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Using Eye-Tracking to Measure Lexical Inferences and its Effects on Reading Rate during EFL Reading

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Abstract

Inferring unknown word meanings by using contextual clues is a common strategy employed by EFL learners during reading. This study aims to (a) investigate the effect of familiarity on lexical inferences in EFL reading; (b) examine inference efficiency among EFL readers with different levels of vocabulary knowledge and reading proficiency; and (c) use eye-tracking to reveal the effect of lexical inferences on EFL reading rate. According to the eye movement data acquired from 72 EFL learners, accurate inferences and learning gains were driven by vocabulary knowledge and reading proficiency. Moreover, while correct inference rate and learning gains were significant; employing this strategy had a degenerative effect on EFL reading rate. Second pass time and I-WPM were also found to be consistent with previous studies.

Keywords: EFL Reading, eye tracking, second pass time, lexical inference, reading rate

1. Introduction

Using contextual clues to infer the meanings of unknown words - also known as 'guessing meaning from context' - refers to the reading strategy of inferring novel word meanings in a text by referring to the words' neighboring linguistic or situational context. When L2 learners meet a novel word during reading, some of its characteristics can be noted, such as a suffix or prefix, or the stem or the form, and the word can be associated with a potential meaning within the surrounding lexical environment and the topic of the text. The predicted meaning sometimes works well within that context, but most of the time this prediction is not fully correct (Dubin & Olhstain, 1993; Hulstijn, 1992). This attempt is usually quite risky; incorrect inferences are likely to disrupt a reader's comprehension especially if the word is a critical one. Regarding learning gains, employing inferences within the context is an understandable strategy but an inefficient way of learning new vocabulary, as in many cases the predicted meaning of the word will be quickly lost (Grabe, 2010).

By using eye-tracking methodology, the primary aims of this research paper are: (a) to identify the eye movement characteristics involved in the inference of unknown word meanings as a common strategy employed by L2 learners during L2 reading; (b) to reveal the rate of accurate inferences and learning gains made; and (c) to scrutinize the relationship between this strategy and the L2 reading

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rate. In this research, the use of linguistic context by L2 learners was examined, since the parameters of their situational context could not be measured by eye-tracking.

1.1. Theoretical background

1.1.1. Effective Factors in Lexical Inference Efficiency during L2 Reading

In L2 reading there are a number of factors that predict the success rate of guessing novel word meanings and vocabulary learning gains. These include the type of context, and the reader's active vocabulary storage and proficiency level. Contexts vary to a great extent and the type of context is critical to facilitate readers' correct inferences. Beck, McKeown, and Kucan (2002) identify four types of context: (a) misdirective contexts; (b) nondirective contexts; (c) general contexts; and (d) directive contexts. Misdirective contexts inhibit correct guesswork and may lead learners to incorrect inferences. Nondirective contexts are neutral and provide no assistance in directing learners to any particular meaning of a word. For general contexts, inference support is minimal. In terms of facilitating guesswork only directive contexts can provide clear clues to help readers successfully guess the meaning of a novel word. However, a number of studies have shown that any context can still be misleading. Beck, McKeown, and Kucan (2002) found that adults were able to guess only one out of thirteen words correctly when the context was quite supportive. Gough and Wren (1999), though, reported a 14% correct guessing rate in a nondirective context, while a study of 60 students by Bensoussan & Laufer (1984) showed that context helped lexical guessing by only 13%. This degree of variation in guessing efficiency regarding context indicated that other influential factors were also involved: namely, vocabulary knowledge and proficiency level. In this research, the effect of context type was controlled and the text stimuli used were rather supportive as most of the lexical contents were consistent with each other and with the topic.

When compared with the effect of context type the case of a reader's insufficient vocabulary knowledge is more dramatic: related research showed that only readers with larger active vocabulary storage could use context efficiently to make correct guesses and to learn new words (Waring & Nation, 2004). When an L2 reader with low vocabulary knowledge is trying to understand a text, he will be unable to apply effective guessing strategies used in L1 reading. As Ellis (2005) asserts, using a guessing strategy to learn new words is far from being accurate and consistent, especially for beginner readers suffering from weak vocabulary knowledge. Thus, efficient use of context information to infer meanings of new words carries lexical demands, primarily requiring learners to recognize the surrounding lexical environment to a great extent - a quality inevitably unlikely in weaker readers (see Barnett, 1989; Koda, 2005). Indeed, vocabulary knowledge and proficiency are positively associated. Hence, less proficient L2 learners lack the necessary lexical and syntactic skills for lexical inference and most of the time weak L2 learners are unable to use context to make reasonable or correct guesses (Fukkink & de Glopper, 1998; Gough & Wren, 1999; Nassaji, 2003; Swanborn & de Glopper, 1999). Due to low word recognition and sentence processing skills among such learners guessing which may work for them in L1 fails in L2 and most inferences prove to be incorrect.

