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BRIEF COMMUNICATION

Brief Report: Perception of Body Posture—What Individuals With Autism Spectrum Disorder might be Missing

Catherine L. Reed · Paula M. Beall · Valerie E. Stone · Lila Kopelioff · Danielle J. Pulham · Susan L. Hepburn

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Abstract Autism has been associated with atypical face and configural processing, as indicated by the lack of a face inversion effect (better recognition of upright than inverted faces). We investigated whether such atypical processing was restricted to the face or extended to social information found in body postures. An inversion paradigm compared recognition of upright and inverted faces, body postures, and houses. Typical adults demonstrated inversion effects for both faces and body postures, but adults with autism demonstrated only a face inversion effect. Adults with autism may not have a configural processing deficit per se, but instead may have strategies for recognizing faces not used for body postures. Results have implications for therapies employing training in imitation and body posture perception.

Keywords Autism · Face inversion effect · Body inversion effect · Configural processing · Face recognition

C. L. Reed (✉) · P. M. Beall · L. Kopelioff · D. J. Pulham
Department of Psychology, University of Denver, Denver, CO 80208, USA
e-mail: creed@du.edu

V. E. Stone
School of Psychology, University of Queensland, Brisbane, QLD 4072, Australia

S. L. Hepburn
Department of Psychiatry, University of Colorado Denver Health Sciences Center, Denver, CO 80262, USA

Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized primarily by impairments in social reciprocity. Correctly perceiving and recognizing social cues displayed in a person's face and body posture are, in part, essential for appropriate social interaction. Faces and body postures both tell us about a person's emotional state, whether that person is friend or foe, whether that person is attending to us, what that person intends to do, and what actions we should take subsequently. Hence, body postures convey much of the same social information as faces. Additionally, humans have similar experience recognizing body postures as they do faces and are experts at processing both. This visual expertise is evidenced by configural processing (e.g., Reed, Stone, Bozova, & Tanaka, 2003; Reed, Stone, Grubb, & McGoldrick, 2006). Nonetheless, research in autism has focused on the connection between face recognition deficits and social impairment ignoring the influence of the body. A current controversy in the literature debates whether social deficits seen in ASD arise from a face-processing deficit per se or a more general configural processing deficit for social stimuli. In this study, we address this controversy by comparing faces with body postures, another class of social stimuli that relies on configural processing for recognition.

The face is a primary source of social information. Despite a range of performance, people with ASD often demonstrate limitations in facial processing (e.g., Dawson et al., 2002; Dawson, Webb, & McPartland, 2005; Gepner, de Gelder, & de Schonen, 1996; Grelotti, Gauthier, & Schultz, 2002; Klin et al., 1999). One of the earliest reported symptoms of ASD in infancy is an inattention to faces (Osterling & Dawson, 1994; Osterling, Dawson, & Munson, 2002; Swettenham et al., 1998). Further, individuals with ASD appear to view and represent faces differently from typically developing individuals. For example, Boucher and Lewis (1992) used a recognition task in which participants viewed pictures of unfamiliar faces and later determined which faces had been seen before. Relative to controls, the ASD group demonstrated impaired face recognition: when asked to distinguish a face or a house from a larger set of pictures, they were better at discriminating pictures of houses than pictures of faces. Other studies have emphasized atypicalities in the processing of facial features and regions of the face (Hobson, Ouston, & Lee, 1988; Pelphrey et al., 2002). In particular, individuals with ASD pay an abnormal amount of attention to the mouth and lower portions of the face compared to the eyes (Joseph & Tanaka, 2003; Klin, Jones, Schultz, Volkmar, & Cohen, 2002; Langdell, 1978). Thus, individuals with ASD appear to use atypical strategies to recognize faces. These findings have led some researchers to posit a face-processing deficit in ASD.

However, other researchers have proposed that the face recognition deficits observed in ASD can be attributed to a more general configural processing deficit. A feature processing advantage is robust in ASD (Frith, 1989; Happé, 1996; Mottron, Belleville, & Ménard, 1999; Plaisted, Swettenham, & Rees, 1999). Weak central coherence theory (e.g., Frith, 1989; Happé, 2005; Lopez, Donnelly, Hadwin, & Leekam, 2004) suggests that when individuals with ASD are provided with complex visual information, they often over-attend to detail, at the cost of recognizing the whole construct or gestalt (Hill & Frith, 2003; Rinehart, Bradshaw, Moss, Brereton, & Tonge, 2000). People with ASD tend to focus on local detail information in a visual stimulus rather than the more global and configural aspects of the feature relations (Brosnan, Scott, Fox, & Pye, 2004; Happé, Briskman, & Frith, 2001; Rinehart et al., 2000). This theory has implications for face processing. Typical individuals usually recognize faces by the global configuration of facial features and their specific spatial arrangement (Diamond & Carey, 1986; Rakover, 2002; Searcy & Bartlett, 1996; Tanaka & Farah, 1993; Tanaka & Sengco, 1997). If individuals with ASD rely on featural information for recognition, then they should be impaired at any task that requires global, configural processing whether it involves faces or not.

