Journal of Experimental Child Psychology 104 (2009) 313–325

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

Location representation in enclosed spaces: What types of information afford young children an advantage?

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ARTICLE INFO

Article history:
Received 27 September 2008
Revised 13 May 2009
Available online 27 June 2009

Keywords:
Location
Disorientation
Young children
Scalar dimensions
Composite information
Spatial representation

ABSTRACT

It has been suggested that young children can only reorient, locating a target object, when the geometry of an enclosed space provides distinctive shape information [e.g., Hermer, L., & Spelke, E. (1994). A geometric process for spatial reorientation in young children. *Nature, 370*, 57–59]. Recently, however, young children were shown to specify location in a square-shaped space, where geometry is uninformative, so long as scale-like information was available on the walls of the space [Huttenlocher, J., & Lourenco, S. F. (2007a). Coding location in enclosed spaces: Is geometry the principle? *Developmental Science, 10*, 741–746]. Here we build on this work by examining more closely what types of cues afford 18- to 24-month-olds an advantage in locating a target object following disorientation. Their performance was assessed when linear scale-like information was presented either in isolation or in composite form. It was found that, even in isolation, young children searched at the appropriate locations, with added benefit when presented as a composite. We suggest that linear scale-like dimensions, especially when available in composite form, play a critical role in supporting location representation in young children.

Introduction

It was once believed that young children were incapable of using information in the surrounding environment to specify the location of objects or places (e.g., Piaget & Inhelder, 1948/1967). During recent years, however, there have been numerous demonstrations of even toddlers relying on

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doi:10.1016/j.jecp.2009.05.007

geometric information about the shape of an enclosed space to locate a target object hidden at one of the corners of the space (e.g., Hermer & Spelke, 1994, 1996; for reviews, see Cheng & Newcombe, 2005; Lourenco & Huttenlocher, 2007). Despite the growing literature, questions concerned with how toddlers process location information such as geometry have been difficult to answer. Of particular importance is whether they can use only geometry to represent location or whether they are also capable of using other more general environmental cues. In the current study, we are concerned with characterizing more precisely how location is processed and remembered by young children. To this end, we examine whether particular types of environmental cues are advantageous when specifying the location of a target object.

Geometric information (shape of enclosed spaces)

In a seminal study, Hermer and Spelke (1994) showed that children as young as 18 to 24 months of age not only used geometric information about the shape of an enclosed space to specify location, but they also favored this information over nongeometric cues. In that study, young children were tested inside a rectangular room with and without a different-colored wall. There were four identical containers, one at each corner, and on every trial the child watched as a toy was hidden in one of the containers. Following the hiding event, and before being allowed to search for the toy, the child was disoriented by having the parent spin him or her around several times with the child's eyes covered. The disorientation procedure was critical because it prevented the child from relying exclusively on egocentric information (e.g., "to my left") to solve the location problem. In the condition without the different-colored wall, children searched for the hidden object at the two geometrically appropriate corners (e.g., the corners with the short wall to the left of the long wall), indicating that they could use the shape of the surrounding space to reorient and determine where to search for the hidden object. In the condition with the different-colored wall, children continued to rely on geometry; they did not use the additional nongeometric information to distinguish the corners (e.g., the corner with the short *blue* wall to the left of the long white wall vs. the corner with the short *white* wall to the left of the long white wall). Because young children appeared to favor geometry following disorientation, Spelke and colleagues have argued that the process of reorientation is modular, that is, based on geometry alone (e.g., Hermer & Spelke, 1994, 1996; Hermer-Vasquez, Spelke, & Katsnelson, 1999; Lee, Shusterman, & Spelke, 2006). In their view, other types of environmental cues are not used to represent location on disorientation tasks; only geometric information about the shape of an enclosed space is used for this purpose.

Other research, however, has not supported the modular view of geometric processing. For example, in larger rectangular spaces, young children have been shown to rely on nongeometric cues (e.g., a different-colored wall) to locate a hidden object (Learmonth, Nadel, & Newcombe, 2002; Learmonth, Newcombe, & Huttenlocher, 2001). Nevertheless, there is reason to believe that geometry may be highly salient and prepotent to young children. In particular, it has been shown that they use geometric information to represent the location of a target object under a variety of conditions, including spaces of different shapes (isosceles triangle: Huttenlocher & Vasilyeva, 2003; Lourenco & Huttenlocher, 2006; rhombus: Hupach & Nadel, 2005; octagon: Newcombe & Ratliff, 2006) and different sizes (larger rooms: Hupach & Nadel, 2005; Learmonth et al., 2001, 2002; smaller rooms: Lourenco & Huttenlocher, 2006; Lourenco, Huttenlocher, & Vasilyeva, 2005; models: Huttenlocher & Vasilyeva, 2003) as well as from different viewing perspectives (inside or outside: Lourenco et al., 2005) and following different types of disorientation procedures (viewer or space movement: Lourenco & Huttenlocher, 2006). There is even evidence that some sensitivity to geometric information may emerge during infancy, as early as 5½ months of age (Lourenco & Huttenlocher, 2008).

Scale-like properties

Why might the shape of an enclosed space be used so robustly by young children in representing location? And what are the specific properties that support location representation on disorientation tasks? To begin to address these questions, consider a rectangular-shaped space that has been used in several studies with young children (e.g., Hermer & Spelke, 1994; Learmonth et al., 2001; Lourenco