research by William and Morris (2004), the general consensus persisted. In this study, two eye tracking experiments scrutinized the effects of word familiarity on word processing and text comprehension during silent L1 reading. The text stimuli were consisted of words varied in familiarity and frequency and a multiple-choice test was implemented to assess comprehension. According to the results, time spent on high and low frequency words did not differ when familiarity was controlled for moderately familiar words. Readers clearly spent more initial processing time on novel words than familiar words. Vocabulary test scores also showed that readers successfully acquired some novel word meanings. Both research took attention spent on unfamiliar words as the vantage point. The present study also adopts this with a difference; not in L1 but in L2. L1 is quite abundant regarding familiarity and word processing studies. On the contrary, except a few studies indirectly mentioning values for known and unknown words (Dolgunsöz, 2015; Godfroid et al., 2013), there is still a gap in the literature about EFL word processing and familiarity effects.

2.2. Recent Eye Movement Research in Language Learning

Using eye tracking in L2 research has been recently gaining momentum and picked up by many L2 researchers as it can present moment-to-moment cognitive processes. It can represent robust and objective data acquisition due to its process-oriented nature. This

advantages have made eye tracking technique a trendy data collection tool for a number of language learning research recently.

Brunfaut and McCray (2015) examined the cognitive processes in testing and assessment. Eye movements of 25 test-takers were recorded while they complete "Aptis reading tasks". In addition to eye movement data, retrospective interviews were conducted. The results revealed that testees involved in wide range of cognitive processes during Aptis reading tasks. The study also showed that only a few potential threats to the test's construct validity were identified. Being directly related to SLA, the study by Godfroid et al. (2015) examined the grammatical judgement test (GJT) performances of 20 native and 40 non-native English speakers via eye tracking. The findings indicated that both natives and non-natives employed regressions on untimed, grammatical items. Secondarily, their results argued that timed and untimed GTJs assess different constructs; implicit and explicit knowledge. In their study, Prichard and Atkins (2016) evaluated the previewing strategies of 38 Japanese EFL learners by using eye tracking. They adapted a text from Wikipedia consisted of 471 words and recorded eye movements while learners previewed the text. In general, the findings showed that learners barely previewed the text. In another similar research, Prichard and Atkins (2017) utilized eye tracking to examine global text processing of Japanese EFL learners. They used a text with Wikipedia-style formatting and recorded eye movements of 55 participants while they process the text. Their results showed that most learners did not read selectively and preferred to read linearly by paying no selective attention to important units such as the topic sentences. As for pedagogical implications, they emphasized that most learners lack strategic competence and suggested reading instruction activities such pre-reading, previewing and summarizing.

Recently, Godfroid et al. (2017) examined how readers acquire new words incidentally in natural reading context by using eye tracking. Their primary aim was to reveal any effect of accumulation exposure to unfamiliar words and how attention changes after certain number of exposures. Native and non-native English speakers read an English novel including Dari words while their eye movements were recorded. After reading, an unannounced posttest was utilized. The findings showed that number of exposures strongly predicted time spent on unfamiliar words and learning gains. Carroll and Conklin (2017) examined how idioms are processed in L1 and L2 in a cross-linguistics perspective via eye tracking. Both English and Chinese learners participated in the study. For textual stimuli, Chinese idioms were used. The results of 2 experiments showed that native speakers of Chinese showed recognition of the L1 form in the L2, but figurative meanings were read more slowly than literal meanings, suggesting that the non-compositional nature of idioms makes them problematic in a non-native language. Révész and Gurzynski (2017) aimed to reveal ESL teachers' perspectives on task difficulty by using eye tracking and think aloud protocols. 16 ESL teachers were asked to judge the linguistic ability required for four pedagogic tasks, and express how they would manipulate the tasks to suit the abilities of skilled and non-skilled ESL learners. Throughout the experiments, teachers though aloud and their eye movements were recorded. The results showed a consistency between eye tracking data and think aloud comments; teachers were mostly concerned with linguistic factors when assessing task difficulty. Conceptual demands such as pictorial manipulation and reasoning were usually ignored. Interactional demands, on the other hand, were totally ignored.

As the most recent L2 research suggested above, eye tracking has been used both for instructional and theoretical language learning research. This study mostly falls into the theoretical camp attempting to describe word processing in EFL reading. In this respect, the primary aim of the current study is to shed light on EFL word processing regarding

familiarity effects during reading. This study sought answers for the following research questions:

1. Is there a predictive effect of word familiarity on Total Fixation Duration?
2. Is there a predictive effect of word familiarity on Gaze Duration?
3. Is there a predictive effect of word familiarity on Second Pass Time?