Configural processing refers to recognition based on the upright, hierarchical, and spatial arrangement of an object's features (Mauer, Le Grand, & Mondloch, 2002). In typically developing individuals, the face inversion effect is one indicator of configural processing of faces: adults are fast and highly accurate at recognizing upright faces, but perform poorly when a face is inverted (Carey, 1992; Scapinello & Yarmey, 1970; Searcy & Bartlett, 1996; Valentine, 1988; Yarmey, 1971; Yin, 1969). Although most upside down objects are somewhat more difficult to recognize than upright objects, inversion *disproportionately* disrupts the recognition of faces relative to the recognition of most other objects (e.g., houses, landscapes). Most objects do not show an inversion effect because they are recognized by individual features. In contrast, faces do show an inversion effect because they are recognized by the specific spatial relationship among its features which is based on the canonical upright orientation; this arrangement of features is altered by inversion.

The inversion paradigm reveals differences in the extent to which different types of objects rely on configural processing. In ASD, some studies have demonstrated the lack of a face inversion effect (e.g., Dawson et al., 2005) suggesting a lack of configural processing of faces**.** Other studies have reported *inverted* face inversion effects in that inverted faces were recognized *better* than upright faces (Hobson et al., 1988; Langdell, 1978) suggesting a reliance on featural processing. For example, Hobson et al. (1988) asked people with ASD to match upright and inverted faces based on identity. In contrast to controls, individuals with ASD were relatively better at recognizing inverted faces than upright faces. Further, this inverted inversion effect could not be attributed to a general recognition or memory impairment (Boucher & Lewis, 1992; Cipolotti, Robinson, Blair, & Frith, 1999; Corsello, 2000; Gepner et al., 1996). Nonetheless, the absence of a face inversion effect cannot distinguish between a selective face-processing deficit or a more general configural processing deficit.

In this study, we investigate whether these processing atypicalities in ASD are restricted to the face or whether they are part of a more general configural processing deficit and extend to other social information in the form of body postures. We examined the ability of individuals with ASD to recognize non-meaningful body postures as well as faces and houses. In addition to the face inversion effect, robust body inversion effects have been found for typically developing individuals (McGoldrick, 2004; Reed et al., 2003, 2006).

Reed et al. (2003) compared the recognition of faces, body postures, and houses. Adults showed strong inversion effects for faces and body postures but not for houses, suggesting similar configural processing for faces and body postures. The body inversion effect is well suited for studies with individuals with ASD because it is a robust effect, does not have a strong memory load (Teunisse & de Gelder, 2003), and represents a configural stimulus category other than faces. The presence of a body inversion effect can indicate whether individuals with ASD demonstrate adequate configural processing mechanisms and body posture processing.

Here we compare the performance of adults with and without ASD on a series of inversion tasks. We contrast inversion effects for faces, body postures, and houses (i.e., a class of non-social stimuli that do not show inversion effects). For typically developing adults, we expect inversion effects for faces and body postures but not houses. This pattern would confirm previous findings using the same stimuli and paradigm (e.g., Reed et al., 2003). If adults with ASD have a general configural processing deficit for social stimuli, then we predict no inversion effects for either faces or body postures. Alternatively, a discrepancy between the processing of faces and body postures could suggest two possibilities. If adults with ASD have a selective face-processing deficit, then they should produce an inversion effect for body postures, but not for faces or houses. In contrast, an inversion effect for faces but not body postures would suggest that adults with ASD do not have a general configural processing deficit for social stimuli, and instead have atypical processes for recognizing body postures.

