Finding where and saying where: Developmental relationships between place learning and language in the second year

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How do we remember locations and find our way back to them? After all, we regularly find our way, even, like our ancestors, without a GPS. Avoiding getting lost matters, as does finding your car in the middle of the night after getting off the airport shuttle, jet-lagged and weighted down with baggage. In addition to being able to represent locations spatially, we can also talk about them, using language like prepositions, which tell us about the relationship between things. For example, in the real world, you could walk to or point to the car's location in Figure 1, and also describe its position as *under* the tree *beside* the flowers and *in front of* the house. Does spatial language bear any relationship to our non-spatial representations of where things are? How do these systems (verbal and non-verbal) develop in relationship to each other?

Figure 1

There are different ways people can remember locations and navigate to them. One is ego-centric (related to ourselves), and another is truly spatial. You can remember that something is on the left of you (egocentric), and you can also remember that it is north (spatial). If you walk out the door of our infant lab, for example, the parking lot is on your left, and also to the west. No matter where you face, the parking lot will always be west of the lab, but if you turn 180 degrees to face the door, the parking lot will now be on your right. Place learning, the interest of this study, is the ability to calculate spatial locations using distances and directional information from distant features, regardless of

egocentric information (Newcombe, Huttenlocher, Drummey & Wiley, 1998; Sluzenski, Newcombe, & Satlow, 2004).

In young children, there is long developmental trajectory of spatial skill development. Initially, infants develop an awareness of their own movements, (Landau & Spelke, 1988; Lepecq & Lafaite, 1989; Rieser & Heiman, 1982; Tyler & McKenzie, 1990), and this egocentric information gradually is supplemented with spatial coding. In the second year of life, place learning emerges between 20-24 months (Newcombe et al., 1998; Sluzenski et al., 2004). For example, when children are faced with the task of finding a hidden object after a position change, only children older than 22 months can use external features (the skill involved in place learning) to increase the accuracy of their searches (Newcombe et al., 1998).

Developmentally, there are different theories of how language and spatial concepts emerge. The specificity hypothesis (Gopnik & Meltzoff, 1986; 1987) suggests that during the single word acquisition period of language development (15-24 months) there is a relationship between the emergence of linguistic skills and non-linguistic skills that rely on shared foundational knowledge (e.g. spatial navigation and spatial language skills). Prepositions, specifically, have been discussed as emerging from and capturing infants' perceptions of spatial relations, such as the locations of objects, as well as the path component of action events. For example, actions that involve going in or moving out will be captured as the prepositions "in" and "out" (Mandler, 2006). By these accounts, similar domains in cognition and language would be expected to show a relationship to each other during development.

The purpose of this experiment was to explore the relationship between prepositions and place learning at an age when both are emerging, looking at how children are able to begin to remember locations, and whether or not this spatial awareness can be seen in their first words. Children were tested using a spatial task adapted from the Morris water maze (Morris, 1984), and the MacArthur Communicative Development Inventory. In the place learning task, children were placed in a round enclosure and a puzzle was hidden under the floor at one location. Before each trial, children were spun, to disorient them, and placed down at a different starting position, and asked to find the hidden puzzle. Their search types and success at finding the puzzle were coded.

Figure 2: The place learning task apparatus. Note that during the task the puzzle was hidden under the pool's floor.

What we found was that older children had significantly larger expressive vocabularies than younger. In addition, they had significantly stronger spatial skills, as shown by searching in the correct area of the pool more often than younger children, as well as pinpointing the goal location (place learning) (see Figure 3). Although language and place learning both correlated with age, once age was partialled, there was no correlation between them. The crucial exception was prepositions, the acquisition of which was correlated with place learning. The finding of a spatial- specific language linkage, as both language and place learning undergo rapid change, suggests an intriguing story about the interaction between various cognitive systems, beginning as early in development as when the systems themselves emerge.

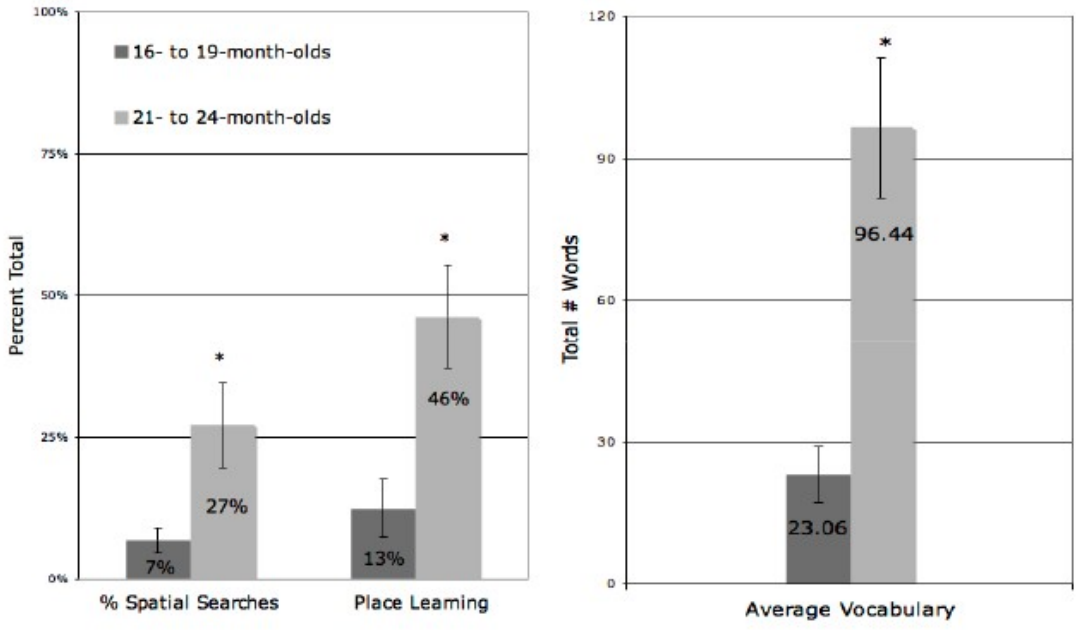

Figure 3

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