1.1.2. Previous Research

Related research has shown that learner guesses are often poor and vocabulary learning rates are quite low. In a study by Bensoussan & Laufer (1984), 60 first year students were given a list of 70 words to translate into L1. After a week, the same word list with the addition of a text containing all the words was given to the same learner group. The results showed that context helped lexical

guessing in only 13% of the responses, for only 24% of the words. Moreover, even proficient learners could not use context as expected. Nassaji (2003) asked 21 EFL students to infer meaning from context while reading. He scrutinized their use of strategies and knowledge sources in L2 lexical inferences and their relationship to inferential success. According to the introspective and retrospective think-aloud protocols, the rate of success was low even when learners employed the strategies and knowledge sources they had at their disposal, and success was associated more with the quality rather than the quantity of the strategies used. In another study Nassaji (2004) examined the relationship between ESL learners' depth of vocabulary knowledge, their use of lexical inference strategy, and their success in deriving word meaning from context. In this study learners were asked to read a passage containing 10 unknown words and to derive the meanings of the unknown words from their context. Using Introspective think-aloud protocols and the Word-Associate Test (WAT), the study revealed a significant positive relationship between depth of vocabulary knowledge and the degree and type of strategy use, and their ultimate success. According to the results higher vocabulary knowledge led to more effective use of guessing strategies and contributed to individual readers' success. In a study by Na & Nation (1985) low frequency words at two different densities in a text were replaced by nonsense words, and learners were asked to guess the meanings of these words by using contextual clues. The results showed that highly proficient learners successfully guessed between 85% and 100% of the unknown words while the success rate was dramatically lower, between 30% and 40%, for the low proficiency group. In another study, involving 100 L2 learners, Kaivanpanah & Alavi (2008) conducted three methodological phases. These included a Likert scale, a self-assessment technique and a proficiency test, to examine the reliability of the guesses made by L2 learners. Results revealed that most guesses in general were not reliable.

1.1.3. Reading Rate and Fluency

Reading fluency is a fundamental component of reading success. It refers to a reader's ability to read a text quickly, accurately, and with proper expression (National Reading Panel, 2000; Kame'enui & Simmons, 2001). In the case of L1, a fluent reader can read most texts at between 250–300 words per minute. This is due to a combination of various skills: advanced word recognition; automaticity; higher syntactic knowledge; and higher discursive skills (Taylor, 1965; Carver, 1990, Rayner, 1998; Smith, 2004). In the context of L2, learners can commonly read a standard text with fair comprehension but with limited fluency. According to Segalowitz et al. (1991) L2 reading rate is at least 30% slower when compared with L1 reading and L2 students in academic contexts can only read at an average rate of 80–120 wpm, which is fairly low when compared with an L1 reader. Furthermore, fluency is not only a primary L2 reading objective but also a medium of development. Fluent readers are more susceptible to learning novel linguistic elements because fluency enhances linguistic exposure, expands automaticity in word recognition during reading and boosts motivation in formal and informal L2 learning contexts (Grabe, 2010). On the other hand, dysfluent reading is discouraging, adversely affecting learners' motivation to read. Slower rates of reading make learners pessimistic about their ability to read, which in turn reduces their reading experience to a labored and frustrating task (Meyer & Felton, 1999). In time, less motivated learners avoid reading and their rate of exposure to novel words and structures inevitably decreases (Stanovich, 1986). Besides, fluency is also a predictor of comprehension; related research demonstrates a strong positive correlation between reading fluency and comprehension (Dowhower, 1987; Tan & Nicholson, 1997). Previous findings showed that slow reading rates impede understanding, since fluency allows the reader to focus on the meaning of text rather than on the mere mechanics of reading (Samuels, 1979; Adams, 1990). Especially for L2 reading, when the limits of working memory capacity are considered, the reading process is greatly slowed and comprehension inhibited when cognitive resources are occupied trying

to infer meanings from context, or by regressing through sentences and rereading target words. As a result of an inadequate reading rate the learner cannot build a proper textual network to understand the text. Given that reading rate is one of the three components of fluency, along with accuracy and fluidity (Chang, 2010), current research treats reading rate as the main predictor of silent reading fluency, assuming that words read per minute largely predict reading fluency.

