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I use my space not yours: Use of gesture space for referential identification among children with autism spectrum disorders

Wing-Chee So*, Miranda Kit-Yi Wong

Department of Educational Psychology, The Chinese University of Hong Kong, Faculty of Education, Room 208, Ho Tim Building, Hong Kong

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ABSTRACT

Background: Speakers move their hands (gesture) when they talk. They indicate non-present referents by gesturing those referents in the same locations as the previous gestures for the same referents (spatially-consistent referent-identifying gestures). We examined whether children with autism spectrum disorders (ASD), whose gesture development is slow, produce this kind of gesture in two circumstances: (1) demonstration task in which they had to follow experimenters' established referents and spatial locations; and (2) spoken narrative task in which they created their own referents and locations.
Method: School-aged children with ASD and typically-developing children (TD) demonstrated daily-life activities after the experimenter had orally described and gestured the spatial locations of non-present objects involved (demonstration task) and enacted the characters of a story from a picture (spoken narrative task).
Results: ASD children produced fewer spatially-consistent referent-identifying gestures than TD children in the demonstration task. When not following experimenter's locations, they established their own gestural locations and kept them consistent. They produced a comparable number of spatially-consistent referent-identifying gestures to their TD counterparts in the spoken narrative task. The ability to produce spatially-consistent referent-identifying gestures was negatively correlated to communication and social interaction skills in the demonstration task in both groups. However, such relationship was not found in the spoken narrative task in ASD children.
Conclusion: ASD children have the ability to use consistent gestural locations to represent referents, but this ability may be limited when they have to follow others' perspectives. Communication and social interaction abilities are crucial when taking others' perspectives.

1. Introduction

Speakers not only use linguistic devices (nouns, pronouns, or zero anaphora) but also produce gestures to indicate referents. Co-speech gestures are spontaneous hand movements produced when speaking (McNeill, 1992, 2005). They serve multiple functions including but not limited to expressing culture-specific meanings (e.g., producing a THUMB-UP gesture to praise others), making requests (e.g., POINTING to a cookie to request the cookie), describing dimensions of objects (e.g., producing a ROUND gesture to describe the shape of a cake), and representing concrete objects (i.e., referents) in a real or

* Corresponding author.
E-mail addresses: wingchee@cuhk.edu.hk (W.-C. So), mirandakywong@gmail.com (M. Kit-Yi Wong).

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virtual environment (e.g., POINTING to John while he was standing at the speaker's right; POINTING to the empty space at the right to represent John again, who has left the room). The present study focuses on the last function of gesture—referential identification.

Gesture conveys visual-spatial information (Cassell & McNeill, 1991; McNeill, 1992, 2005). Therefore, speakers can easily exploit the visual-spatial nature of gesture to indicate non-present referents by forming associations between the spatial locations of their gestures and the corresponding non-present entities (Gullberg, 1998, 2003, 2006; So, Coppola, Licciardello, & Goldin-Meadow, 2005; So, Kita, & Goldin-Meadow, 2009; Yoshioka, 2008). Specifically, they produce gestures in non-neutral spatial locations (i.e., left, right, center, top, or bottom relative to the location of the speaker) when representing non-present referents. These gestures are called "spatially modulated gestures" (see discussion of spatially modulated signs in Senghas & Coppola, 2001). A spatially modulated gesture, which is produced in the same location as previous spatially modulated gestures for the same referents is considered spatially consistent. We call this kind of spatially modulated gesture as spatially-consistent referent-identifying gesture in this paper.[1] Locations of spatially-consistent referent-identifying gestures are often maintained throughout the discourse (Gullberg, 1998, 2006). That is, both speaker and listener(s) produce gestures at the same locations when the same referents are mentioned later on in the discourse. Below is an example of spatially modulated and spatially-consistent referent-identifying gestures. Imagine a speaker is telling a story about a cat. He might say:

> There is a cat [right hand points to the left] and there is a tower in front of it [right hand points to the center]. The cat flies to the tower [right hand moves from the left to the center]. However, the tower later collapses [right hand flips outward at the right] because the cat is heavy.