Methods

Participants

Ten adults with ASD (9 males; M_{age} = 28 years) and 14 typically developing adults (8 males, M_{age} = 34 years) participated in this study. Participants were recruited from an existing database maintained by the Autism and Developmental Disorders Research Group, as well as from both clinical and community-based sources. Each individual with ASD had an independent diagnosis of high-functioning autistic disorder or Asperger syndrome by a licensed psychologist with extensive experience working with adults with autism. In addition, participants in the ASD group met criteria for ASD on Module III or IV of the Autism Diagnostic Observation Schedule (Lord, Rutter, DiLavore, & Risi, 1999) and obtained a score above 15 (M_{ASQ} = 21.13, sd = 3.72) on the Social Communication Questionnaire (SCQ; Berument, Rutter, Lord, Pickles, & Bailey, 1999). The SCQ is a 40-item questionnaire derived from the Autism Diagnostic Interview—Revised (Lord, Rutter, & Le Couteur, 1994) that has been shown to be a valid measure for discriminating between individuals with pervasive developmental disorders and controls. Cognitive ability was assessed using the Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999). Participants who met criteria for the experiment had a full-scale IQ and a performance IQ of 75 or greater ($M_{\text{full-scale IQ}}$ = 106.88, sd = 11.75; $M_{\text{verbal IQ}}$ = 110.00, sd = 12.29; $M_{\text{performance IQ}}$ = 102.50, sd = 15.15). Participants also answered a face recognition questionnaire. Only two participants with ASD reported difficulty recognizing faces.

Participants in our control group were typically developing adults who were matched on VIQ with the individuals in the ASD group (independent sample t-test: $t(22) = 1.136$, $P > .25$: $M_{\text{full-scale IQ}}$ = 106.88, sd = 11.75, $M_{\text{verbal IQ}}$ = 110, sd = 12.29; $M_{\text{performance IQ}}$ = 102.50, sd = 15.15). No participants in the control group reported difficulty recognizing faces based on the face recognition questionnaire. All participants were paid $10 for each half hour of their participation.

Materials

The stimuli were the same stimuli used in Reed et al. (2003). The images of body postures were 3-D male and female figures that were approximately 14 cm × 10 cm (Fig. 1). Each figure's limbs were positioned to create asymmetrical abstract poses that were visually distinguishable from each other, physically possible, and could not be easily labeled. ''Different'' target stimuli (or distractors) were constructed by altering the position of one or two body parts of the original stimulus: an arm, a leg, or the head of the figure was placed at a different angle or in a different position. The house stimuli were 3-D line drawings and were approximately 12 cm × 17 cm. Distractors were created by altering the position or shape of one or two of the following elements: the door, steps, chimney, main window, or small window. The face stimuli were black-and-white photographs of bald male and female Caucasian, African-American, and Asian faces and were approximately 8 cm × 9 cm. Distractor stimuli were faces of different people that matched the stimulus face in terms of gender and ethnicity, but differed on one or two salient features, such as facial hair.

Procedure

Participants were tested individually in a room with white walls and no wall decorations. They sat approximately 70 cm from a 17-in. computer monitor so that

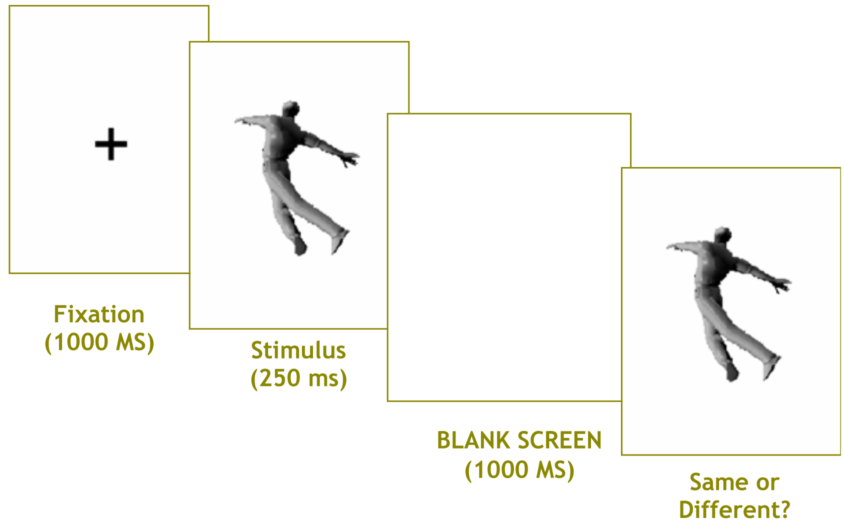

Fig. 1 Example body posture stimuli and the basic inversion paradigm. After fixation, a stimulus was presented, followed by a blank inter-stimulus-interval, and a target stimulus in the same orientation as the stimulus. Participants determined whether the target was the same as the stimulus

