Priming effects of spatial distance on semantic similarity: Abstract sentence comprehension is modulated by unrelated visual context

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During comprehension, a sentence-embedded word (e.g., *piano*) can guide visual attention towards its referent but also to semantically related objects (e.g., *trumpet*) [1,3]. In addition, visual context can rapidly facilitate language comprehension[1,2]. It is not clear, however, to which extent visual context information (e.g., distance between objects) can modulate incremental language comprehension even when it is neither referenced by, nor overtly lexically associated with, words in the target sentence. To the extent that this happens, situated language comprehension accounts will want to accommodate these effects.

We conducted three eye-tracking reading studies in which participants inspected a visual context with two playing cards in different positions before reading a sentence that described the relationship between abstract nouns (e.g., *stupidity* and *wisdom*). We predicted that spatial information could modulate semantic similarity processing[4]. To test this prediction we manipulated the distance between the cards (close vs. far) and the semantic similarity expressed in sentences like (1) and (2) (similar vs. dissimilar, respectively). If spatial distance can modulate semantic interpretation of similarity in real time, we should see its effects when semantic similarity is mentioned (at the ADJ, e.g., 'similar'). In principle, effects could appear even earlier (at NP2) since semantic similarity could be established as soon as the two abstract nouns have been read.

Begabung_{NP1} $\text{und}_{coord.}$ Weisheit_{NP2} sind_{VP1} freilich_{ADV} $\text{entsprechend}_{ADJ}$, das erklärte_{VP2} der Professor_{NP3}.
'$\textit{Talent}_{NP1}$ $\textit{and}_{coord.}$ $\textit{wisdom}_{NP2}$ $\textit{are}_{VP1}$ $\textit{indeed}_{ADV}$ $\textit{similar}_{ADJ}$, $\textit{explained}_{VP2}$ $\textit{the professor}_{NP3}$'

Dummheit_{NP1} $\text{und}_{coord.}$ Weisheit_{NP2} sind_{VP1} bestimmt_{ADV} verschieden_{ADJ}, das erklärte_{VP2} der Professor_{NP3}.
'$\textit{Stupidity}_{NP1}$ $\textit{and}_{coord.}$ $\textit{wisdom}_{NP2}$ $\textit{are}_{VP1}$ $\textit{certainly}_{ADV}$ $\textit{different}_{ADJ}$, $\textit{explained}_{VP2}$ $\textit{the professor}_{NP3}$'

Experiment trials consisted of three consecutive steps. First, participants inspected the cards, which moved from the center of the screen to different locations (far apart vs. close together for critical trials). Subsequently, participants read a sentence and judged (*yes* vs. *no*) whether it described possible facts based on their world knowledge. Next, a picture with two cards was presented and participants verified (*yes* vs. *no*) whether they were identical to the cards seen before the sentence.

The independent variables (card distance; semantic similarity) were identical across all three experiments. Between experiments, we varied how the cards related to the sentence. If their relationship influences visual context effects, then we should see a modulation of any spatial distance effects: In Experiment 1, critical trials (N=48) displayed the first two sentential nouns of the subsequent sentence, while most filler trials (N=72) had blank cards. In Experiment 2, by contrast, only fillers presented nouns of the subsequent sentence and participants learnt the first two sentential nouns of the experimental (and some filler) trials before each of six experiment blocks. This can reveal whether spatial distance effects emerge even when semantic information is separated from the visual context. In Experiment 3, all trials had blank cards.

Analyses of the eye-tracking data (each N=32) revealed rapid and extended interaction effects between spatial distance and semantic similarity in all three experiments with some time-course variation. In Experiment 1, we found first-pass (ADJ; NP3) and total-time (NP3) interaction effects, whereby reading times were shorter for sentences implying similarity (1) after seeing cards close together (vs. far apart), and vice versa for sentences implying difference (2). In Experiment 2 we observed these effects in regression path duration (ADJ) and total times (ADJ), and in Experiment 3, we only observed first-pass interaction effects (NP2; VP2). Our results suggest that sentence comprehension can be incrementally modulated by non-linguistic information even in the absence of direct referential or lexical-semantic associative links and that such modulation is relatively (but not entirely) invariant across different picture-sentence relationships.

References

[1] Tanenhaus, M. K., Spivey-Knowlton, M. J., Eberhard, K., and Sedivy, J. C. (1995). Integration of visual and linguistic information in spoken language comprehension. *Science, 268,* pp. 632–634.

[2] Knoeferle, P., Crocker, M.W., Scheepers, C., & Pickering, M.J. (2005). The influence of the immediate visual context on incremental thematic role-assignment: evidence from eye-movements in depicted events. *Cognition, 95*, 95-127.

[3] Huettig, F., & Altmann, G. (2005). Word meaning and the control of eye fixation: semantic competitor effects and the visual world paradigm. *Cognition*, *96*, B23–B32.

[4] Lakoff, G. & Johnson, M. (1999) *Philosophy In The Flesh: the Embodied Mind and its Challenge to Western Thought*. Chicago, IL: University of Chicago Press.