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# Generation of Bridging and Predictive Inferences during Reading Comprehension: A Brain Stimulation Study

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Submitted in partial fulfillment of the requirements for the Master's Degree

in the Faculty of Education, Bar-Ilan University

Ramat-Gan, Israel 2022

**Abstract**

Reading comprehension is the ability to understand and to logically integrate linguistic ideas into a bigger and wider meaningful notion. This ability involves many mechanisms and cognitive procedures. One of them is Inference making. Inference making enables joining different parts of text, and integrating parts of text and the reader's personal knowledge. There is a wide range of inferences types, and at the present study we focused on two main types. Predictive inferences- relate to the ability to predict future events in the text. These inferences rely substantially on the reader's memory, require cognitive resources and considered as non-automatic. Bridging inferences- relate to the ability to connect between different ideas of the text. These inferences take part while reading, they are more automatic and consume less attention resources. In light of the connection between inferences and reading comprehension, various intervention programs have been constructed to enhance inference making among readers (Bos, De Koning, Wassenburg & Schoot, 2016). Part of the programs tried to improve reading comprehension through improving working memory, due to a strong connection between working memory and inference making (Cain et al., 2004; Carretti, Caldarola, Tencati & Cornoldi, 2014). These intervention programs lasted several weeks and required long training.

In the current study we examined the possibility of improving inference making in a faster and more direct way by using electric brain stimulation technique (tDCS- Transcranial Direct Current Stimulation). tDCS is a low-intensity extracranial electrical stimulus, a non-invasive technique that allows the creation of changes in cortical arousal in certain areas of the brain. tDCS has been used extensively in research in a variety of fields and populations (Nitsche et al., 2008). In this study, we used tDCS in Broca's area, which is located in the Inferior Frontal Gyrus (IFG) of the left hemisphere. This area is linked to verbal abilities in general, and in particular to higher order understanding, sentence understanding and inference making ability. The purpose of this study was to examine whether tDCS stimuli to Broca's area would improve inference making among normal adults. Moreover, to check which types of inferences would improve as a result of the stimulation. Finally, to examine how it might be influenced by the participants' working memory.

For this purpose, 40 participants were recruited to our study for two sessions: one session included a memory test (verbal or phonological), following different electrical stimulation (active- electrical stimulation, SHAM- placebo stimulation). Finally, they underwent a task to evaluate their ability to arouse inferences. In the second session they underwent a different memory test, a different electrical stimulation and the inference evocation task.

Results showed that active stimulation did not affect inference making compared to SHAM stimulation, so that inferences evoked equally under the two stimulation conditions. In addition, results showed no differences between the different types of inferences (bridging, predictors), so that the two types of inferences evoked equally. Furthermore, results indicated that participants with low working memory evoked fewer bridging inferences after active stimulation (compared with SHAM stimulation) than those with high working memory.

In other words, active stimulation reduced the arousal of bridging inferences among participants with low working memory. One possible explanation for this finding is that since the Broca's area is also linked to homographic word (ambiguous words that have multiple meanings) processing, and given that third of the test words in the experiment (in retrospective examination) were homographic. Therefore, the active stimulation to Broca's area may have led to further irrelevant interpretations for the target words in our method, leading to a late response time at the experiment.

Furthermore, since the present study involved many parameters such as the intensity of stimulation, duration and frequency of the stimulation, etc., it might have been not precise enough for the present study's purposes. Therefore, the stimulation did not arouse more inferences under the condition of active stimulation as we expected. The present study is in line with recent literature arguing that the reliability of tDCS is questionable, especially in specific fields of research such as cognition and under a normal research population (as is the case in the present study). Indeed, recent meta-analyzes have found that under these conditions, the effectiveness of tDCS is negligible (Horvath, Forte & Carter, 2015).