their eyes were level with the center of the screen. There were told that the experiment had three parts: in each part they would recognize houses, body postures, or faces. For all types of trials, the first stimulus was presented for 250 ms, followed by a blank screen for 1,000 ms, and then a second stimulus of the same object type and in the same orientation as the first stimulus appeared until the participant responded (Fig. 1). Participants pressed the "S" key using their left index finger if the two stimuli were the same or the "L" key using their right index finger if the stimuli were different. The experimenter monitored the participant to ensure that the participant kept focused attention on the task throughout the experimental session. For all trials, participants were asked to respond as fast and accurately as possible. Accuracy was recorded.

House, body, and face stimuli were presented in separate blocks, with block order counterbalanced across participants. Each block contained 64 trials, for a total of 192 trials. Each stimulus pair was presented four times each. Half of the trials were presented in an upright orientation and the other half were presented in an "inverted" or 180-degree orientation. Half of the trials were "same" and half were "different." Each block started with four practice trials, two "same" and two "different" trials. The entire testing session lasted approximately 30 min.

Results

For each participant, the mean proportion accuracy was calculated for each condition. All participants were above chance (i.e., 50% accuracy) in all conditions. To compare inversion effects for faces, body postures, and houses for individuals with and without ASD, we conducted a mixed-model group (ASD, control) × orientation (upright, inverted) ANOVA for each type of object using mean proportion accuracy data (Fig. 2).

For faces, a significant orientation effect was found [$F(1,22) = 30.45$, $P < .0001$], but no effects of group [$F(1,22) < 1$] or the interaction [$F(1,22) < 1$] were found. Both groups demonstrated similar overall accuracy rates (ASD = .89 vs. control = .90). More importantly, post-hoc analyses confirmed that both the ASD group [$F(1,9) = 11.13$, $P < .01$; upright = .82, inverted = .80] and the control group [$F(1,22) = 20.71$, $P < .001$; upright = .88, inverted = .80] showed significant face inversion effects.

For body postures, a significant orientation effect was found [$F(1,22) = 12.93$, $P < .002$]. However, there was also a significant orientation × group interaction [$F(1,22) = 4.44$, $P < .05$]. Post-hoc analyses confirmed that the control group produced a body inversion effect [$F(1,13) = 23.11$, $P < .00001$], but the ASD group did not [$F(1,9) < 1$]. The lack of a significant group effect [$F(1,22) < 1$] ruled out the possibility that the group differences in the body inversion effect could be attributed to group differences in overall body posture discrimination.

For houses, no orientation effect [$F(1,22) = 1.34$, $P > .25$] or orientation × group interaction [$F(1,22) < 1$] were found. These findings indicate that neither group demonstrated an inversion effect for houses. However, a marginal effect of group was found [$F(1,22) = 3.38$, $P = .08$], indicating that the control group (.71) was able to better discriminate between houses than the ASD group (.76)