1.1.4. Second Pass Time: A Special Case of Contextual Clues

Early measures - first pass reading time - have been shown to differ markedly from late measures. Where early measures refer to initial word recognition processes and lexical access, eye movement research showed that late measures, including second pass time, were closely associated with later syntactic and discursive processes during reading. Among these were information reanalysis, discourse integration, and recovery from processing difficulties (Paterson, Liversedge, & Underwood, 1999; Rayner & Pollatsek, 1989). Second pass reading time is a late measure and indicative of reanalysis, which refers to the sum of all fixation durations made within an area of interest after the region was initially exited (either by a regression or a forward saccade) (Roberts & Siyanova-Chanturia, 2013; Winke, Godfroid & Gass, 2013). In a number of studies the strong reprocessing aspect of second pass time led to this measure being interpreted as an indicator of reanalysis (Hyöna & Olson, 1995; Rayner & Raney, 1996; Schmauder et al., 2000, Chaffin et al., 2001; Godfroid et al., 2013, Williams & Morris, 2004). In general, these studies concluded that frequency and familiarity were significant factors of reanalysis time: less frequent and less familiar words were more likely to be reanalyzed (depending on the context). In the L1 setting, Williams and Morris (2004) interpreted second pass time on unknown words as being indicative of the reader integrating the newly acquired contextual information with the unfamiliar word. In the present study second pass time and regressions to the target word were used as a measure of reanalysis, and the results showed that low frequency and unfamiliar words were reread significantly more often than high frequency and highly familiar words. Recently in L2 setting, Godfroid et al. (2013) assumed that second pass time within a supportive context might be indicative of the reader using contextual clues to infer novel word meanings during L2 reading; they argued that 'the addition of an appositive cue following the novel word will induce higher second pass reading times for the novel word' (p. 498). However, despite the contextual richness and higher second pass time on novel words without appositive condition, those unknown words were not revisited significantly by readers in a related situation in which a novel word was followed by its known match. Although the results were positive, the assumption and findings were contradictory; this may have been due to limited sample size. Following on from these studies, the present research also assumes that second pass time refers to the process of reanalysis and the use of linguistic context to infer unknown word meanings during L2 reading, and aims to employ an in-depth analysis of second pass time as a measure of lexical inference during L2 reading.

1.1.5. The Present Research

This study aims to examine vocabulary learning gains and the accuracy of guesswork by gauging advantages and disadvantages of readers guessing meaning from context, in terms of incidental vocabulary acquisition and reading rate in L2 reading. In doing so it factors in familiarity, vocabulary knowledge and proficiency. A vast amount of research has proposed that vocabulary can be acquired incidentally from reading through attentional mechanisms (see Jenkins, Stein and Wysocki, 1984; Nagy, Anderson and Herman, 1987; Day, Omura and Hiramatsu, 1992; Laufer, 2003; Hulstijn, 2003; Laufer and Hulstijn, 2001). This well-established assumption lies within learning psychology's proposition that the repetition of new vocabulary items promotes their retention (Anderson, 2005;

Baddeley, 1997). Relying on the Noticing Hypothesis (Schmidt, 1990) and on Robinson's hierarchical Memory Model (Robinson, 1995, 2003), which was itself premised on Cowan's (1988) model of memory, this study treats attention (second pass time) as the medium through which input is encoded in working memory and through which it is retrieved from long term storage. Thus, primarily, second pass time is hypothesized to be closely associated with word familiarity and assumed to have a facilitative effect on further recognition of unknown words. Secondarily, the study aims to reveal, on one hand, effects caused by different levels of vocabulary knowledge and proficiency on the accurate use of context to infer unknown word meanings and, on the other, the effect of second pass time on L2 reading rates.

1.2. Research questions

The research questions are as follows:

1. Do L2 learners take more second pass time and revisit unknown words than known words during L2 reading? Is there any strong effect on second pass time resulting from proficiency and vocabulary knowledge?
2. Does second pass time have a facilitative effect on further recognition of unknown words? If so, do the recognition rate and accuracy vary between different vocabulary knowledge and proficiency levels?
3. How do second pass time and revisiting words affect the L2 reading rate?

2. Method

2.1. Sample / Participants

82 participants were involved in all of the procedures of the experiment and received course credit for their participation. 10 participants were excluded for the following reasons: the eye movement data of 4 participants were inadequate, with too many offsets due to wet contact lenses and mascara; 2 participants had a different L1 background; 3 participants were at C2 level; 1 participant failed the comprehension check test. All participants were EFL students in an ELT department with at least B1 level (B1= 25, B2=37, C1=10) and fell within the age range of 19 to 22 years old. All of the participants had started to learn English after a certain age with the same L1 background. In total, 72 participants (12 males and 60 females) were included in the data analysis. All participants had normal or corrected-to-normal eyesight.

