

A Multi-Dimensional Scaling Analysis of English Spatial Prepositions

Christina M. Manning, Herbert L. Pick, Jr., and Maria D. Sera

University of Minnesota

christie@turtle.psych.umn.edu

People are quite successful at finding their way around in the world by following another person's verbal directions. This is interesting and also somewhat surprising given that a verbal description of a space is limited in the information it provides compared to the information provided by the direct perceptual experience of moving around in an environment. Some previous research has looked at the similarity between perceptual representations and linguistic representations of spatial relations (for example: Hayward & Tarr, 1995), but there has been little empirical examination of the structure of spatial language itself. The main linguistic element by which we talk about spatial location in the English language is the closed-class set of terms called prepositions. In the present study the psychological structure of the meaning of 25 English spatial prepositions was examined. The goal was to determine the most salient dimensions of spatial meaning, and where the various prepositions fall along these dimensions. Different groups of participants rated the similarity in meaning of pairs of prepositions under different context conditions. The first condition was a neutral or no context condition where prepositions were presented alone (for example the words "in" and "on" were presented on a computer screen). Contexts were generated by embedding the prepositions in a carrier sentence containing a figure object and a referent object.

Average similarity ratings for preposition pairs were analyzed using multi-dimensional scaling (MDS). Four spatial dimensions emerged: verticality, containment, front/back, and distance. The dimension of verticality was

strongly evident in all contexts, and not much influenced by differences in context. The dimensions of containment, front/back, and distance also emerged consistently across different sentence contexts, but order of individual words within these dimensions changed with different contexts. Additional evidence for the validity of the MDS dimensions was found with a converging measure obtained by presenting a different group of participants with a drawing of each dimension and asking them to place prepositions in order along it.

Thus, the psychological structure of spatial terms is organized around four primary spatial dimensions. These dimensions are very robust across contexts, although the positions of individual prepositions move slightly from one context to another. It would seem that particular prepositions direct attention to the general spatial area being described by indicating a location along each dimension. Context may then modify or constrain the spatial meaning of the preposition. The meaning of each preposition is flexible enough to allow a shift in meaning according to context.