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The role of crawling and walking experience in infant spatial memory

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Abstract

This research explored infants' use of place learning and cue learning in a locomotor task across the transition from crawling to walking. Novice and expert crawling and walking infants were observed in a novel locomotor task—finding a hidden goal location in a large space. In Experiment 1, infants were tested with distal landmarks. Infants with fewer than 6 weeks of experience, either crawling or walking, could not find the goal location. All infants with more locomotor experience were more successful. Learning did not transfer across the transition to walking. In Experiment 2, novice and expert crawlers and walkers were tested with a direct landmark. Again, novice crawlers and walkers with fewer than 6 weeks of experience could not find the goal, whereas those with more experience could. Taken together, these findings suggest that infants' spatial learning is inextricably linked to mode of locomotion.

Keywords: Motor development; Locomotor experience; Spatial memory; Infant development

Introduction

For decades, psychologists, biologists, ethologists, and others have sought to understand how humans and other animals learn about space and remember spatial

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information. For most species, knowing where one has previously traveled is critical for survival. Spatial memory allows animals to remember the locations of things such as predators, home, and food. Navigational memory also allows animals to track their own movements through the environment. This enables animals to remember and revisit desirable locations (e.g., a large food cache) and to avoid undesirable locations (e.g., a predator's lair).

There is no single way of coding space; it all depends on what information is available to the user. There are two general categories of available cues: those with respect to the self and those with respect to external landmarks (e.g., Gallistel, 1990; Woodin & Allport, 1998). Within those categories, there are two different types of cues: those involving simple association and those involving distance and direction.

Self-referenced spatial coding involves encoding the position of the self while moving. A simple associative self-reference coding system is response learning, where what is remembered is a particular motor sequence. An example of response learning is a rat in a maze remembering to turn left twice and then right. This system is limited in that it is accurate only when the position of the coder and the spatial situation has not changed. A more complex self-reference system, one that requires distance calculations, is known as dead reckoning. Here, distance and direction of one's own movements are coded to continually update position. This method is also limited in that it is extremely difficult to gauge distance based only on one's own movements. Moreover, errors in one's calculations are difficult to detect and are magnified over great distances. Both response learning and dead reckoning are known as egocentric responding in the human infant spatial literature.

Externally referenced spatial coding involves noting spatial relations among objects and locations, such as landmarks, which are long-term stable reference systems for specific areas. Again, there are two kinds of spatial coding systems within this category. The simpler one is cue learning, where an association is established between a location and a visible landmark, typically one that is close by. The more complex type of externally referenced coding is place learning (also called allocentric responses). Place learning involves specifying the distance and relations between distal landmarks to find a location. In general, two landmarks are required to locate a third position.

Much early research has focused on self-referenced coding in infants (for a review, see Newcombe & Huttenlocher, 2000). However, response learning and dead reckoning are more limited and less useful than the external reference coding systems because they rely on (a) the environment remaining unchanged and (b) knowledge of distance traveled. In addition, most infants learn about space in an environment that contains cues, either direct or indirect. Thus, the current studies focused on the development of the two externally referenced coding systems: place learning and cue learning.

Development of place learning and cue learning in infants

One of the most robust findings on infants' spatial knowledge is that very young infants tend to use self-referenced cues (e.g., Acredolo, 1978; Bremner, 1978a,