2.2. Instrument(s)

To assess participants' lexical access on 12 AOIs, a vocabulary knowledge scale was designed, for both unannounced pre-test and immediate post-test use (see Joe, 1995; McNeill, 1996; Scarcella and Zimmerman, 1998; Wesche and Paribakht, 1996). In this scale learners were required to choose the best of the 3 options - 'I know the word'; 'I am familiar but not sure'; or 'I have no idea'. If one of the first 2 options were chosen, participants should write down the Turkish meaning(s) or their prediction(s) about the word. This familiarity option was used to ensure that learners had minimal word recognition of certain words.

2.2.1. Apparatus

Eye movements were recorded using the Tobii TX300, with a sampling rate of 300hz, equivalent to a temporal resolution of 3.3 ms. The Tobii TX300 allows the reader large head movements and provides a natural experimental setting without a chinrest. The system is designed for studies that

require a higher sampling rate. Among these are Neuroscience research, Ophthalmology research, Psycholinguistic and reading research, all of which require detailed analysis of saccades, correction saccades, fixations, pupil size changes and blinks. In this study, for eye movement data acquisition, visualization and analysis Tobii Studio Enterprise Software 3.2.3 was used.

This study is a within-subject design with a pre-test and a post-test. All participants were exposed to the same group of 12 different vocabulary items, with different recognition levels, length and frequency. To maintain homogeneity and minimize any effect of length and frequency on second pass time, both long and short words with higher and lower frequencies were used. Word frequencies were determined by using COCA (Corpus of Contemporary American English). The mean frequency for the words was 10713 and the mean word length was 8,41.

Table 1. Words as AOIs

AOI	LENGTH (characters)	RECOGNITION RATE (%)	FREQUENCY
Retail	6	2,80	10624
Mainstay	8	6,90	772
To spring up	9	16,70	328
Catering	8	22,20	1670
Souvenirs	9	40,00	1033
To pour into	9	48,60	874
Accommodation	13	81,90	2133
Domestic	8	82,00	27446
Survey	6	87,50	32827
Agriculture	11	92,00	11750
Traveler	8	95,80	2907
To travel	6	98,60	36197
OVERALL MEAN	8.41	56,25%	10713

2.2.2. Stimulus

A standardized reading text was used to promote validity and reliability. The text was an IELTS General Reading passage retrieved from the internet (http://www.ielts-exam.net/docs/reading/IELTS_Reading_General_13_Passage_1.htm.). As the passage was too long for an eye-tracking study, only its first half was adopted as the text stimulus. The reading passage comprised 1297 characters, 203 words, and 11 sentences with Times New Roman, 18-pt font. The extracted passage was divided into 2 homogenous parts ready to be visualized on a 23-inch TFT monitor. To avoid any bias and to check whether participants really read for comprehension purposes during the experiment a multiple choice comprehension test with 3 items was prepared by the researcher. This test was given to the participants immediately after the eye-tracking session to avoid any time-decay effect on their memory. Most participants were observed to have read properly and to have responded correctly to all 3 questions.

2.2.3. I-WPM: Computing Reading Rate by Eye Movements

Rather than depending on subjective traditional estimation of word per minute (wpm) as the reading rate, this research used participants' eye movements to compute their reading rate, which depended entirely on eye movement data. Unlike other traditional techniques which primarily rely on how many words are read in a given time, this technique offers a robust, objective and accurate means of determining reading rates. In this research, wpm calculation with eye movements was named 'I-

WPM'. I-WPM depends principally on the formula of Bullimore and Bailey (1995) by which they calculated the reading speed of maculopathy patients. Contrary to traditional wpm calculation, this formula directly and objectively involves both forward and regressive saccades with dwell time to compute how many characters are read in a second. To benefit from this formula in second language reading, the researcher assimilated and developed it one step further: task features were added to the formula to allow it to calculate how many words were read in the given time. Primarily, the formula is as follows:

$$\frac{Letters}{Second} = \frac{Total\ Saccades}{Dwell\ Time\ on\ Task\ (second)} \times \frac{Total\ Forward\ Saccades}{Total\ Saccades} \times \frac{Total\ Task\ Character\ Count}{Total\ Forward\ Saccades}$$

All saccadic data (total saccades, regressive saccades, forward saccades, dwell time) were extracted from eye-tracking software. To find the Reading Rate (RR), this formula proposes that Total Saccades divided by Dwell Time equals the Fixation Rate (FR). Total Forward Saccades are computed by subtracting Regressive Saccades from Total Saccades. Then, Total Forward Saccades divided by Total Saccades equals the Forward Saccade Ratio (FSR). The Total Task Character Count divided by the Total Forward Saccade equals the Characters per Forward Saccade (L/FS).

