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Developmental change in young children's use of haptic information in a visual task: The role of hand movements

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ABSTRACT

Preschoolers who explore objects haptically often fail to recognize those objects in subsequent visual tests. This suggests that children may represent qualitatively different information in vision and haptics and/or that children's haptic perception may be poor. In this study, 72 children (2½–5 years of age) and 20 adults explored unfamiliar objects either haptically or visually and then chose a visual match from among three test objects, each matching the exemplar on one perceptual dimension. All age groups chose shape-based matches after visual exploration. Both 5-year-olds and adults also chose shape-based matches after haptic exploration, but younger children did not match consistently in this condition. Certain hand movements performed by children during haptic exploration reliably predicted shape-based matches but occurred at very low frequencies. Thus, younger children's difficulties with haptic-to-visual information transfer appeared to stem from their failure to use their hands to obtain reliable haptic information about objects.

Introduction

The use of perceptual information obtained in one modality (e.g., haptics) to perform a task in another modality (e.g., vision) involves intermodal information transfer. Intermodal transfer allows for intersensory predictions, for example, anticipating what an object will look like given that one has touched but not yet seen it. Perceptual features that can be apprehended in only one modality—color, odor, and temperature—will clearly not be useful in tasks requiring intermodal transfer. However,

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information about object properties such as shape, texture, and rhythm can be obtained in more than one modality (Lewkowicz, 1994, chap. 8). Such information can also be obtained in one modality and then used for a task in a different modality. The fact that intermodal transfer of perceptual information is possible implies that representations built from input in one sensory modality are accessible to multiple perceptual modalities (Gibson, E.J., 1969; Gibson, J.J., 1966).

Adults appear to have no difficulty in accessing novel information gathered in one perceptual modality for use in a second one (e.g., Abravanel, 1971, 1973; Easton, Srinivas, & Greene, 1997; Reales & Ballesteros, 1999). In contrast, children up to 5 or 6 years of age have difficulty with tasks involving intermodal transfer (e.g., Goodnow, 1971; Milner & Bryant, 1970; Rose, Blank, & Bridger, 1972), especially the transfer of information from haptics to vision. Two explanations for these findings have been proposed. The first proposal is that the representations that children form from visual and haptic experience may contain different kinds of perceptual information (Abravanel, 1968; Birch & Belmont, 1965; Blank, Altman, & Bridger, 1968; Bryant & Raz, 1975; Bushnell & Baxt, 1999). Thus, visually based representations might highlight information about object shape, whereas haptically based representations might highlight information about object texture or mass. The result would be at least partial incompatibility between representations in the two modalities that could hamper translation between them.

The second proposal is that young children might have poor haptic perception (e.g., Milner & Bryant, 1970; Rose et al., 1972; Scofield, Hernandez-Reif, & Keith, 2009). Two different potential deficits in haptic perception can be distinguished. It might be that young children cannot efficiently or accurately form percepts from haptic sensory input; or it might be that the haptic input itself is deficient—perhaps because young children have poor manual exploratory abilities.

The three proposed explanations are not mutually exclusive; for example, it is possible that children form generally impoverished mental representations in haptics because they are capable of only limited manual exploration or that young children's hand movements just happen to provide ample textural information but only limited shape information about the objects they touch. The current study was designed to gain insight into the reasons for children's poor haptic-to-visual information transfer abilities by examining both their performance in a haptic-to-visual object-matching task and the exploratory hand movements associated with the different object matches they make.

Do children form separate and qualitatively different representations from haptic and visual exploration?

A number of researchers have reported evidence that young children may represent qualitatively different information following their exploration of objects in different modalities (e.g., Abravanel, 1968; Birch & Belmont, 1965; Blank et al., 1968; Bushnell & Baxt, 1999). In Blank and colleagues' (1968) study, 3- and 4-year-olds studied novel objects either visually or haptically and then were tested for recognition in the opposite modality. Children were good at recognizing previously seen objects by touch but were not good at visually recognizing objects they had previously explored with their hands. The authors proposed that representations of information obtained haptically might not be easily used in visual tasks. More recently, Bushnell and Baxt (1999) used real-world familiar and unfamiliar objects to test 5-year-olds in intra- and intermodal object recognition tasks—vision to vision, haptic to haptic, vision to haptic, and haptic to vision. The children did well in object recognition in intramodal tasks with both familiar and unfamiliar objects and in intermodal tasks with familiar objects. The authors concluded that 5-year-olds' haptic abilities are actually quite good. However, children's intermodal performance was much poorer with unfamiliar objects, especially when information obtained haptically was tested visually. Bushnell and Baxt suggested that "hand-mages"—representations formed from haptic exploration—differ in important ways from visual images and might not be sufficient for visual recognition. They proposed that attention during haptic exploration might be focused on material-based properties (e.g., texture, mass, rigidity) and that such information might not transfer well to vision or might be outweighed in visual object identification by shape and color information (Klatzky, Lederman, & Metzger, 1985).

None of the studies cited above measured children's hand movements during haptic exploration. It is possible that children did not use their hands effectively to gather information about the objects, so that they obtained less usable information in haptics than in vision. Thus, the information that