3. Method

3.1. Participants

60 learners of EFL in an ELT department with and age range of 19 to 22 (M=19.7, SD=3.4) participated in the study voluntarily and received course credit for their participation. All of the participants scored over 50 in the reading proficiency exam conducted in the beginning of 2017-18 Fall Semester and started to learn English after a certain age in Turkey with the same L1 background.

3.2. Apparatus and Software

For the data acquisition, Tobii TX300 with a sampling rate of 300hz equivalent to a temporal resolution of 3.3 ms was utilized. As for software, all data acquisition, visualization and analysis was conducted via Tobii Studio Enterprise Software 3.2.3.

3.3. Text Stimuli

To assess the effect of word familiarity by controlling word length and frequency effects, both long-short and low-high frequency words were used. 16 words in different length and frequency were defined through COCA (Corpus of Contemporary American English). These words are presented in identical simple sentence pairs to control proficiency effects as shown in the sample below:

*"In this part of the country, an **elk** can be seen at any time of the day."*

*"In this part of the country, the **conflict** between these radical groups never ended."*

Length and frequency characteristics of the words used are as follows:

Table 1. *Length and frequency characteristics of 16 words*

Long words with low frequency	**Word Length (letters)**	**Word Frequency**
cathedral	9	4402
formulate	9	1493
ineffective	11	2727
ambitious	9	6963
Short words with low frequency		
flee	*4*	*2899*
fry	*3*	*2707*
ale	*3*	*1386*
elk	*3*	*4616*
Long Words with High Frequency		
decided	*7*	*57388*
influence	*9*	*38307*
development	*11*	*96195*
conflict	*8*	*30043*

Short Words with High Frequency		
cup	3	57106
pass	4	44611
fat	3	43607
nice	4	51477

3.4. Vocabulary Test

To assess learner familiarity with the words, a vocabulary test was applied a day before the eye tracking experiment. In this test, learners were given 16 words in bold in 16 different sentences. They were required to recognize and write down the Turkish meaning(s) of the words directly in 20 minutes. Each correct answer was calculated as 1 point. Maximum score that could be taken was 16.

3.5. Procedure

One day before starting the eye tracking experiment, the participants were required to complete the vocabulary test in given time. For the eye tracking experiment, each participant was tested individually within the control of the researcher. Calibration procedure was done with 9-point grid calibration setting. Then the sentences were presented in pairs in Times New Roman, 18-pt font, on a 23'' monitor with 1920x1080 screen resolution set up at 67 cm from the participants' eyes. At this distance, 4.0 character spaces equaled 1° of visual angle. To avoid cognitive reactivity, no time limit is given; participants were asked to read the sentence pairs freely and pass by clicking with the mouse.

3.6. Research Design and Data Analysis

This research has a within subject design in which each participant was tested for the same 16 words. In this respect, 3 main eye movement measures were analyzed by drawing homogeneous AOIs on 16 items. Time spent on AOIs were then averaged to reveal mean total fixation duration, gaze duration and second pass time. To measure the predictive effect of word familiarity on three eye movement measures, a linear regression procedure was conducted eye movement measure as the dependent variable and vocabulary score as the predictor variable. Descriptives were calculated with General Linear Model (GLM) analysis.

3.7. A Brief Description of the Measures Used

Three main eye movement measures were used in this study: Gaze Duration, Second Pass Time and Total Fixation Duration. While gaze duration is concerned with the initial processes (i.e. the first encounter with the word), second pass time is a late measure indication re-analysis. Total fixation duration is also a late measure, but more than that, it draws a general cognitive map.

3.7.1. Gaze Duration

Figure 1. Sample gaze duration

Gaze duration refers to the sum of initial fixations made before exiting the AOI. In the sample above, the reader processed the pseudoword "smang" initially with 154th and 155th

fixation then exits. The sum of these two fixations (561+361 milliseconds) equates gaze duration on that AOI.