And it follows from this that:

$$RR = FR \times FSR \times L/FS$$

At the end of the calculation, RR refers to how many characters are read in a second. To find out how many words are read in a minute in a second language, the following equation was developed:

$$\frac{Task\ Character\ Count}{Task\ Word\ Count} = Mean\ Character\ Count\ per\ Word$$

Then:

$$RR \times 60 = Characters\ Read\ per\ Minute$$

And then:

$$\frac{Characters\ Read\ per\ Minute}{Mean\ Character\ Count\ per\ Word} = Words\ Read\ per\ Minute$$

In other words:

$$I - WPM = \frac{RR \times 60}{MCC/W}$$

2.3. Data collection procedures

All participants were volunteers and ignorant of the research questions. To define learner proficiency levels, a sample IELTS General Reading test was conducted. Before their eye-tracking session each participant individually undertook the vocabulary knowledge scale as their pre-test. Each participant then sat for the eye-tracking session one-by-one under the direction of the researcher. Learners were reminded about using the contextual clues to infer unknown word meanings and reread unknown words freely. No time limit was set: this was to avoid anxiety and emotional arousal which might cause reactivity and inflate second pass time values. A calibration procedure was carried out using a 9 point grid calibration setting. Texts were then presented in Times New Roman, 18-pt font, on a 23-inch 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. Immediately after each experiment, the

participants were given the unannounced post-test. At this point they also took the brief comprehension check test. Including tests and experimental procedures the average participant completion duration for all procedures was about 15 minutes.

3. Results

All statistical assumptions were tested and met including normal distribution, linearity, sample size, outliers and homoscedasticity.

3.1. Second Pass Time and Rate Relative to Word Familiarity, Vocabulary Knowledge and L2 Reading Proficiency

For research question 1, it was hypothesized that unknown words were revisited more than known words. A similar effect was also expected for different vocabulary knowledge and proficiency levels. Unknown words were observed to have significantly more second pass duration (m=170, sd= 212) when compared to known words (m=96, sd= 161); t(71)= 2,144, p = 035.[i] As known words were less prone to revisits, second pass time and rate were expected to be affected by individuals' reading proficiency and the level of known words in the text. Regarding vocabulary knowledge, participants were classified into 2 homogenous groups by cluster analysis. The weak group (N=32) recognition rate was between 16% and 50% while that of the strong group (N=40) ranged from 58% to 91%. Proficiency levels were determined by an IELTS test. The results were as follows:

Table 2. Second Pass Time and Rate Relative to Reading Proficiency and Vocabulary Knowledge Levels

	VOCABULARY KNOWLEDGE		*PROFICIENCY LEVEL*		
	STRONG	WEAK	B1	B2	C1
Second Pass Time (ms/sd)	38/41	34/34	50ms/42,5	33ms/35	17ms/21,2
Second Pass Rate (%)	12	10	12%	11%	10%
N	40	32	25	37	10

Contrary to expectations, second pass duration and rate did not significantly differ among word recognition rates; identical values were found. On the other hand, the results were found to be partially consistent with the hypothesis regarding proficiency level. All proficiency levels were observed to have a similar second pass rate; these were not found to be significant. However, regarding second pass duration, B1 learners' second pass time was of the highest value (m=50, sd=42,5) followed by that of B2 learners (m=33, sd=35). C1 learners were observed to have spent the least second pass time (m=17, sd=21,2). A significant effect of the proficiency level on second pass duration was obtained: [F(2,69) = 3,244, p = ,045]. As expected, Scheffe post hoc results were also found to be significant among the groups.

3.2. Learning Gains and Second Pass Time: The Effect of Vocabulary Knowledge and L2 Reading Proficiency

For research question 2, the hypothesis was that second pass duration has a facilitative effect on further word recognition and that the rate of accuracy and learning gains are affected by vocabulary knowledge and L2 reading proficiency. Given that attention can facilitate retention and incidental vocabulary acquisition in SLA (Robinson, 2003; Schmidt, 1990; Godfroid et al., 2013), the expectation was that second pass time values on an unknown word could predict its further recognition and retrieval from long term memory. Indeed this is why most L2 learners aim to infer new word

meanings by searching for contextual clues while reading. It was also predicted that the rate of further recognition would vary among the rate of words known in the text and L2 reading proficiency. The study used GEE logistic regression to estimate the effect of second pass time on further word recognition. The technique of Generalized Estimating Equations provides accurate and robust data analysis within subject designs in which each participant is tested under the same conditions, and with a dichotomous or binary outcome (Diggle, 2002; Ziegler, 2011; Godfroid et al., 2013). To avoid overestimation, GEE was used in the present research with a nested design rather than simple logistic regression, since this technique can blend repeated measures and logistic regression by allowing nesting test variables among participants. For the GEE procedure, post-test results were nested among the participants as the dichotomous outcome, and second pass time was taken as the predictor covariate. To obtain a more meaningful β_1 coefficient, the test was run with second pass time/100. The results of the odds calculation were multiplied by 1000 to obtain results for 1 second.

