Attention guidance EMME paradigm for reading task completion in a foreign language

Nina Zdorova*
Center for Language and Brain
HSE University
Moscow, Russian Federation
Department of Experimental Study of Speech
The Institute of Linguistics of the Russian Academy of Sciences
Moscow, Russian Federation
nzdorova@hse.ru

Daria Kozlovskaia*
Center for Language and Brain
HSE University
Moscow, Russian Federation
dkozlovskaya@hse.ru

Abstract

The Eye Movement Modelling Examples (EMME) paradigm is a guided attention technique that uses a recorded expert's gaze during a task completion to visualize their cognitive processing to a novice learner and to facilitate a transfer of an abstract instruction into practice and more successful learning. Recent studies showed a positive effect of EMME in tasks with a strong visual or algorithmic component, but not in abstract or more creative tasks. The present pilot study tested the EMME paradigm in a reading task completion in English as a foreign language, where students were supposed to acquire and apply reading strategies like skimming and scanning. We observed a positive effect of EMME that reduced the total time of the task completion with a preserved comprehension accuracy. However, there was no evidence in reading data that reading strategies were applied, which unfolds a discussion of the limitations of EMME.

Keywords

guided attention, reading strategies, eye tracking, EMME

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1 Introduction

Reading strategies can be defined as a series of specific goal-directed mental operations that control and modify reader's efforts to decode and understand a text [Weinstein and Mayer 1983, p. 315]. In teaching a foreign language studies [Agustin et al. 2023; Azmi et al. 2020; Nimah 2022], it was shown that reading comprehension and reading rate improve from application of reading strategies like *skimming* and *scanning*. *Skimming* refers to reading for a gist that enables a reader to answer general questions regarding the main idea of the text [Brown and Abeywickrama 2019, p. 213]. *Scanning* stays for reading with a search for specific information or a detail [Brown and Abeywickrama 2019, p. 209]. In eye movements, the use of the strategies is primarily observed in different reading times and saccade amplitude [Strukelj and Niehorster 2018].

Whereas the explanatory definitions of skimming and scanning may sound intuitively clear, their acquisition in a foreign language together with their application under time pressure in examination settings is more challenging. Namely, it requires a transfer of an abstract concept in the professors' instruction to the practice. Hence, relying on the eye-tracking evidence in the differences between reading strategies and the rationale behind using a guided attention technique for teaching and training, [Grant and Spivey 2003; Litchfield et al. 2010], the present study suggests using the meta-information about eye movements while reading a text with a certain strategy in order to teach students these strategies.

2 Related Work

A guided attention technique that was first introduced in [Van Gog et al. 2009] and that is now gaining its popularity in teaching due to its positive effects on learning outcomes (for review see [Emhardt et al. 2023; Xie et al. 2021]) is the *Eye Movement Modelling Examples (EMME)* paradigm. This is a method of instruction and navigation through a task, where a task performer is given a demonstration of an expert's eye movements while completing the same task. However, the efficiency of EMME depends on the task type being effective in tasks with a significant algorithmic or visual component [Jarodzka et al. 2013; Roach et al. 2019; Van Gog et al. 2009] and less effective in abstract and more creative tasks [van Marlen et al. 2016].

The use of EMME in reading research was so far limited to reading an illustrated text [Mason et al. 2015, 2016, 2017; Scheiter et al. 2018] and demonstrated surprisingly positive learning effects in that area taking into account that reading is not a strict algorithmic task. The present study suggests the use of the EMME paradigm for reading tasks training, which remains understudied. We hypothesized that the visualization of an expert's gaze while skimming and scanning a text in a foreign language will enhance students' application of these strategies in reading task completion, which should

*Both authors contributed equally to this research.

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be observed in different reading times and saccade amplitudes between the strategies, as well as in a faster task completion with preserved comprehension accuracy after the EMME presentation.

3 Methods

In a pilot study, we collected eye movement data from 20 participants (17 women; Mage = 20.35 years, SD = 0.49, age range 20–22), who were advanced L2 English learners while completing a reading task. Their proficiency according to the university English exam on a scale 1-10 with 10 as the highest was on average 7.6 (SD = 1.27, range 5-10). The average self-rated reading proficiency on the same scale was 8.05 (SD = 0.89), and their self-reported current reading exposure in English was 7.05 (SD = 1.57).

Experimental reading materials were 16 academic texts 77-118 words in length (Mean = 94.3, SD = 13.9) with a comparable complexity (Mean Gunning Fox Index was 19.4, SD = 1.9, range 16.8-22.3). Texts were equally distributed across four conditions: for skimming before EMME, for scanning before EMME, for skimming after EMME, and for scanning after EMME. The reading task was to read a text and answer a comprehension question with multiple-choice options. In all conditions there was a written instruction before the text presentation that prompted which reading strategy was to be applied.

Experimental procedure used block design in line with experimental conditions, stimuli within a block were counterbalanced. The conditions with the EMME presentation showed two videos with gaze replay of an English professor who was instructed to skim and scan a practice text correspondingly. Expert's eye movements were superimposed onto the texts as a moving solid translucent yellow dot.