3.7.2. Second Pass Time

Figure 2. Second pass time

Second Pass Time is a measure of re-analysis. Sometimes readers need to revisit and reread certain parts in a text due to various reasons. Revisiting a pre-read unit (i.e. a word or any AOI) lasts for a certain time and the time spent during this reanalysis process is called second pass time. In the sample, the pseudoword "goomb" was initially analyzed with 94th and 95th fixations and the reader exited. However, the reader re-analyzed the AOI with 101st fixation with a time span of 164 milliseconds. Thus, second pass time for this AOI is 164 ms.

3.7.3. Total Fixation Duration

Figure 3. Total fixation duration

Total fixation duration refers to the total time spent on an AOI regardless of fixational feature (i.e. gaze duration, second pass time, first pass time). In the sample above, total fixation duration for the pseudoword "zirgs" is calculated by summing up all the fixations on it; 79th, 80th, 81st and 82nd.

4. Findings

The data was observed to have distributed normally. As a general finding, learners mean test score was 11 (min=7, max=14) with a standard deviation of 1,50. Mean eye movement measures on 16 words were given in the table below:

Table 2. *Mean metrics*

	Min*	Max*	Mean*	Std. Deviation*
Total Fixation	203	677	405	111
Gaze Duration	229	572	384	88
Second Pass	0	220	56	50

**values in milliseconds (ms)*

4.1. Predictive Power of Vocabulary Knowledge on Total Fixation Duration

For a detailed analysis of descriptives for familiarity values for total fixation duration, GLM procedure with a linear scale response was employed total fixation as the dependent variable and familiarity as the binary factor (known vs unknown). This procedure was conducted in long data format. The descriptives were given below:

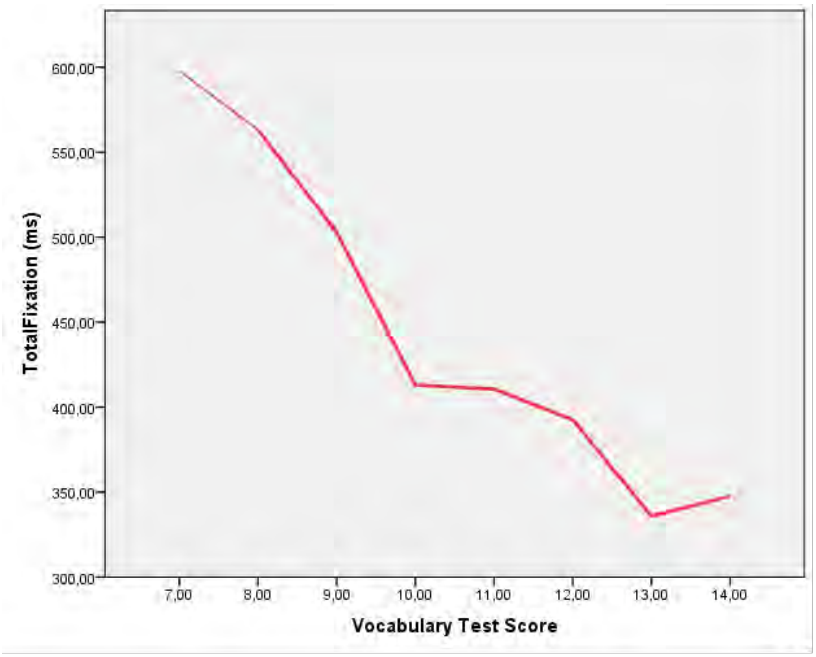
Table 3. *Descriptives for total fixation duration*

Word Type	Mean (ms)	Std. Error	95% Wald Confidence Interval	
			Lower	Upper
Unknown	567,413	19,328	529,531	605,295
Known	409,975	10,165	390,052	429,898

In general, learners were observed to have spent more total time and cognitive load on the words they know (M=410, SE=10) than they did on unfamiliar words (M=567, SE=19).

Additionally, Pearson correlation results showed a strong negative relationship between total fixation duration and vocabulary test scores; as vocabulary knowledge increases, total time spent on words decreases; r (60) = -437, p=.000.

To reveal the predictive power of word familiarity on total fixation, a simple linear regression was employed total fixation as the dependent variable and vocabulary score as the predictor covariate. A significant regression equation was found (F(1,58)= 13.680, p = .000, with an R^2 of .191. Participants' predicted weight is equal to 766 + -32. Total fixation duration decreased 32 milliseconds (ms) for each point gained in the vocabulary test.



