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Spatial updating with linguistically-encoded scenes

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Previous studies using perceptually-based scenes provide evidence that people are able to update egocentric relations effortlessly and in an on-line fashion when they change their position or simply their orientation in the scene (e.g., Presson & Montello, 1994). Such effortless updating, however, does not take place when the movement is only imagined (e.g., Rieser, 1989). Taken together, these findings suggest that the vestibular and kinesthetic cues that accompany physical locomotion serve as important inputs to the spatial updating mechanism.

In a series of experiments, Avraamides (in press) examined whether these findings extend to scenes that are not experienced directly via perception but are instead learned through language. Participants read narratives describing themselves in remote environments and were asked to locate objects after they had performed physical or imagined rotations. This procedure paralleled the one typically employed by studies with perceptual scenes with the exception that the described scenes were used instead. Spatial updating was assessed by comparing the latency for locating objects from the original perspective (that is, the perspective in which participants encoded the scene) and the remaining novel perspectives. Results from the first two experiments showed that latencies were longer for novel perspectives than the original perspective suggesting that participants did not update spatial relations at the time of rotation. More importantly, this pattern was found with both imagined and physical rotations. This result is at odds with the finding from studies with perceptual scenes showing that spatial updating takes place on-line with physical movements. A third experiment introduced perceptual markers at the time of encoding (colored circles were put at canonical directions around participants to indicate object locations) to encourage sensorimotor encoding of locations (i.e., encoding locations relative to an actual body-centric reference frame rather than to an imagined egocentric frame). In this experiment results were different and in line with the findings of previous studies; participants were equally fast when tested from the original and novel perspectives, provided that they had performed physical rotations. Taken together, the results from all three experiments suggest that spatial updating takes place effortlessly and in an on-line manner with physical rotations but only when objects are encoded within a sensorimotor framework.

Another result from these experiments was that participants were particularly slow when responding to objects located on their left or right. Although on the basis of previous studies (e.g., Franklin & Tversky, 1990) this result was expected, further results from the experiments showed that the difference between left/right and the other dimensions was smaller whenever the actual body-centric frame of the participant was aligned with the imagined egocentric frame centered on the narrative protagonist (i.e., both original and novel perspectives in the case of physical rotations and only the original

perspective in the case of imagined rotations). This result suggests that the orientation of one's body is important even when people are operating in a purely mental framework. One possibility is that people use bodily cues (e.g., their handedness) to select and assign verbal labels to the appropriate regions of space; the conflict of reference frames (body-centric vs. imagined egocentric) that exists when people reason about space from imagined perspectives could have made spatial-term assignment harder in those cases. Indeed, when a direction vs. dimension manipulation was introduced in Experiment 1 (i.e., participants responded by either choosing a direction or simply an axis), results revealed that the left/right difficulty was attenuated when participants did not need to distinguish the poles of an axis (e.g., when they could respond with "left-right" for either objects on the left or right). Compatible with the hypothesis that the actual body is important for spatial reasoning using verbal labels are results provided by Avraamides and Carlson (2003). In that study, participants received spatial instructions (direction and distance information) to mentally navigate a checkerboard grid. Results showed that movements to the left or the right were particularly slow when the instructions were to be interpreted on the basis of an imagined facing direction that was not aligned with the participant's actual facing direction.

In conclusion, the results from Avraamides (in press) suggest two things. First, effortless spatial updating seems to have two prerequisites: Physical movements and sensorimotor encoding. Because other studies typically use perceptual scenes, the sensory encoding requirement is always met. Second, the orientation of the physical body is important for spatial reasoning with linguistic terms (but see Avraamides, Klatzky, Loomis, & Golledge, in press).

References: See References section in Avraamides (in press). A preprint of this article, along with a reprint of Avraamides & Carlson (2003), is available at <http://www.psych.ucsb.edu/~avraamid/index2.html>