According to the results, then, second pass time was a significant predictor of the post-test recognition: Wald $\chi 2$ (1) = 4,530, p = ,033, β_1= 0,144. Depending on the related regression coefficients, however, the estimation was that a second pass time of 1 second longer on an unknown word increased its recognition in post-test by a mere 5%.[ii] This rate for learners with higher vocabulary knowledge was found to be 14% with significance; Wald $\chi 2$ (1) = 8,022, p = ,005, β_1= 0,246.[iii] On the contrary, no significance was found for weaker learners. Significant differences were also observed regarding proficiency levels. For B1 learners, second pass time was found to have no facilitative effect on further recognition. B2 learners were observed to have used second pass time more efficiently and their further recognition rate was 14% with significance; Wald $\chi 2$ (1) = 4,981, p = ,026, β_1= 0,239.[iv] This rate was highest for the C1 group; second pass time increased post test recognition by 46%[v] and found to be significant; Wald $\chi 2$ (1) = 8,274, p = ,004, β_1= 0,446. In sum, inference efficiency, learning gains and second pass time correlated only under certain conditions, namely, when a reader possessed high vocabulary knowledge and higher L2 reading proficiency. It should be noted that, in general, the second pass time facilitation rate was rather low (5%). This rate increased only with the increasing vocabulary knowledge and proficiency level, while, accordingly, second pass duration had no facilitative effect for learners with weak vocabulary knowledge and a low proficiency level.

3.3. The Effect of Second Pass Duration on L2 Reading Rate

Regarding research question 3, second pass duration was expected to have a negative effect on reading rate. Second pass time consists of regressive saccade(s) which are employed after forward saccade(s) or regressions. In some situations, the target region may even be revisited more than once, which refers to more than a single regressive saccade. In this research, given that regressive and forward saccades strongly determine reading rate, it was hypothesized that second pass time and reading rate are negatively associated; higher second pass values are in fact expected to cripple reading rate. Computed I-Wpm rates in L2 reading are as follows:

Table3. I-Wpm in L2 Reading

	N	*Mean (wpm)*	*SD*	*95% CI*	
				Lower Bound	*Upper Bound*
B1	25	175,94	29,13	163,91	187,97
B2	37	209,80	55,92	191,16	228,45
C1	10	239,35	70,36	189,01	289,69
Total	72	202,15	54,47	189,35	214,95

According to the findings L2 learners in general could read about 203 words per minute.[vi] While B1 learners could read approximately 176 words per minute, this rate was 210 words for B2 learners. C1 learners had the highest I-WPM rate, with 240 words per minute. The I-WPM variance among proficiency levels was found to be significant at the $p<.05$ level [$F(2,69) = 6,449$, $p =,003$]. As expected, this rate was somewhat slower than the L1 reading rate, assumed to be optimally around 250-300wpm[vii] (see Taylor, 1965; Carver, 1990; Rayner, 1998) . This finding indicated that even skilled L2 readers read at least 20% more slowly than skilled L1 readers.

To reveal the relationship between reading rate and second pass time, a simple linear regression with I-WPM as the dependent variable and second pass time as the predictor covariate was conducted. The results of the regression revealed that second pass time explained 11.5% of the variance ($R2=.11$, $F(1,71)=9.107$, $p=.004$). It was observed that second pass time significantly predicted I-WPM values ($\beta = -.486$, $p= .004$). That is, roughly, 100ms more second pass time on each of 12 words would decrease words read per minute by approximately 49.

4. Discussion

The findings were found to be consistent with previous eye movement research. In the study by Godfroid et al. (2013), second pass time on novel words was found to be approximately 182ms and 42ms for known words. In this research, second pass time for unknown words was found to be 170ms and 96ms for known words. Comparatively, the increase in second pass time on known words in this research was probably due to the nature of the words used, the L2 learner profile and the sample size. On the other hand, second pass time on unknown words was highly consistent. In this respect, it can be asserted that L2 learners' second pass time on unknown words was roughly between 150-190ms during reading, while it was 40-100 for known words. When compared to the research by William & Morris (2004) in an L1 setting, the findings of this research are rather inflated. According to these authors' findings, the unknown word second pass time was 77ms, while for known words it was 30ms. In the present study equivalent findings nearly doubled L1 values. Thus, it can be argued that L1 and L2 second pass characteristics are totally different. L1 revisits and contextual clue processing are both faster, and each demands less effort while the same processes are quite demanding and slower in readers at L2.