Participants' eye movements were recorded with the EyeLink 1000+ Desktop Mount eye-tracking system at a sampling rate of 500 Hz [SR Research Ltd 2020]. The stimuli were displayed in black Arial font, font size 22 pt., on a light-gray background of the 27" monitor with 1440×2560 screen resolution and 144 Hz refresh rate in a vertical orientation so that both a text and comprehension question were displayed on the same screen page. Participants were seated 88 cm from the screen with their head positioned on a chin rest. A nine-dot calibration was used.

Data analysis was performed in R [R Core Team 2023] and included a paired t-test for comprehension accuracy depending on the condition (before EMME / after EMME) and mixed-effects models built with lme4 package [Bates et al. 2015] for two eye-tracking measures: total viewing time in the interest area (the whole screen with the text, a question, and answer options) and saccade amplitude. Both dependent variables were log-transformed for the normality of data distribution. Each model had three independent variables: reading strategy (skimming / scanning), condition (before / after EMME), and English exam grade. Random effects were participant number and trial number.

4 Results

Descriptive statistics of the total viewing times and saccade amplitude is provided in Table 1. We found no statistically significant differences in comprehension accuracy before and after EMME presentation (t = 0.41, df = 159, p = 0.7). However, we observed a significant decrease in total viewing time (Est = -0.22, p < 0.001) and significant increase of saccade amplitude (Est = 0.08, p < 0.001) in the condition after the EMME presentation. Participants with a higher English exam grade needed overall less total viewing time (Est = -0.23, p = 0.009). The results from the regression models are summarized in tables 2 and 3 below.

Table 1: Means and SD of eye-tracking measures and comprehension accuracy across reading strategies and conditions.

Condition	TT	SA	Accuracy
skimming before EMME	30.24 (14.8)	7.29 (1.28)	0.85 (0.1)
scanning before EMME	24.11 (8.9)	8.16 (1.27)	0.88 (0.09)
skimming after EMME	37.13 (21.25)	7.65 (0.89)	0.79 (0.1)
scanning after EMME	29.77 (20.4)	8.02 (0.99)	0.83 (0.1)

TT - Total viewing time, sec; SA - Saccade amplitude, degrees of visual angle; Accuracy - Comprehension accuracy.

Table 2: Model estimates of total viewing time. Significant effects are marked in bold.

Predictors	Estimates	SE	Statistic	p
(Intercept)	12.10	0.58	20.90	**<0.001**
after-EMME condition	-0.22	0.05	-4.64	**<0.001**
reading strategy (skimming)	-0.14	0.08	-1.80	0.291
English exam grade	-0.23	0.07	-3.10	**0.009**

Table 3: Model estimates of saccade amplitude. Significant effects are marked in bold.

Predictors	Estimates	SE	Statistic	p
(Intercept)	2.08	0.19	11.06	**<0.001**
after-EMME condition	0.08	0.01	6.34	**<0.001**
reading strategy (skimming)	-0.02	0.03	-0.64	1.000
English exam grade	-0.01	0.02	-0.41	1.000

5 Conclusions and Future Work

In the pilot study of the EMME paradigm effectiveness for reading task completion in a foreign language, we found a significant positive effect of EMME in reduced times of the task completion and greater (i.e. more targeted) saccade amplitude with preserved comprehension accuracy. However, we found no statistically proven evidence in eye movements measures that reading strategies were actually applied as they were expected to. This makes us conclude that participants did improve their reading task completion after the EMME presentation, but not necessarily in the way of applying the strategies. In this regard, it poses a great potential to investigate the presence or absence of reading strategies applied by means of other eye movement measures and investigate whether they change due to the guidance by EMME.

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A The direction of the EMME effects in the regression models

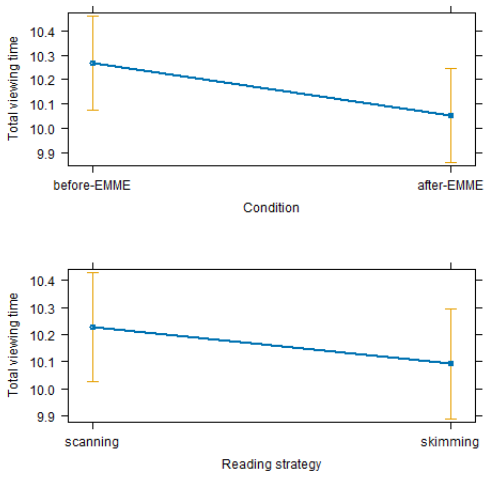

Figure 1: Main effects of the EMME condition and reading strategy on total viewing time

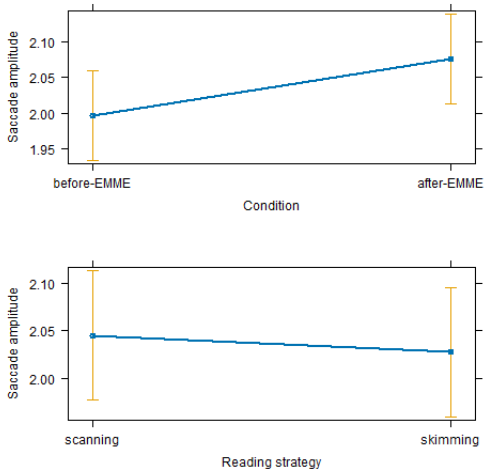

Figure 2: Main effects of the EMME condition and reading strategy on saccade amplitude

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