Graph 1. Line graph for total fixation and vocabulary test scores

4.2. Predictive Power of Vocabulary Knowledge on Gaze Duration

Same procedure was employed for gaze duration. Descriptives are as follows:

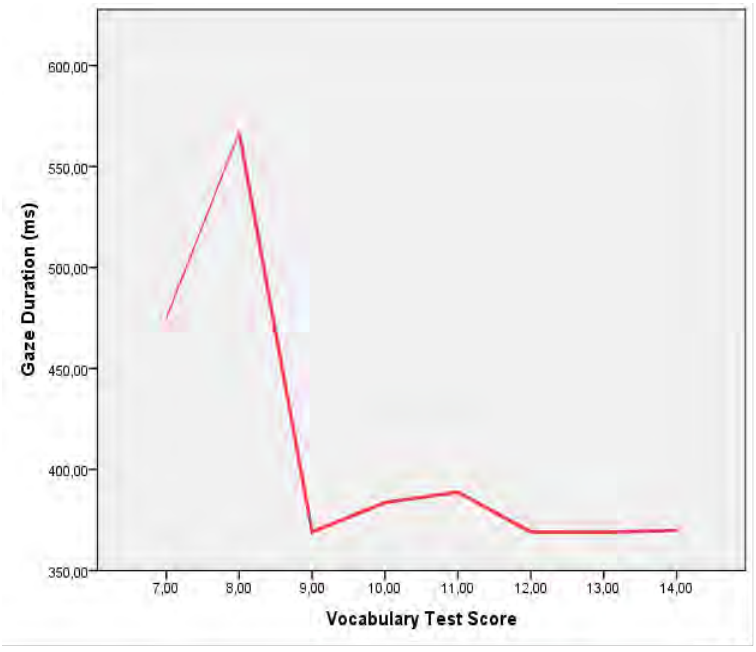
Table 4. *Descriptives for gaze duration*

Word Type	Mean (ms)	Std. Error	95% Wald Confidence Interval	
			Lower	Upper
Unknown	488,313	15,955	457,041	519,584
Known	354,759	8,391	338,313	371,206

Depending on the descriptive statistics, learners relatively spent more time on unfamiliar words in their initial encounter (M=488, SE=16) than they did on familiar words (M=355, SE=8).

Pearson correlation results indicated a negative relationship between gaze duration and vocabulary test scores; as vocabulary knowledge increases, the initial processing of the words decreases; r (60) = -226, p=.041.

To reveal the predictive power of word familiarity on total fixation, a simple linear regression was employed gaze duration as the dependent variable and the vocabulary test score as the predictor covariate. Contrary to the descriptives and simple correlation results, no significant regression equation was found in p<.05 level; (F(1,58)= 3.123, p = .082, with an R^2 of .035. Thus, this finding showed that the level of word familiarity cannot predict learner's initial processing.



Graph 2. Line graph for gaze duration and vocabulary test scores

4.3. Predictive Power of Vocabulary Knowledge on Second Pass Time

The descriptives are as follows:

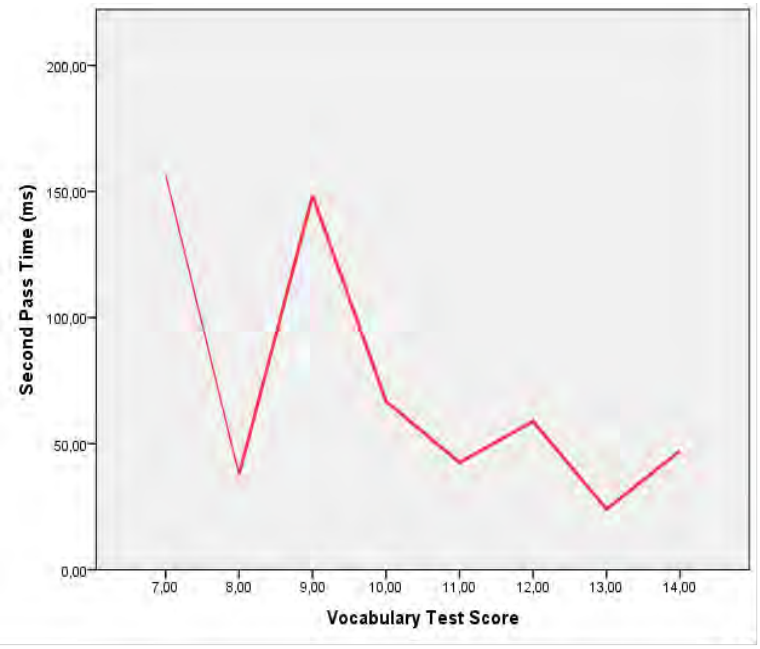
Table 5. *Descriptives for second pass time*

Word Type	Mean (ms)	Std. Error	95% Wald Confidence Interval	
			Lower	Upper
Unknown	74,226	10,647	53,359	95,093
Known	46,598	5,599	35,624	57,573

According to the Table X, learners tend to turn back in the text and reread unknown word more (M=74, SE=11) than they revisited familiar words (M=47, SE=6).