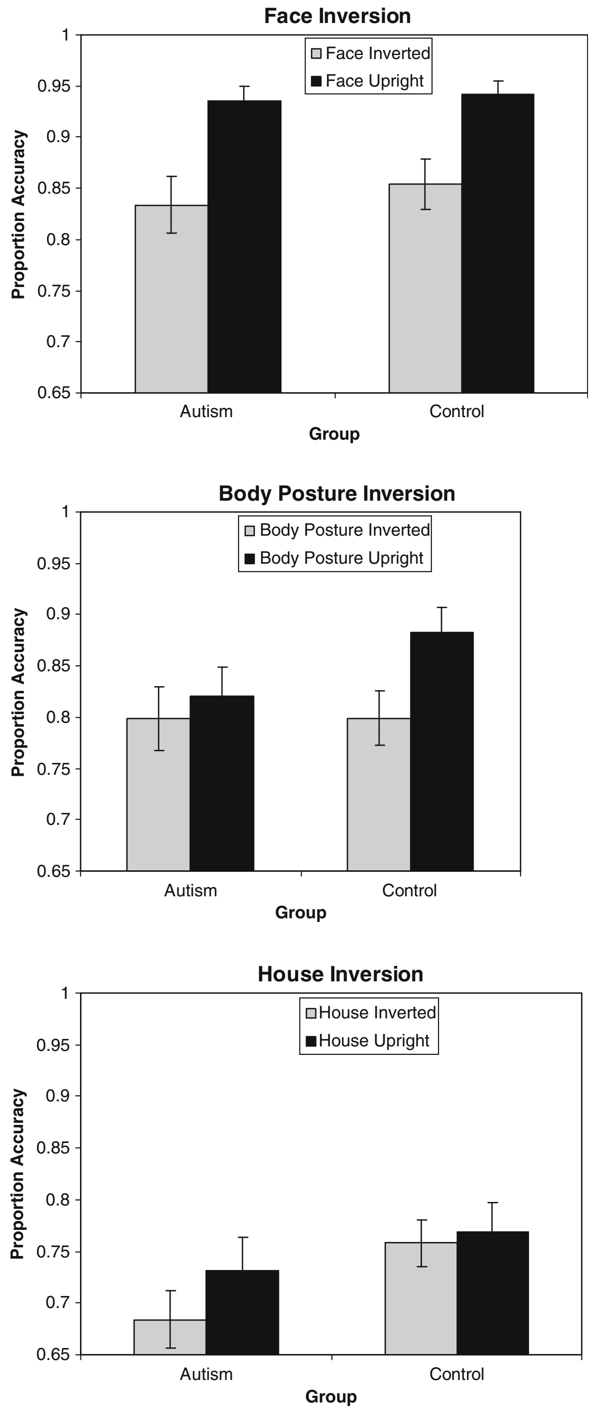

Fig. 2 Recognition performance for autism and control groups—inversion effects for faces, body postures, and houses. *Error bars* depict standard error. The control group produced significant inversion effects for faces and body postures, but not for houses. In contrast, the autism group only produced a significant inversion effect for faces

Individual Differences

Seven of the ten ASD participants showed a face inversion effect for accuracy data, but only three participants showed a body inversion effect (i.e., better performance for upright than inverted conditions). All participants who showed a body inversion effect also showed a face inversion effect. The two ASD participants who did not show a face inversion effect also reported having difficulties recognizing faces on a face recognition questionnaire. In contrast, 12 of the control participants showed a face inversion effect for accuracy data, and 13 control participants showed a body inversion effect.

In sum, the data demonstrate that this sample of high-functioning individuals with ASD appear to use configural processing to detect differences between faces. However, this ability does not appear to extend to body postures in most cases.

Discussion

The recognition of other people's faces and body postures is important for appropriate social interaction. However, individuals with ASD have great difficulty understanding the non-verbal cues of other people (Baron-Cohen, 1991; Kanner, 1943). This study examined whether these social processing deficits could be attributed to a specific face-processing deficit or a more general configural processing deficit for social stimuli. Previous research on typically developing individuals demonstrates some similarities in the processing of faces and body postures (Reed et al., 2003, 2006). Both are recognized using configural processing mechanisms as indicated by an inversion effect: upside down faces and body postures are more difficult to recognize than upright faces and body postures. This study compared inversion effects for faces, body postures, and houses in high-functioning adults with ASD and typically developing controls.

In contrast to the findings of some previous studies (Hobson et al., 1988; Langdell, 1978) but consistent with other (e.g., Teunisse & de Gelder, 2003), our results showed strong face inversion effects for this group of high-functioning adults with ASD. These face inversion effects matched those of controls. At least some adults with ASD are able to perform some kind of configural processing on faces. However, unlike controls, adults with ASD did not show body inversion effects. Neither group showed inversion effects for houses. Together, these results do not support either a face-processing deficit per se or a general configural-processing deficit for social stimuli. Instead, they suggest that adults with ASD may use different processing mechanisms to recognize face and body postures. Even in the absence of a face-processing deficit, the processing of other social stimuli can still be compromised.

Specifically, the discrepancy between face and body inversion effects indicated that some individuals with ASD may use configural processing for faces and not for body postures. This is inconsistent with the argument that individuals with ASD have a general global/configural processing deficit or weak central coherence, an argument that would predict no inversion effects for either faces or body postures (Frith, 1989; Teunisse, Cools, van Spaendonck, Aerts, & Berger, 2001). Nonetheless, the face inversion effect found in this study is consistent with other recent literature that supports some global/configural processing abilities in ASD for non-social stimuli. Some studies using Navon-type tasks (Navon, 1977) that require participants to identify either a large letter that is made up of smaller letters or identify the smaller letters have demonstrated global processing in ASD (Plaisted et al., 1999; Rinehart et al., 2000). Further, Teunisse and de Gelder (2003) found a face inversion effect for individuals with ASD when the memory load of the experimental task was decreased. In addition, Rouse, Donnelly, Hadwin, and Brown (2004) found that individuals with ASD were sensitive to the Thatcher effect: Like typically developing individuals, individuals with ASD judged a face to be grotesque to when the facial features were turned upside down in an upright face. Joseph and Tanaka (2003) found that individuals with ASD had better recognition of facial features in the context of the whole face, but that this holistic processing occurred only for lower portions of the face but not upper portions. The above studies suggest that high-functioning individuals with ASD can demonstrate adequate face recognition and configural processing, but the strategies that they use may not always be typical.

