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Plain or decorated? Object visual features matter in infant spatial categorization

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ABSTRACT

The current study investigated infant spatial categorization of a support relation across differences in the perceptual features of the objects. Infants of 8 and 14 months ($N = 67$) were habituated to dynamic support events with objects that were plain and monochromatic or those that were embellished with decorations (e.g., polka dots, feathers). Infants were then tested with events that presented a novel pair of objects, a novel spatial relation (i.e., containment), or both. Infants, particularly those of 8 months, formed an abstract categorical representation of a support relation when habituated with the decorated objects but not the plain objects. The results suggest that the perceptual features of objects can facilitate infants' categorization of spatial relations, at least in some learning settings and especially with younger infants.

Introduction

Early in development, young infants learn to form categorical representations of spatial relations such as support, containment, left versus right, above versus below, between, and tight-fit versus loose-fit relations (e.g., Antell & Caron, 1985; Behl-Chadha & Eimas, 1995; Casasola & Cohen, 2002; Casasola, Cohen, & Chiarello, 2003; Gava, Valenza, & Turati, 2009; Hespos & Spelke, 2004; Quinn, 1994; Quinn, Adams, Kennedy, Shettler, & Wasnik, 2003; Quinn, Cummins, Kase, Martin, & Weissman, 1996). Spatial categorization is evident by 5 months, the youngest age at which infants have been shown to generalize a spatial relation to previously unseen objects (Casasola et al., 2003;

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Hespos & Spelke, 2004; Quinn et al., 2003). These spatial categories contribute to infants' understanding of how the objects in these events should interact (e.g., Baillargeon, Needham, & DeVos, 1992; Dan, Omori, & Tomiyasu, 2000; Hespos & Baillargeon, 2001). Yet, our understanding of *how* infants learn to form these categorical representations remains limited. In the current study, we further examined the development of this ability, focusing on whether the type of objects used to depict a spatial relation influences infant spatial category formation.

Infant spatial categorization is a type of *relational* learning. Although spatial relations are perhaps more concrete (i.e., visually accessible) than other relations, categorization of spatial relations does overlap to some degree with other types of relational learning such as mathematical learning and analogical reasoning. In particular, spatial categorization (similar to mathematical learning and analogical reasoning) requires two key abilities. First, infants must look *beyond* the specific objects to note the type of spatial configuration between or among those objects (Gentner & Kurtz, 2005; Gentner & Markman, 1997). In addition, they must be able to generalize the commonality in spatial relation to a novel exemplar (Quinn et al., 2003). This ability develops in stages, with infants first demonstrating the ability to discriminate changes in the spatial configuration of specific objects and only later demonstrating the ability to generalize from a specific instance or set of instances to a new example of that relation (Quinn et al., 1996). It is the ability to generalize from one set of examples of a spatial relation to a new one that was the focus of our current investigation.

There are only a few studies that offer insight into how infants overcome these two cognitive hurdles to form spatial categories. These insights emerge from studies that vary the spatial categorization task. For example, varying the number of exemplars presented during habituation affects infant spatial categorization. Whereas 14-month-olds form spatial categories under more diverse conditions (Casasola & Park, 2013), 10-month-olds form spatial categories when provided with at least four to six exemplars of a spatial relation (Casasola & Cohen, 2002; Casasola & Park, 2013). That is, younger infants require more exemplars to form a spatial category, in line with results seen in infants' object categorization studies (Bomba & Siqueland, 1983; Needham, Dueker, & Lockhead, 2005; Quinn & Bhatt, 2005). The contrasting spatial relation also matters. When contrasted with a support relation, infants formed the category of containment, but not when contrasted with an occlusion relation (Rigney & Wang, 2015). Providing spatial language during habituation also facilitates spatial categorization in older infants (Casasola, 2005a; Casasola & Bhagwat, 2007; Casasola, Bhagwat, & Burke, 2009), possibly because spatial labels direct infant attention to the spatial relations and facilitate abstraction.

In addition, the use of simple objects may facilitate generalizing a spatial relation to a new set of objects. Hespos and Spelke (2004) showed that 5-month-old infants generalized a tight-fit spatial relation to a new example of this relation following familiarization to a single exemplar. This result contrasts with previous work in which infants of 10 and 18 months did not generalize the tight-fit relation to a new instance (Casasola & Cohen, 2002) despite viewing four exemplars of the tight-fit relation. Two notable differences across the two studies may account for the discrepant results. First, Hespos and Spelke (2004) used perceptually plain objects, a simple cylinder and a cylindrical container, to depict the tight-fit relation, whereas Casasola and Cohen (2002) used toys and everyday objects such as a cookie cutter and a basket that were more perceptually complex. In addition, Hespos and Spelke presented live events, whereas Casasola and Cohen presented videotaped versions of the events. Possibly, the use of simple objects, presented as live events, rather than toys presented on video explains why younger infants succeeded in forming a spatial category that older infants did not. Using the contrast between these two studies as a backdrop, we focused on the issue of whether the perceptual features of the objects in events shape infants' spatial categorization in the current study.

Although the role of the perceptual features of objects is a question that has not been examined in infants, there is a rich literature with children's relational learning (of which infant spatial categorization can be argued to be one example) that has compared young children's relational learning across the sparseness versus richness of surface features of the objects employed to depict a relation. In some cases, perceptually simple objects enhanced relational learning, whereas more perceptually complex ones created a more challenging task (Kaminski & Sloutsky, 2009, 2010; Kaminski, Sloutsky, & Heckler, 2006; Rattermann, Gentner, & DeLoache, 1990; Son, Smith, & Goldstone, 2011). In one study,