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Motor and verbal perspective taking in children with Autism Spectrum Disorder: Changes in social interaction with people and tools

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ABSTRACT

Background: Children with Autism Spectrum Disorder (ASD) have difficulty communicating with others nonverbally, via mechanisms such as hand gestures, eye contact and facial expression. Individuals with ASD also have marked deficits in planning future actions (Hughes, 1996), which might contribute to impairments in non-verbal communication. Perspective taking is typically assessed using verbal scenarios whereby the participant imagines how an actor would interact in a social situation (e.g., Sally Anne task; Baron-Cohen, Leslie, & Frith, 1985).

Method: The current project evaluated motor perspective taking in five children with ASD (8–11 years old) as they participated in a narrative intervention program over the course of about 16 weeks. The goal of the motor perspective-taking task was to facilitate the action of an experimenter either hammering with a tool or putting it away.

Results: Initially, children with ASD facilitated the experimenter's action less than neurotypical control children. As the narrative intervention progressed, children with ASD exhibited increased motor facilitation that paralleled their increased use of mental state and causal language, indicating a link between verbal and motor perspective taking.

Conclusions: Motoric perspective taking provides an additional way to assess understanding and communication in children with ASD and may be a valuable tool for both early assessment and diagnosis of children with ASD.

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Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized, in part, by impairment in social communication (5th ed; DSM-5). Social deficits can include reduced response to social overtures of others or abnormal eye contact and/or gestures (Capps, Losh, & Thurber, 2000; Eigsti, de Marchena, Schuh, & Kelley, 2011). For example, a child with ASD may have difficulty interpreting the raising of an eyebrow to indicate surprise or the shrugging of shoulders to indicate confusion. Such deficits have been associated with impaired social communication (e.g., Beall, Moody, McIntosh, Hepburn, & Reed, 2008).

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Perspective taking is typically assessed by asking questions and recording a participant's verbal responses (Baron-Cohen, Leslie, & Frith, 1985). In one commonly used measure, a participant watches a video of two people interacting and then describes the emotions each person may have felt during the interaction (Gehlbach, 2004). In another commonly used measure, which does not require a verbal response but does require understanding the verbal instructions of the experimenter as well as the visual perspective of the person looking at the object, a child is asked to point out which object another person is looking at (Baron-Cohen, 1989).

If individuals with ASD have trouble with verbal comprehension or communication, perspective taking could be assumed to be insufficient when, in reality, it is not. Reduced use and understanding of mental state and causal language (e.g., she *thought* she was in trouble *because* her mom *looked mad*) has been associated with difficulties in perspective taking (García-Pérez, Hobson, & Lee, 2008). However, a failure to use phrases such as “she thought” or “he decided to” to mark perspective may actually be related to linguistic limitations rather than deficits in the ability to take another's perspective. Evidence for this phenomenon has come from studies of neurotypical infants in which perspective taking was measured using eye tracking rather than verbal responses. Findings revealed that young children's eye gaze patterns demonstrated knowledge of perspective taking long before they were able to do so verbally (Southgate, Senju, & Csibra, 2007).

Many perspective taking measures evaluate non-motor aspects of perspective such as another's emotions, general intentions, or what objects are in his/her line of sight (Pearson, Ropar, & Hamilton, 2013). Some recent research, however, indicates that individuals with ASD may be able to more-readily perceive the intentions of another person if those intentions are conveyed motorically (e.g., through motor actions; Alderidge, Stone, Sweeney, & Bower, 2000; Gonzalez, Glazebrook, Studenka, & Lyons, 2013). Recently, adults with ASD demonstrated the ability to facilitate the actions of another individual during a social-motor interaction that involved handing a tool to another person in a manner that facilitated its use (Gonzalez et al., 2013). Specifically, participants were asked to hand the experimenter a hammer for the purpose of hammering a peg. For some trials, facilitating the examiner's use of the hammer involved turning it around so that the handle was easily graspable. Although this task involved verbal commands such as “help me hammer,” facilitation of the experimenter's hammering relied on the ability of the participant to consider the experimenter's perspective in which it would be best to receive the hammer by the handle rather than by the hammerhead. In other words, grasping the tool initially in an uncomfortable manner to facilitate the experimenter's grasp was a motoric demonstration of the participant's ability to take the examiner's perspective. Individuals with ASD facilitated the experimenter's grasp only 65–73% of the time (Gonzalez et al., 2013) as compared to neurotypical participants who facilitated the examiner's grasp 80–97% of the time (Gonzalez, Studenka, Glazebrook, & Lyons, 2011). Furthermore, Scharoun, Scanlan, and Bryden (2016) asked a similar question using the functional task of lifting a cup and handing it to a researcher to facilitate pouring water. The posture with which children handed the glass to the researcher did not differ between those with ASD and neurotypical children suggesting either that children were familiar enough with cups that planning was not sufficiently taxed, or that perspective taking, and therefore, motor planning, was facilitated via motor actions. In both of these paradigms, the inference of perspective is based on social interaction, which may involve visual attention and visual perspective taking.

Visual perspective is typically assessed in two ways. Level 1 visual perspective tasks assess a participant's ability to judge what another person is looking at. Level 2 visual perspective tasks assess a participant's ability to judge what another person is looking at and how that person might see the object differently than him/herself (Flavell, Abrahams, Everett, Croft, & Flavell, 1981). Individuals with ASD have particular difficulty with level 2 perspective taking (Hamilton, Brindley, & Frith, 2009; Pearson et al., 2013). It is possible that visual perspective taking is a necessary component of understanding how another person might need to grasp an object, and therefore, a lack of visual perspective taking on either level might predispose an individual to hand an object in a way that does not facilitate the action of the experimenter. In other words, in the social-interaction task above, those with ASD may be unable to visualize the tool from the experimenter's perspective, and therefore, may have trouble understanding how the experimenter may need/want to grasp an object, leading to poorer motor perspective taking and less helpful interactions.

Perspective taking plays an important role in language development in typical children (Comparini, Douglas, & Perez, 2014; Nurmsoo & Bloom, 2008; San Juan, Khu, & Graham, 2015) as well as in children with ASD (Hamilton et al., 2009; Volden, Mulcahy, & Holdgrafer, 1997). However, as described above, perspective taking in social-motor interaction has only been explored in high functioning adults with ASD who have more general motor and social experience than children with ASD, and in a group of children using a task that may have elicited a habitual response rather than testing motor planning (Scharoun et al., 2016). Furthermore, although motor impairments are considered key features of ASD, they are not currently included as diagnostic criteria, nor is the potential impact of motor impairment on social communication and interaction fully understood. Deficits in understanding the plans of others may be directly related to deficits in motor control and planning within an individual. In addition to general impairment with gross and fine motor control and coordination (Fournier, Hass, Naik, Lodha, & Cauraugh, 2010; Manjiviona & Prior, 1995; Ming, Brimacombe, & Wagner, 2007), individuals with ASD also have demonstrated differences in motor planning. One typical experimental paradigm used to measure motor planning is the end-state comfort effect. End-state comfort refers to the observation that individuals sometimes choose awkward or uncomfortable initial postures to ensure comfort at final postures (e.g., grasping a cup with a thumb down grasp in order to end with a thumb-up, more comfortable, posture for pouring; Rosenbaum et al., 1990). A review of end-state comfort in typically developing children revealed an increase in adoption of end-state comfort from 3 to 12 years of age in typically developing children (Wunsch, Henning, Aschersleben, & Weigelt, 2013). Less adoption of end-state comfort in children with ASD (28% compared to 71% in ten year olds) was shown by Hughes (1996) using a bar transport task similar to the

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