Moreover, confirming descriptives above, a strong negative correlation was observed between second pass time and vocabulary test scores; learners tended to reread and re-process the words that they were not familiar with; r (60) = -412, p=.001.

To see whether word familiarity predicts second pass time, a simple linear regression was calculated second pass time as the dependent variable and the vocabulary test score as the predictor covariate. A significant regression equation was found (F(1,58)= 11.858, p = .001, with an R^2 of .170. Participants' predicted weight is equal to 210 + -14. Second Pass Time decreased for 14 ms for each point gained in the vocabulary test.



Graph 3. Line graph for second pass time and vocabulary test score

5. Discussion

Controlling length and frequency effects, this study aimed to investigate the effect of word familiarity on word processing during EFL reading by adopting eye tracking technique. To fulfill this aim, total fixation duration, gaze duration and second pass time was analyzed with vocabulary score as the predictor variable. The results showed that EFL vocabulary size

significantly predicted total time spent on words and reanalysis duration, but not initial word processing.

The results of this study is consistent with previous research and fits the hypothesis that L2 word processing requires more cognitive effort than in L1. A detailed table is given below:

Table 6. *Mean fixation values for similar studies*

Study	Gaze Duration		Second Pass Time		Total Time	
	Familiar	Unfamiliar	Familiar	Unfamiliar	Familiar	Unfamiliar
L1 Research						
Chaffin, Morris & Seely (2001)	302	461	437	952	-	-
William & Morris (2004)	310	432	30	77	-	-
Frisson & Pickering (2007)	358	392	68	157	429	551
L2 Research						
Godfroid et al., (2013)	268	506	42	182	321	707
Dolgunsöz (2015)	364	479	297	405	379	569
Current Research	354	488	46	76	409	567

Note: All values are in milliseconds

5.1. Gaze Duration and Initial Word Processing

When compared to general findings of L1 research, there is not a huge gap between present findings and previous L1 research in terms of gaze duration on familiar word processing. In a rough estimate, readers in L1 initially spent about 320ms on a familiar word when they first met it in the text. Same value for current research was 354ms, slightly above L1 value. In L1 reading, initial processing for unfamiliar words are higher than familiar ones; readers spent approximately 420ms on initial processing of unfamiliar words. This value is higher for L2 reading; EFL learners spent roughly 490ms when they first encountered an unknown word in a text. In this respect, while familiar words are processed in similar time spans for both L1 and L2; initial processing of unfamiliar words in L2 needs more effort.

The findings of the present research are quite consistent with previous results. It can be inferred that EFL learners spent about 250-350ms to process familiar words during EFL reading. Initial processing times increases on unfamiliar words; learners spent up to 500ms while they process these words. It should be noted that no significant difference was found for gaze duration in this study, but 2 previous research mentioned in Table 6 found a significance at $p < .05$ level. It may be related to sample size.

5.2. Second Pass Time and Reanalysis Duration

The results of this study showed that learners reread unfamiliar words more than familiar ones. As seen in Table 6, previous L1 studies also showed that readers spent more rereading time on novel words. The results for the study by Chaffin, Morris and Seely (2001) seems fairly inflated but other 2 studies show that L1 readers only spend roughly 30 to 70ms to re-process familiar words. In L2 this value does not differ much as second pass findings for Dolgunsöz (2015) seems inflated. However, re-analysis times for unfamiliar words increases for unfamiliar words. In L1 this value is roughly 120ms. For L2, learners spent slightly higher time for rereading an unfamiliar word; it is about 130ms. These values are valid by not

counting 2 inflated results. In this respect, it can be proposed that re-analysis features do not differ much across L1 and L2 as it is a more syntactic and contextual reading behavior rather than being completely lexical.

