Presented at CSLD/ESLP 2010, University of California at San Diego, USA as a poster

Affecting sentence comprehension by perceptual or linguistic manipulation

Martin Rakovský,[1] Stephanie Schreitter,[2] Igor Farkaš[1]
[1] Comenius University in Bratislava
[2] University of Vienna

We focus on situation models that underlie sentence comprehension, as proposed by situated and embodied language and cognition view. We provide results from two separate experiments that focused on how the process of constructing a situation model can be affected in a sentence comprehension task, either be perceptual manipulation (habituation to a particular color) or by linguistic (syntactic and/or semantic) manipulation of presented sentences.

In experiment 1, we illustrate the perceptually related effect on sentence comprehension, namely color habituation effect that implies the slowing down the color-sensitive neurons. We extend the hypothesis by Wiemer-Hastings and Kurby who showed that the visual cortex plays an important role in the representation of content words (using a color habituation paradigm). We extend their hypothesis and show that similar effects can be observed on the sentence level. In particular, the experiment focuses on habituation of color-selective (yellow and blue, considering the theory of opposing processes) neurons in the visual cortex that is followed by a cognitive task – recognizing sentences that contain a yellow or a blue concept (expressed either explicitly or implicitly). After habituation to one of these colors (shown on a screen for 2 minutes), the reaction times of recognizing a sentence containing a concept of the same color (e. g. word “banana” in case of yellow habituation) are longer than in the case of habituation to the opposite color. The habituation effect was evident when the color concept (in either color) was explicit in the sentence (e. g. “Cooked maize is a big delicacy.”) and in case of yellow color also when it had to be inferred (“John slipped on a discarded peel.”). These results support the hypothesis that in recognition of sentences containing a color concept, the participants create a situation model whose simulation includes the (low-level) representations of a corresponding color residing in the visual cortex. In this experiment, well-formed sentences were mingled with meaningless sentences whereas the subject's task was to judge whether the sentence was ok or not. However, only well formed sentences were used for subsequent evaluation.

In experiment 2, we deal with the hypothesis that arose from the previous experiment, namely that meaningless sentences are not a homogeneous group of stimuli but rather can differ in their degree of image vividness that can be required for constructing a situation model and that can be affected by specific linguistic manipulation. To investigate this hypothesis, we systematically affect the syntactic and semantic information (or both) in concrete sentences that were matched for sentence length and word frequency. An experiment is presented in which the reaction times of participants on four conditions is measured. The resulting mean reaction times can be ranked in the following order: $RT(ok) \ll RT(sem) \ll RT(syn) \leq RT(sem\&synt)$, where $\ll$ denotes the significant difference. This finding is interpreted as follows: (1) well formed sentences are are easiest to process (i. e. checking their well-formed-ness), (2) The subjects are less affected by semantic violation (e.g. “The girls is reading a new book.” vs. “The rain is reading a new book.”) than by syntactic violation (“The girl is read a new book.”). This might be due to subject's ability to personalize non-animate subjects (as often read in science fiction). (3) There is no difference between sem and sem&synt conditions (hence $\leq$). Afterwards, the participants performed a subjective evaluation of sentence vividness. The ranking was found to differ from that of RTs, namely $Viv(ok) \ll Viv(syn) \ll Viv(sem) \ll Viv(sem\&synt)$. This seems to suggest an alternative hypothesis that subjects find it easier to filter syntactic errors in making a situation model than dealing with semantic violations. Further experiments may be needed to resolve this issue.

Acknowledgement: Both experiments were performed by master students within MEi:CogSci programme. I.F. was supported by Slovak Grant Agency for Science (grants no. 1/0361/08 and 1/0602/10). Authors are thankful to Dr. Berry Claus for her kind assistance in designing the exp. 2.