The findings in the present study reveal a facilitative effect of only 5% on second pass time on unknown words: a longer second pass time and a frequent second pass rate therefore did not necessarily lead to the recognition of a target word. Identical second pass time rates showed that most L2 learners commonly used contextual clues to infer word meanings regardless of their vocabulary knowledge and proficiency. Also, vocabulary knowledge did not have an effect on second pass time and rate; both weak and strong L2 learners attempted to infer meanings by using contextual clues with identical second pass time values. Despite isomorphic values, vocabulary knowledge was however found to be a strong predictor of accurate guessing and vocabulary gains. While strong vocabulary knowledge facilitated further recognition by 14%, weaker vocabulary knowledge was found to have no significant effect on readers' accurate inference or learning gain. These findings confirmed related studies (Waring & Nation, 2004; Barnett, 1989; Koda, 2005) in which knowing the surrounding lexical context was the major pre-requisite for correct guesses. In terms of proficiency, the findings revealed that success in inferring word meanings through the context and in vocabulary learning gains were proficiency-driven. Less skilled L2 learners have more second pass values while skilled readers need to revisit slightly less and pay less extra attention to unknown words. Despite their lower second pass time and rate, more proficient L2 learners made better use of context, made more accurate inferences and learned more, because they could easily integrate a new word into the syntactic construction in the text. This rate was found to be quite dramatic for weaker learners who tried to use

contextual clues more than proficient learners but could achieve neither accurate inferences nor vocabulary gains. These findings were found to be consistent with previous literature which asserts that due to weak syntactic and lexical skills, poor L2 learners are unable to use context to make reasonable and correct guesses (Fukkink & de Glopper, 1998; Gough & Wren, 1999; Nassaji, 2003; Swanborn & de Glopper, 1999). Most importantly, it was found that less skilled learners with poor vocabulary knowledge achieved only weak inferences, despite their higher second pass time and rate: this confirmed research by Nassaji (2003), in which he asserted that quality was more important than quantity in lexical inferences during reading. According to the present findings, readers' learning gains and quality of inferences were found to be positively associated with their proficiency and vocabulary knowledge. The quantity of second pass time values and rate had no noteworthy impact on readers' accuracy and learning; rather, the most significant factor was their existing lexical and syntactic skill.

The prime controversy however was what readers sacrificed to make their inference attempts during reading. This strategy is common but highly risky, requiring learners to make regressive saccades and reread related targets. As second pass time involves regressive saccades most of the time, inevitably participants' reading rate was affected by both second pass time and rate. The regression analysis showed that readers' attempts to use contextual clues to infer unknown word meanings consciously consumed a certain amount of reading rate. The findings indicated that second pass time slowed learners down during L2 reading regardless of their vocabulary knowledge and proficiency level. But, especially, the most adversely affected L2 learners were the weaker ones whose reading rate was crippled as they were already capable of only relatively slow rates of reading. These learners could not make efficient use of contextual clues but still insisted on making inferences and so lost a considerable amount of their reading rate (about 30%) besides making inaccurate guesses. These learners would surely be the most affected by disadvantages of dysfluent reading such as lack of motivation, lesser exposure to novel structures, departure from focus on meaning and problems of comprehension.

5. Conclusions

This research examined the role of inferring word meanings from context in L2 reading, and scaled its pedagogical outcomes and any possible disadvantages via the use of eye-tracking. The primary finding was that efficiency of inferences and vocabulary gains were dependent on existing reader proficiency and vocabulary knowledge. The amount of extra attention paid to a word after initially exiting its region in the text did not result in additional accurate inferences and learning unless learners were above a certain proficiency level and had a proper active vocabulary storage. On the other hand, inferential attempts were found to be demanding, which used up and depleted the reading rate during L2 reading. This consumption proved to have impairing effects especially for weak learners who already struggled to make efficient use of contextual clues. For these learners, a decrease in their reading rate would surely have adverse long-term effects such as reduced motivation to read, inability to acquire new words by reading and difficulty with comprehension. Employing this strategy should therefore be handled with care; it is strategic and efficient only for L2 learners at least in the B2 level.

Eye movements in SLA have been gaining importance in the analysis of second language topics for a few years now. Recently, novel eye movement measures and innovative methodologies have been introduced for SLA purposes, for example Scanpath Analysis (see Godfroid et al., 2015). In this respect, the present research proposed two eye movement measures for use specifically in second language research. The first of these is the 'second pass time' which was treated as an indicator of a reader's use of contextual clues to infer new word meanings (also see Godfroid et al., 2013). The findings and results were largely consistent with previous related literature, which means that second pass time can be used to measure such processes in SLA research. The second measure was the 'I-

WPM' method which refers to computing the reading rate of L2 readers by using their eye movement data, including forward saccade ratio, dwell time and task features. I-WPM standards for different L2 proficiency groups were also consistent with previous reading literature and confirmed expectations. When the rising trend of eye movements is taken into consideration, these two eye movement measures seem promising for future SLA research.