5.3. Total Fixation Duration and General Cognitive Effort

The results of the current research indicated that total time spent on words are strongly predicted by word familiarity in EFL reading; unknown words need more cognitive effort than familiar ones. It is hard to give a certain value for familiarity effects in both L1 and L2 reading as there are numerous factors affecting it. It is assumed that L1 readers process words in 225ms in average during silent reading including factors such as word length, frequency, familiarity and contextual constraints (Rayner, 1998). First two L1 studies in Table 6 did not analyze total time, but according to Frisson and Pickering (2007), L1 readers process familiar words in 429ms and unfamiliar ones in 551ms. In EFL word processing, this value is much higher for unfamiliar words. While processing of familiar words did not differ much between L1 and L2; EFL learners spent over 600ms in average to process unfamiliar words. Thus, it can be argued that processing of unfamiliar vocabulary during EFL reading requires considerable amount of cognitive effort than L1 reading.

As for mentioned L2 studies, the results confirm each other. While processing of known words finished around 350ms, unfamiliar or novel words attract more total attention reaching up to 600ms. Indeed, it is natural especially for learning new vocabulary depending on noticing hypothesis (Schmidt, 1990). This long-known attention based hypothesis assumes that attention and learning cooperate for learning and retention and learners are required to pay attention to linguistic input to convert them into intake through memory mechanisms. (Schmidt, 2010). The facilitative effect of exposure and attention was examined by previous L2 research by using eye tracking (Godfroid et al., 2013; Dolgunsöz, 2015; Godfroid et al., 2017) and the amount of attention on novel L2 vocabulary was observed to have improved learning gains.

6. Conclusions and Pedagogical Implications

The results of this study indicated that EFL readers spent more cognitive effort to process unfamiliar or novel words when compared to familiar ones even when length and frequency effects were held constant. Vocabulary size strongly predicts total attention on words and reanalysis time during reading. In contrast to previous L2 eye movement research, initial processing times were not predicted by vocabulary knowledge. Findings also showed consistency with L1 reading research and it was concluded that EFL reading requires more amount of cognitive effort especially for texts including unfamiliar and novel words.

Depending on these findings, it can be argued that word processing in EFL reading is highly related to linguistic characteristics of words. Turkish learners already starts with cross-linguistic disadvantages and hence were required pay higher amounts of cognitive effort to process words, especially novel ones. Teachers, material designers and language policy makers walk on a tightrope; including too much novel items in EFL reading instruction may lead cognitive exhaustion. Additionally, they need to balance between familiar and unfamiliar word load in EFL texts by regarding frequency and length effects. On the other hand, when designed in a balanced fashion, an EFL text consisting of both novel and familiar words suited to learner proficiency may provide facilitative attention which boost working memory mechanism and retention of new vocabulary. In this respect, it can be concluded that incidental vocabulary acquisition in instructional EFL setting can be possible by regarding length, frequency and familiarity of the target words.

References

Anderson, R. C. (1996). Research foundations to support wide reading. In V. Greaney (Ed.), *Promoting reading in developing countries* (pp. 55-77). Newark, DE: IRA.

Balota, D. A., Pilotti, M., & Corteze, M. J. (2001). Subjective frequency estimates for 2,938 monosyllabic words. *Memory and Cognition*, *29*, 639–647.

Brunfaut, T., & McCray, G. (2015). *Looking into test-takers' cognitive processes whilst completing reading tasks: A mixed-method eye-tracking and stimulated recall study*. Lancaster: British Council.

Carrol, G., & Conklin, K. (2017). Cross language lexical priming extends to formulaic units: Evidence from eye-tracking suggests that this idea 'has legs'. *Bilingualism: Language and Cognition*, *20*(2), 299-317.

Chaffin, R., Morris, R. K., & Seely, R. E. (2001). Learning new word meanings from context: a study of eye movements. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *27*(1), 225-235.

Connine, C. M., Mullenix, J., Shernoff, E., & Yelen, J. (1990). Word familiarity and frequency in visual and auditory word recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *16*, 1084–1096.

Crystal, D. (2002). *The English Language*. UK: Penguin.

Cunningham, A. E. (2005). Vocabulary Growth through Independent Reading and Reading Aloud to Children. In E. H. Hiebert & M. L. Kamil (Eds.), *Teaching and learning vocabulary: Bringing research to practice* (pp. 45-68). Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers.

Dolgunsöz, E. (2015). Measuring attention in second language reading using eye-tracking: The case of the Noticing Hypothesis. *Journal of Eye Movement Research*, *8*(5), 1-18.

