

# Using Space for Language: Deictic Pointers and Thematic Role Assignment

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## Introduction

Although language processing has traditionally been viewed as a modular process, there is a growing body of evidence suggesting that information from other domains such as vision and space may play a significant role in the way language is processed (e.g., Tanenhaus et al., 1995). For example, the use of space to indicate coreference is grammaticized in sign language and is prevalent in home-signs and the gestures that accompany speech. There is also evidence that space may play a role in the representations of thematic roles: experiments with normal subjects suggest that people tend to systematically associate thematic roles with certain regions of space (Chatterjee, Southwood, & Basilico, 1998).

We investigate whether space can play a functional role in thematic role assignment. Theories of embodied cognition hold that cognitive processes may use spatial locations to index information (Ballard et al., 1997). We explore the possibility that space can help bind nouns and thematic roles, aiding language comprehension.

## Experiment

In each of three experiments, subjects heard a series of 8 sentences that described events (e.g., “The fox ran from the barn to the well”) while simultaneously viewing black and white line drawings of the event participants (e.g., the fox, the well, and the barn). The images were arranged randomly within a 3x3 grid and appeared in a different configuration for each of the 8 sentences. Each sentence was presented 3 times in pseudorandom order and the images appeared in the same locations each time a particular sentence was heard.

In Experiment 1, subjects heard 24 test sentences (8 identical, 8 with nouns assigned to different roles, and 8 novel) and had to decide whether each sentence described an event they had heard during presentation. A blank 3x3 grid was displayed throughout the testing phase and subjects’ eye movements were recorded.

In Experiment 2, subjects heard the 8 “identical” sentences but altered so that in each one, one noun was followed by a beep. Subjects had to click on the location where that noun’s image had appeared during presentation.

In Experiment 3, the presentation phase was changed. Subjects were divided into two groups: in the Same condition, each time a sentence was presented the images associated with the sentence were displayed in the same configuration. In the Different condition, the images

appeared in different locations on each of the 3 presentations. After all of the sentences were presented, subjects were given a filler task that lasted an average of 5-7 minutes. Subjects were then tested as in Experiment 1.

## Results

Eye-tracking analyses from Exp 1 reveal that even though the screen was blank during test, subjects looked to the 3 target locations (the locations where the images had appeared during presentation) significantly more often than chance. In Exp 2, subjects accurately indicated which location was associated with each noun. This suggests that subjects associated the specific locations with the specific nouns in each sentence. In Exp 3, subjects in the Different condition performed significantly worse on certain trials than the subjects in the Same condition. Eye-tracking revealed that subjects remembered the locations of the images over 5-7 minutes.

## Conclusions

Even though the locations of the images were irrelevant to the task in Exp 3, subjects encoded the semantic information of the sentences better when the corresponding images were displayed in stable rather than varying positions. This suggests that linguistic processes may make use of spatial information when performing thematic role assignment. The fact that subjects retained the detailed spatial information associated with the lexical items over the course of several minutes is a novel finding. Typically, irrelevant spatial information (as in the Simon effect) is retained only for 500-600 ms. We propose a theory for how spatial indices could be utilized to bind thematic roles to nouns.

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## References

- Ballard, D.H., Hayhoe, M.M., Pook, P.K., Rao, R.P.N. (1997). Deictic codes for the embodiment of cognition. *Behavioral and Brain Sciences*, 20(4), 723-767.
- Chatterjee, A., Southwood, M.H., Basilico, D. (1998). Verbs, events and spatial representations. *Neuropsychologia*, 37, 395-402.
- Tanenhaus, M.K., Spivey-Knowlton, M.J., Eberhard, K.M., Sedivy, J.C. (1995). Integration of visual and linguistic information in spoken language comprehension. *Science*, 268, 1632-1634.