The Effect of Fatigue on Eye Movements and Metaphor Comprehension in Reading

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Abstract

A controversial question in the research on processing metaphorical language is the analysis of processing time. Different models have been proposed without reaching a consensus regarding the core processing properties and their temporal dynamics (Brisard et al., 2001; Gibbs, 1992; Glucksberg, 2013; Bowdle & Gentner, 2005). The methodological framework of the current study is based on eye movement analysis (cp. Just & Carpenter, 1980). Our main research perspective is to explore a possible impact of the metaphorical content on the characteristic eye movements in reading. Additionally, we analyze the impact of fatigue on the metaphor comprehension. Three different texts, containing (a) simple, (b) complex or (c) no metaphors were used as experimental stimuli. Eye movements were recorded using IViewX Hi-Speed system. Our results indicate that (1) average processing time is shorter in fatigued participants and (2) contrary to non-fatigued participants the shortest fixation times are observed when reading text without metaphors. Comprehension was not affected by complexity of the text or the level of fatigue.

Introduction

Metaphor is a mapping of a source domain (a non-metaphorical understanding) of an object or event onto a target domain, i.e., a metaphorically transferred understanding of it. Metaphors have a great importance in everyday communication not only by highlighting certain aspects of the target, but also by helping explaining different terms and concepts (Lakoff & Johnson, 1980; Lakoff, 1992).

Some of the questions on metaphor perception and comprehension that still have not been completely resolved are: what determines which aspects of the target and vehicle will be combined (metaphorical mapping) and is the assignment of a metaphorical meaning faster than the non-metaphorical meaning. Further, it is not clear whether in the processes of metaphorical meaning assignment involve the non-metaphorical (literal) meaning. When studying temporal dynamics of metaphor processing, the results show that reaction times for processing metaphorical language are tendentially higher than for literal language (Brisard et al, 2001), suggesting that the literal meaning of the sentence might be analysed prior the metaphorical meaning.

Another way of studying temporal dynamics of language comprehension is eye movement analysis that can also be used as an objective tool for studying cognitive processes (Hayhoe, 2004). Fixation duration, as well as the number of regressions are frequently used as tools for analysing moment-by-moment (online) information processing (Just & Cerpenter, 1976; Irwin, 2004; Raney, 2014).

Research questions

1. Is understanding metaphors a more time consuming process than the understanding literal language? I.e., is metaphorical mapping (linking non-metaphorical and metaphorical information) more time consuming than the processing of literal language?
2. Whether and how does mental fatigue interfere with processing metaphorical language?
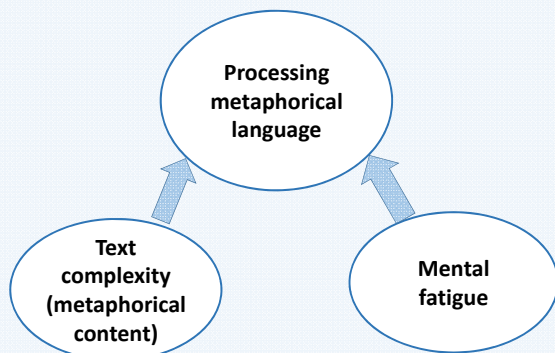

Method

Sixteen subjects (2 males, 14 females), aged 19-26, participated in the experiment. 8 subjects performed the task in the morning (non-fatigued) and the other 8 performed the task in the evening (fatigued) .

3 different texts containing simple, complex or no metaphors were presented to the participants. The texts were generated based on a study material of Latvian literature for the 10th grade students.

The task was to read the 3 texts in a randomized order and to answer questions regarding the content of each text.

Eye movements were recorded with a video-oculograph *iViewX Hi-Speed 1250Hz*. Stimuli were presented on a CRT (1280 x 1024 pixels) screen. The distance between the participants' faces to the screen was 60 centimeters. During the experiment the participant's head was fixed. Data was analyzed with the program *BeGaze2*. Further statistical analysis was conducted with MS Excel and IBM SPSS software.

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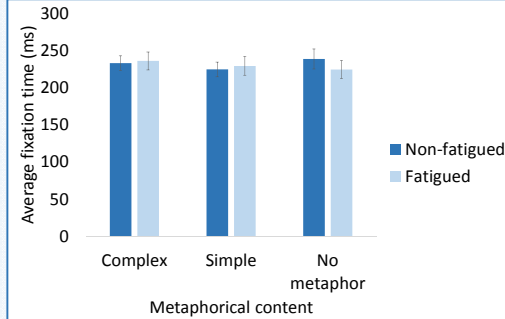
Results

Wilcoxon signed-rank test was performed to evaluate the differences between the average fixation times for each participant reading texts with different metaphorical content.

Mann-Whitney U test was performed to evaluate the impact of fatigue on the average fixation time.

Although a tendency can be observed that contrary to non-fatigued participants the average fixation time for the fatigued participants is smaller in the case of reading texts containing no metaphors, the statistical analysis (Wilcoxon signed-rank test) does not confirm the results (p>0.05). This means that the type of the stimuli does not statistically influence the information processing time (t.i. the average fixation time) for both the non-fatigued and fatigued subjects. Furthermore, when analyzing the differences between fatigued and non-fatigued participants, no statistically significant differences were also found (Mann Whitney-U test, p>0.05).

No statistically significant differences were observed when comparing the average number of refixations when reading texts with different complexity of metaphorical content (Wilcoxon signed-rank test, p>0.05), as well as comparing results for non-fatigued and fatigued participants (Mann-Whitney U test, p>0.05).

Although the fatigued participants demonstrated a slightly higher precision when answering the questions about the text, statistical tests did not show a significant difference: comprehension was not affected by complexity of the text or the level of fatigue.
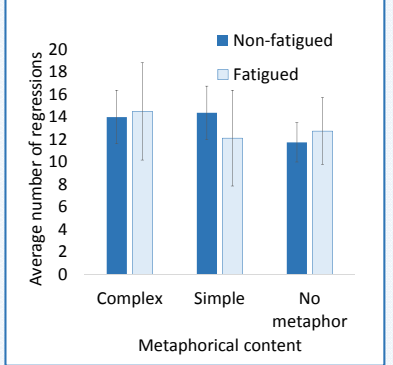
Discussion

Eye movement analysis was used to explore the possible impact of the metaphorical content and mental fatigue on the eye movement patterns in reading. The results demonstrate that neither processing time (i.e., average fixation duration) nor the number of regressions were significantly affected by metaphor complexity. In our study metaphors were presented as embedded in a wider context; therefore it is not surpising that the results are consistent with the study by Columbus et al (2015), demonstrating that when the methaphor is supported by rich prior contextual information, metaphorical sentences are read as quickly as literal ones.

Previous studies analysing the influence of fatigue on the performance of different visual and cognitive tasks, demonstrate ambient results (Saito, 1992; Stasi et al, 2014). Saccadic velocity analysis (Stasi et al, 2014) indicates minor changes in eye movement patterns after prolonged cognitive task, although a performance of another cognitive task afterwards was not affected. In our study we demonstrate similar results: although we did not observe significant changes in fixation and regression patterns, we show – consistently with Stasi et al (2014) – that short period cognitive task performance was not affected by fatigue.

Future directions

- Analyzing gaze patterns when reading metaphors with or without prior context;
- Analyzing gaze patterns when reading different type of metaphors (spatial, poetic, et al.)

Acknowledgement