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Learning what children know about space from looking at their hands: The added value of gesture in spatial communication

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ABSTRACT

This article examines two issues: the role of gesture in the communication of spatial information and the relation between communication and mental representation. Children (8–10 years) and adults walked through a space to learn the locations of six hidden toy animals and then explained the space to another person. In Study 1, older children and adults typically gestured when describing the space and rarely provided spatial information in speech without also providing the information in gesture. However, few 8-year-olds communicated spatial information in speech or gesture. Studies 2 and 3 showed that 8-year-olds did understand the spatial arrangement of the animals and could communicate spatial information if prompted to use their hands. Taken together, these results indicate that gesture is important for conveying spatial relations at all ages and, as such, provides us with a more complete picture of what children do and do not know about communicating spatial relations.

Introduction

When people talk, they gesture. Gesture and speech serve complementary roles, and effective communication often requires both modalities. In some cases, gesture highlights or emphasizes information conveyed in speech (Cassell & McNeill, 1991). For example, speakers can use their fingers to count

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when describing a list of items in order of importance. In other cases, gesture provides unique information (McNeill, 2005; Rauscher, Krauss, & Chen, 1996), including information that would be difficult, if not impossible, to communicate in words (Goldin-Meadow, 2003).

The communication of spatial information is a good example of a domain in which gesture has the potential to play a particularly important role. For example, when talking about locations in space, speakers can use deictic gestures to indicate specific locations. The speech component of this communicative act can be simple and spatially vague (e.g., "here" or "there"; McNeill, 2005), leaving gesture to do most of the communicative work in specifying the locations.

One of the roles gesture can play in communicating spatial information is to help us overcome an inherent limitation of language—the linearization problem (Levelt, 1981, 1982). Spatial relations must be communicated serially in language (Newcombe & Huttenlocher, 2000). Only one spatial relation can be described at a time. Some words encode direction but not distance (e.g., "right" and "left"), and some words encode distance but not direction (e.g., "near" and "far"). Of course, people may be able to mentally integrate the serial descriptions given in speech into some form of mental map, but the number of relations that must be spoken, recalled, and integrated can become mentally taxing (e.g., Brunye, Rapp, & Taylor, 2008).

In contrast, gesture can be used to convey multiple pieces of information simultaneously. Thus, gesture can help speakers to deal with some of the challenges of the linearization problem. For example, speakers can use their hands to set up locations in space and then refer back to those locations throughout the communication. Using gesture in this manner allows the structure of a physical space (or a metaphorical space such as a diagram) to emerge through the depiction of multiple relations (Enfield, 2005; So, Coppola, Licciardello, & Goldin-Meadow, 2005). Thus, a particularly important use of gesture is to communicate relations among locations, which we refer to here as *relational information*. For example, Emmorey, Tversky, and Taylor (2000) asked English-speaking adults to describe the layout of several large-scale spaces (e.g., a town and a convention center). Although the participants were not instructed to gesture, many did gesture. Some participants used gestures to form models of the space, which were particularly useful in conveying spatial relations. One participant conveyed the spatial relations among the school, the town hall, and the store by holding his left hand (which he identified as standing for the school) in one location and positioning his right hand in relation to the left in order to locate the town hall and store. With just a few hand movements, speakers were able to convey important features of a complex environment that would have taken many words to express and much mental effort to understand. Because gesture afforded speakers the ability to visually depict relations and reference points, its use greatly facilitated the communication of spatial relations.

Although earlier research on spatial communication focused primarily on speech, more recent research has begun to take seriously the unique and complementary role gesture can play in communicating spatial information that would be difficult to convey in speech. However, relatively little research has taken a developmental approach to using gesture to communicate spatial information, particularly spatial relations. Our goal in this research was to consider the role of gesture in the development of spatial communication, with a focus on the communication of spatial information that can be difficult to express in words.

Gesture and the development of spatial communication

Our focus here is on how gesture is used over development to communicate spatial relational information. There are two reasons to investigate this issue. First, at a general level, gesture has been shown to be both an important influence on and an important indicator of cognitive development and learning. Children's gestures when solving problems sometimes reveal that they know more about the underlying concept than their words alone reveal. For example, when solving Piagetian conservation problems (Church & Goldin-Meadow, 1986) and mathematics equivalence problems (Alibali & Goldin-Meadow, 1993; Garber, Alibali, & Goldin-Meadow, 1998; Perry, Church, & Goldin-Meadow, 1988), children often use gestures that indicate they are beginning to reach a new stage of understanding even when their words suggest otherwise. Moreover, gesture can be used as a vehicle for influencing learning. For example, teaching children to use certain gestures (Goldin-Meadow, Cook, & Mitchell, 2009), and even just telling children to move their hands as they explained how they solved a set of