One explanation for why our group of high-functioning adults with ASD may have developed configural face processing is that they have developed expertise for face recognition from their participation in social skills groups. These individuals are part of a social skills group that provides explicit training on the recognition of faces and facial expressions in other people. In addition, this high-functioning group has sufficient cognitive capacities to make use of this extensive training in face processing. As a result, the presence of the face inversion effect may be indicative of more recently acquired face-processing expertise. In contrast, this social skills group does not to emphasize training in the recognition and interpretation of body posture. The lack of body inversion effect may merely indicate that these individuals do not attend to other people's body postures and have not developed expertise for processing body postures in the same way as faces.

The lack of configural processing for body postures is consistent with recently documented deficits in biological motion perception for children with ASD: they have difficulty interpreting human activities portrayed in point-light animations (Blake, Turner, Smoski, Pozdol, & Stone, 2003). Without strategies for processing other people's bodies, individuals with ASD are missing a critical source of social information.

People typically have similar amounts of exposure to faces and bodies, and faces and bodies convey redundant and congruent information regarding what another person is thinking, feeling, or intending to do. However, it appears that individuals with ASD are particularly poor at deriving information from body postures. This lack of configural body processing may contribute to social deficits observed in ASD.

In addition, this apparent lack of expertise in understanding other people's body postures may translate into deficits in personal production of gestures and body postures. Individuals with ASD tend to have a paucity of culturally transferred movement patterns, misinterpret other people's gestures, and imitate other people's gestures with an observable lack of fluency and desynchronized timing (e.g., Attwood, Frith, & Hermelin, 1988). When people with ASD do use gestures or body posture to communicate, the movements are often mechanical or exaggerated. Attwood et al. (1988) found that less able individuals with ASD were impaired in their ability to initiate simple instrumental gestures such as pointing, but all individuals with ASD were impaired in their use of expressive gestures. These gestures were often mistimed with content, suggesting that gestures are a conscious afterthought. The inability to modulate their behavior in response to another person's cues leads to the lack of spontaneity and reciprocity that are often considered hallmarks of the disorder. Gesture use in ASD is often described as stilted, mechanical, out of context, limited and invariant.

This study should be considered as a first step for investigating body posture recognition deficits in individuals with ASD. Our sample was a small group of high-functioning adults. Their training from social skills group participation provided them with a potential source of face-processing expertise that other individuals with autism may not have. Because individuals with ASD often do not attend to faces and social stimuli, younger and less well-trained individuals with ASD may appear to have more general configural processing deficits when performing the present tasks. Also, the heterogeneity of ASD should be taken into consideration because there may be some populations of individuals with ASD that have selective face-processing deficits and others that do not.

In conclusion, the finding that adults with ASD have atypical recognition of body postures has implications for therapy. People with ASD may benefit from therapies that guide them to understand body configurations as well as face configuration. Early training in learning to attend to and imitate other people's body postures might enable people with ASD to use a pivotal skill that would be relevant across many different social situations. Further, for individuals with ASD body postures may provide a less aversive, more accessible means for transmitting social information than faces because they do not require eye contact. Imitation therapies that emphasize attention to body postures could provide a generalizable tool that individuals with ASD could use across a variety of social situations and environments. A number of recent studies have documented greater effectiveness of interventions that include an imitation component over those that do not (Charman & Howlin, 2003; Dawson & Galpert, 1990; Ingersoll, 2003; Odom et al., 2003; Rogers, Hepburn, Stackhouse, & Wehner, 2003; Stone & Yoder, 2001). It is possible that therapies that employ a lot of imitation may not be working so much on imitation processes per se, but instead may be helping clients focus on information conveyed by body posture (Rogers et al., 2003). Understanding and emulating body postures may be an important source of social information that individuals with ASD are missing.

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