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Exploring the effects of similarity on mapping spatial relations

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ABSTRACT

Solving a map task requires transferring information acquired in one spatial context to another context, an ability that marks an important step in cognitive development. This study investigated how preschoolers' mapping performance was affected by the extent of similarity between spaces. Whereas prior work examined effects of similarity in tasks involving matching individual objects, our tasks required considering spatial relations among objects. We found that the accuracy of mapping between two spaces with somewhat different perceptual features was higher than the accuracy of mapping between spaces with identical features. Yet, a further increase in differences between the two spaces had a detrimental effect on mapping. The results suggest that some degree of similarity between spaces is beneficial to children's ability to transfer relational information. However, when the spaces have the same surface features, it may draw children's attention to individual objects and inhibit their ability to focus on common relations across contexts.

Introduction

The ability to solve spatial mapping tasks marks an important step in the development of children's reasoning because these tasks require generalizing and transferring information between different contexts (DeLoache, 1995; Huttenlocher, Newcombe, & Vasilyeva, 1999; Liben & Downs, 1989; Uttal, 1996, 2000). To map locations from one space to another, children must appreciate the overall correspondence between the two spaces. That is, they must understand that information provided in one

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spatial context (e.g., a model, a map) is relevant to thinking about the other one (e.g., a room, a city). In addition to establishing the overall correspondence between spaces, children must be able to map specific locations.

In this article, we examine how children's performance in mapping locations from one space to another is affected by the degree of similarity between the spaces. The role of similarity in the ability to map locations has been addressed in previous studies (e.g., DeLoache, Kolstad, & Anderson, 1991). However, most of these studies involved tasks in which a target object could be identified on the basis of its unique features. In the current research, we used a task in which a target object had the same features as other objects in the layout and the only way to distinguish it was by taking into account the spatial characteristics of its location. Thus, rather than transferring information about individual object features, our mapping task required children to transfer information about spatial relations among objects.

From mapping objects to mapping relations

Researchers distinguish two types of information that can be used in mapping locations: object cues and relational cues (Blades & Spencer, 1994; Marzolf, DeLoache, & Kolstad, 1999; Newcombe & Huttenlocher, 2006; Uttal, 1996). If the target location is marked by a landmark that can be identified by its unique features, such as color, object shape, or texture, the child may use this information to find the corresponding location in another layout by looking for an object with the same or similar features. The ability to use object features in mapping emerges at around 2.5–3 years of age (DeLoache, 1990). For example, when 3-year-olds are shown a model of a room containing several unique objects, they can find an object with similar features in the room itself. Although it has been argued that in solving this task children may use information about spatial relations among objects, the correspondence of object features appears to provide the main basis of young children's performance (Marzolf et al., 1999).

However, there are situations in which information about object features is not sufficient to solve the mapping task. In particular, if a layout contains a large open space or multiple identical objects, one must use spatial cues, such as distance and object configuration, to identify a specific location within the open space or to distinguish between the objects. Preschoolers have more difficulty with mapping tasks that require the use of spatial relational cues than with mapping tasks that can be solved by matching object features (Blades & Spencer, 1994; Liben & Yekel, 1996). At around 4 years of age, children start using spatial relations in the context of simple mapping tasks (Huttenlocher et al., 1999; Marzolf & DeLoache, 1997; Vasilyeva & Bowers, 2006), but their skills are still limited (Uttal, 1996). Thus, the ability to use relational correspondence emerges more than a year later than the ability to use object correspondence.

The delay in children's use of spatial relations in mapping reflects a general trend in cognitive development that has been described by Gentner and colleagues as a relational shift (Gentner & Rattermann, 1991; Markman & Gentner, 1993). Their work showed that when young children attempt to relate two situations, they initially pay attention to the correspondence between the features of individual elements. Only later do they start paying attention to the relations among individual elements within each situation and look for a correspondence of these relations across the two situations. This transition from focusing on individual objects to relational reasoning occurs at different ages in different cognitive domains. In the spatial domain, the evidence of the ability to link relational information across contexts appears at around 4 years of age (e.g., Marzolf et al., 1999). The ability to reason about "relations among relations" has been identified as one of the hallmarks of cognitive development (Piaget & Inhelder, 1967). Thus, it is important to gain a better understanding of factors that may influence children's performance in tasks that require reasoning about corresponding relations across contexts.

The role of similarity in mapping locations

Most of the existing work examining the role of similarity in mapping has involved tasks that could be solved on the basis of object-to-object correspondence (DeLoache et al., 1991; DeLoache, Peralta de Mendoza, & Anderson, 1999; Uttal, Gentner, Liu, & Lewis, 2008). A general finding from these studies is