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Appendix A.

A.1. Text Stimulus (AOIs in bold)

AUSTRALIA

Have you ever travelled to another part of your country and stayed for a few days? **Travel** within one's own country is popular throughout the world. And, according to a **survey** carried out in Australia in 2002, **travelers** are tending to spend more and more money on their holidays.

The **Domestic** Tourism Expenditure Survey showed that domestic travelers – those travelling within the country – injected $23 billion into the Australian economy in 2002. As a result, domestic tourism became the **mainstay** of the industry, accounting for 75 per cent of total tourism expenditure in Australia. International tourism, on the other hand, added $7 billion to the economy. Overall, in present dollar terms, Australians spent $7 billion more on domestic tourism in 2002 than they did when the first survey of tourist spending was completed in 1991.

Thus, tourism has become one of Australia's largest industries. The combined tourist industry now accounts for about 5 per cent of the nation's gross domestic product, compared with **agriculture** at 4.3 per cent and manufacturing at 8 per cent. Tourism is therefore an important earner for both companies and individuals in a wide range of industries. For example, the transport industry benefits from the extra money **poured into** it. Hotels **spring up** in resort areas to provide **accommodation**, and the **catering** industry gains as tourists spend money in restaurants. The **retail** sector benefits as well, as many tourists use their holidays to shop for clothes, accessories and **souvenirs**.

A.2. Sample pre-test and post-test

WORD	OPTIONS	TURKISH MEANING(S)
AGRICULTURE	☐ I KNOW THIS WORD!	
	☐ I AM FAMILIAR BUT NOT SURE.	
	☐ I HAVE NO IDEA!	

NOTES

[*] Unknown words were coded as '0', known words as '2' and familiarity as '1'. Unknown and known word second pass times were computed with 'if' cases for each participant (eg. Compute second pass time if word is 0). The familiarity option was excluded in computations as it was used as the control variable.

[*] Related coefficients are as follows: $b_0 = -1{,}204$, $b_1 = 0{,}144, \exp(b) = 1{,}155$

[*] Related coefficients are as follows: $b_0 = -1{,}712, b_1 = 0{,}246, \exp(b) = 1{,}279$

[*] Related coefficients are as follows: $b_0 = -1{,}379$, $b_1 = 0{,}239, \exp(b) = 1{,}270$

[*] Related coefficients are as follows: $b_0 = -1{,}503$, $b_1 = 0{,}446, \exp(b) = 1{,}562$

[*] This rate was found to be rather different from the one asserted by Segalowitz et al. (1991). However it should be noted that this research did not include beginner L2 learners (A1 and A2) who would have reduced the I-WPM rate to a great extent.

[*] In Rayner (1998), wpm for a skilled reader in L1 was reported as averaging 308. Maximum wpm was 378; minimum wpm was 230.

Yabancı Dil Olarak İngilizce Okuma Sürecinde Kelime Çıkarım İşlemlerinin ve bu İşlemlerin Okuma Hızına Etkilerinin Göz Takibi ile Ölçülmesi

Öz

Bilinmeyen kelimelerinin anlamlarının içeriksel ipuçları kullanılarak çıkarsanması Yabancı Dil Olarak İngilizce öğrenenler arasında oldukça yaygın bir stratejidir. Bu çalışma göz takibi tekniğini kullarak, (a) okuma sürecindeki aşinalık etkilerinin çıkarsamaya etkilerini; (b) farklı kelime ve seviyelerdeki İngilizce öğrenenlerin çıkarsama başarılarını ve (c) bu çıkarsamaların okuma hızı üzerindeki etkisini ölçmeyi amaçlamaktadır. 72 katılımcıdan elde edilen göz hareketi verilerine göre doğru çıkarsama ve öğrenim kazanımları doğrudan kelime blgisi ve seviye ile ilişkilidir. Dahası, doğru çıkarsama ve öğrenme kazanımları anlamlı iken, bu stratejinin uygulanması okuma hızında azalmaya sebep olmaktadır. İkinci geçiş zamanı ve I-WPM değerleri de önceki çalışmalar ile tutarlı bulunmuştur.

Keywords: Yabancı Dil Olarak İngilizce'de okuma, göz takibi, ikinci geçiş zamanı, kelime çıkarsama, okuma hızı

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