In this example, the speaker initially assigned the left-hand space to the cat and center to the tower. These two gestures are spatially modulated. The third spatially modulated gesture, MOVE, is a spatially-consistent referent-identifying gesture because its direction of movement is consistent with the previously established spatial locations of the cat and tower. The fourth spatially modulated gesture, COLLAPSE, is not a spatially-consistent referent-identifying gesture as its location is not consistent with the initial spatial set-up of the tower. Establishing a cohesive use of gesture space is crucial for communicating ideas during a conversation. Listeners can derive the meaning of spatially-consistent referent-identifying gestures by integrating them with the accompanying speech and forming an association between the non-present referents and their corresponding spatial locations. In this way, speakers and listeners can build a conversational common ground.

Previous research has found that adult speakers use gestures to identify referents and maintain spatial locations throughout discourse. Typically developing (TD) children start locating referents in abstract space as early as seven to eight years old (McNeill, 1992) and use them frequently from 10 or 11 years old (Cassell & McNeill, 1991; Sekine & Furuyama, 2010). The question of interest is whether children with autism spectrum disorders (ASD) can produce spatially-consistent referent-identifying gestures in discourse. Previous research has shown that children with ASD have slow understanding and development of gestures (Mastrogiuseppe, Capirci, Cuva, & Venuti, 2015; Medeiros & Winsler, 2014; Stone, Ousley, Yoder, Hogan, & Hepburn, 1997). It is a robust finding that children with ASD are particularly impaired in "proto-declarative" pointing gestures, a type of gesture that elicits joint attention (e.g., a child points to a toy car in order to direct his father's attention to it; Baron-Cohen, 1989; Carpenter, Pennington, & Rogers, 2002; Wetherby & Prizant, 2002). However, their ability to generate proto-imperative pointing—a type of gesture used in making requests—is relatively sparse (e.g., a child points to a cookie to ask his mother to give him one; Baron-Cohen, 1989; Wetherby & Prizant, 2002). Studies have also found that children with ASD have difficulties in producing markers, which carry culturally specific meaning (e.g., the raised thumb for hitchhiking; So, Wong et al., 2015); iconic gestures, which depict actions or attributes associated with objects (e.g., index and middle fingers wriggling for walking); and speech beats, which do not involve semantic meanings but follow the rhythm of co-occurring speech (e.g., index finger flipping outward) (Charman, Drew, Baird, & Baird, 2003; Luyster, Lopez, & Lord, 2007; Wetherby et al., 2004).

However, Capps, Kehres, and Sigman (1998) found that children with ASD were as likely as children with developmental delays to enact activities with gestures in the course of a 6-minute conversation about schools, friends, and vacations. Yet their study did not have a neuro-typical comparison group. In addition, the language age of children with ASD was well below their mental and chronological ages. Therefore, it was not clear whether children with ASD in their study did not have a delay in gesture production. On the contrary, other studies have not found a delay in gesture production in children with ASD. For example, Attwood, Frith, and Hermelin (1988) reported that children with ASD, children with Down's syndrome, and TD children produced comparable numbers of markers when interacting with other children. In an experiment, So, So, Lui et al., 2015 did not find significant differences between children with ASD and TD children in the numbers of iconic gestures and abstract deictic gestures (gestures that point to abstract locations associated with entities) before and after controlling for the amount of speech. So and colleagues reported similar findings in structured interactions between children and their caregivers: children with ASD produced similar numbers of iconic gestures, speech beats, and deictic gestures (except markers) as TD children (So, Wong et al., 2015).

While the production of some types of gesture may not be delayed in children with ASD, a recent study by So, Lui et al. (2015) found that these children may make less use of gestures to communicate about non-present objects in a modified

[1] So and colleagues named this kind of spatially modulated gesture as referent-identifying gesture (So et al., 2009).