Ferraro, F., & Sturgill, D. (1998). Lexical effects and lexical properties associated with National Adult Reading Test (NART) stimuli in healthy young adults and healthy elderly adults. *Journal of Clinical Psychology*, *54*, 577–584.

Frisson, S., & Pickering, M. J. (2007). The processing of familiar and novel senses of a word: Why reading Dickens is easy but reading Needham can be hard. *Language and cognitive processes*, *22*(4), 595-613.

Godfroid, A., Ahn, J., Choi, I., Ballard, L., Cui, Y., Johnston, S., & Yoon, H. J. (2017). Incidental vocabulary learning in a natural reading context: an eye-tracking study. *Bilingualism: Language and Cognition*, 1-22.

Godfroid, A., Boers, F., & Housen, A. (2013). An eye for words. *Studies in Foreign Language Acquisition*, *35*(03), 483-517.

Godfroid, A., Loewen, S., Jung, S., Park, J. H., Gass, S., & Ellis, R. (2015). Timed and untimed grammaticality judgments measure distinct types of knowledge: Evidence from eye-movement patterns. *Studies in Second Language Acquisition*, *37*(2), 269-297.

Gordon, B. (1985). Subjective frequency and the lexical decision latency function: Implications for mechanisms of lexical access. *Journal of Memory and Language*, *24*, 631–645.

Goulden, R., Nation, P., Read, J. (1990). How large can a receptive vocabulary be? *Applied Linguistics, 11*, 341-363.

Hirsh, D., Nation, P. (1992). What vocabulary size is needed to read unsimplified texts for pleasure? *Reading in a Foreign Language, 8*(2), 689-696.

Juhasz, B. J., & Rayner, K. (2003). Investigating the effects of a set of intercorrelated variables on eye fixation durations in reading. *Journal of Experimental Psychology: Learning, Memory & Cognition*, *29*, 1312-1318.

Kucera, H. (1982). *The mathematics of language. In The American Heritage Dictionary*. Boston: Houghton Mifflin. 2nd ed.

Laufer, B. (1989). *What percentage of text-lexis is essential for comprehension*? In C. Lauren and M. Nordman (eds.), Special Language: From Humans Thinking to Thinking Machines. Clevedon: Multilingual Matters.

Na, L., Nation, P. (1985). Factors affecting guessing vocabulary in context. *RELC Journal 16*(1), 33-42.

Nation, I. (2006). How large a vocabulary is needed for reading and listening?. *Canadian Modern Language Review*, *63*(1), 59-82.

Nation, I. S. (2013). *Learning vocabulary in another language.* Cambridge: Cambridge University Press.

Nation, P. (1990). *Teaching and learning vocabulary*. New York: Newbury House.

Prichard, C., & Atkins, A. (2016). Evaluating L2 readers' previewing strategies using eye tracking. *Reading Matrix*, *16*(2), 110–130.

Prichard, C., & Atkins, A. (2017). L2 readers' global processing and selective Attention: An eye tracking study. *TESOL Quarterly*, 1-12.

Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin*, *124*(3), 372-422.

Révész, A., & Gurzynski-Weiss, L. (2016). Teachers' perspectives on second language task difficulty: Insights from think-alouds and eye tracking, *Annual Review of Applied Linguistics, 36*, 182-204.

Schmidt, R. (1990). The role of consciousness in second language learning. *Applied Linguistics*, *11*(2), 129-158.

Schmidt, R. (2010). *Attention, awareness, and individual differences in language learning*. In W. M. Chan, S. Chi, K. N. Cin, J. Istanto, M. Nagami, J. W. Sew, T. Suthiwan, & I. Walker, Proceedings of CLaSIC 2010, Singapore, December 2-4, 721-737). Singapore: National University of Singapore, Centre for Language Studies.

Stahl, S. (2005). Four problems with teaching word meanings. In E. H. Hiebert & M. L. Kamil (Eds.), *Teaching and learning vocabulary: Bringing research to practice* (pp. 95–114). Mahwah, NJ: Erlbaum.

Stanovich, K. E. (2009). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Journal of Education*, *189*(1-2), 23-55.

Whalen, D. H., & Zziga, E. (1994). Subjective familiarity of English word/name homophones. *Behavior Research Methods, Instruments, and Computers*, *26*, 402–408.

Williams, R., & Morris, R. (2004). Eye movements, word familiarity, and vocabulary acquisition. *European Journal of Cognitive Psychology*, *16*(1-2), 312-339.