A FURTHER INVESTIGATION OF GOAL-DIRECTED INTENTION UNDERSTANDING IN YOUNG CHILDREN WITH AUTISM SPECTRUM DISORDERS

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ABSTRACT

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The basic ability to recognize intentionality via the consistent pursuit of goals has been reliably found to emerge early in typical development, but the ontogeny of intention understanding (IU) in individuals with autism spectrum disorders (ASD) is less clear. Findings from research investigating goal-directed IU in children with ASD have been equivocal, in part because of the varying methodologies used across studies. Studies are relatively consistent in their findings that children with ASD are adept at understanding intention when they are simply required to attend to actions on an object. However, when children with ASD must attend to, and incorporate, social-communicative cues to draw conclusions regarding goal-directed intention, evidence of impairment emerges. This study compares both object-oriented and social-communicatively cued goal-directed IU in the same sample of children with ASD and typically-developing children. Relative to matched controls, children with ASD did not exhibit deficits in object-oriented goal-directed IU (paralleling findings from previous studies). Although children with ASD also discriminated between intended and unintended actions (i.e., accidental actions) as cued by social-communication indicators, typically-developing children exhibited significantly greater differentiation between conditions. Performance on the social-communicatively cued task was significantly related to response to joint attention. Results suggest that children with ASD have intact object-oriented goal-directed IU abilities, and are able to incorporate social-communicative cues to develop an understanding of intention. However, they appear to do so to a lesser degree than their typically-developing peers.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Models of intentional action suggest that intentionality is a hierarchical system in which an individual selects a specific plan of action by which to obtain a particular goal (Bratman, 1989; Powers, 1973; Tomasello, Carpenter, Call, Behne, & Moll, 2005). Thus, a fully-developed understanding of intentionality would include an appreciation both of goal-directed actions (i.e., consistent pursuit of a singular goal) and the process by which the goal is obtained (i.e., means) (Tomasello et al., 2005). Studies suggest that infants develop the capacity to infer intentionality in others early in life, with demonstrations of intention understanding documented in children as young as 6-9 months of age (Behne, Carpenter, Call, & Tomasello, 2005; Marsh, Stavropoulos, Nienhuis, & Legerstee, 2010). However, display of intention understanding at this phase of development is built upon a cognitive understanding of goal-directed actions, and does not necessarily involve an understanding of various action plans (Tomasello et al., 2005). While this basic ability to recognize intentionality via the consistent pursuit of goals has been reliably found to emerge early in typical development, the ontogeny of intention understanding in individuals with autism spectrum disorders (ASD) is less clear. In fact, the literature is equivocal to the extent to which children with ASD have the ability to recognize goal-directed intentionality in another.

Questions regarding the abilities of children with ASD to understanding intentionality are largely driven by well-documented findings indicating that children with ASD experience difficulties in joint attention and in the inference of another's mental state to cause a particular action (i.e., theory of mind) (Meltzoff, 2007). Importantly, the understanding of intentional actions, together with the social motivation to share psychological states with another, are hypothesized to underlie development of both of these skills (Tomasello, 1999; Tomasello et al., 2005). Given that children with ASD exhibit significant deficits in both joint attention and theory of mind, it is

important to develop a greater understanding of basic goal-directed intention understanding in this population. However, the investigation of this skill in children with ASD has thus far yielded inconsistent findings. These equivocal findings may be partially explained by the varying methodology used across studies.

Findings appear relatively consistent that children with ASD are adept at understanding intention when they are simply required to attend to actions on an object (Aldridge, Stone, Sweeney, and Bower, 2000; Carpenter, Pennington, & Rogers, 2001; Colombi, Liebal, Tomasello, Young, Warneken, & Rogers, 2009). That is, impairment is not observed when children with ASD engage in goal-directed intention understanding tasks that do not rely on social-communicative skills. Meltzoff's (1995) behavioral reenactment paradigm, which requires attention to an experimenter's manipulation of an object, is the traditional method for assessing goal-directed intentionality in typically-developing (TD) children. In his seminal study investigating understanding of intentions in 18-month-old TD infants, Meltzoff (1995) demonstrated that infants imitate intended actions on objects even if the intended act itself is not modeled. In this paradigm, intention is conveyed by multiple effortful actions on objects, not by linguistic cues or facial expressions. For example, in one of the trials the experimenter held a dumbbell shaped toy composed of two separate pieces. The experimenter repeatedly 'tried' to pull apart the two pieces, but was unsuccessful each time because his hand 'slipped' off the object. When given the opportunity to act on the object, TD infants pulled the two pieces apart rather than mimicking the exact actions of the experimenter. Subsequent research has found that TD infants as young as 12 months are generally successful with this task (Nielsen, 2009).

The Meltzoff (1995) behavioral reenactment paradigm has been used in work examining goal-directed intention understanding in children with ASD. Aldridge, Stone, Sweeney, and Bower

(2000) found that 2-4 year-olds with autism successfully imitated the intended action on objects (even though the intended action was never completed). In fact, they found that these children produced more target acts than mental age-matched typically-developing children. Carpenter, Pennington, and Rogers (2001) found similar results, such that 2.5-5 year-olds with autism and matched developmentally-delayed children produced the same number of target acts after observing a demonstration of the unfulfilled intention. More recently, Colombi and colleagues (2009) used Meltzoff's behavioral reenactment paradigm in their investigation of potential constructs contributing to cooperative performance. Again, no impairment in goal-directed intentionality was identified for ASD children compared to nonverbal age matched developmentally-delayed peers (Colombi et al., 2009).

The findings from these studies, all of which exemplify object-oriented, goal-directed intention understanding, have been used to argue that children with ASD have intact intention understanding (Aldridge et al., 2000; Carpenter et al., 2001; Colombi et al., 2009; Tomasello et al., 2005). However, methodological issues have been identified that may confound the results reported by Aldridge et al. (2000) and Carpenter et al. (2001) (D'Entremont & Yazbek, 2007), and similar confounds are present in Colombi et al.'s (2009) more recent replication of the paradigm. Namely, Aldridge et al. (2000) failed to include a control condition to assess the potential ability of participants to pass the task via detection of object affordances (i.e., only the unfulfilled intention condition was administered). While Colombi and colleagues (2009) included an additional imitation condition (assessing for children's ability to imitate novel, completed actions) as part of their study, the condition was not treated as a control and was excluded from primary analyses. Carpenter et al. (2001) included Meltzoff's original manipulation condition to control for the potential contribution of stimulus enhancement, but they failed to identify a significant difference in

number of target actions completed across the manipulation condition and intention condition. This suggests children with ASD may have passed the behavioral reenactment task due to stimulus enhancement. However, the authors note that the average number of target actions produced in their intention condition was more than double the number produced in the manipulation condition, and that all children produced a greater number of target actions in the intention condition than in the manipulation condition. Thus, their lack of significant findings may have been due to insufficient power. Indeed, only 11 children were included in each group. Additional work, controlling for stimulus enhancement, is needed to clarify children with ASD's goal-directed intention understanding abilities as measured by Meltzoff's behavioral reenactment paradigm.

Using an alternate methodology, Castelli (2006) assessed goal-directed intention in school-age children with high-functioning autism or Asperger's. Castelli's (2006) study was a novel, nonverbal, computer-animated task requiring participants to apply goal-directed intentionality to a non-human agent based on kinetic motion. Participants observed an animated sequence depicting a circle rolling along a U-shaped valley. With each roll, the circle came closer to one of two objects resting on either side of the valley. According to the author, "the persistent motion in one direction and its improving attempts to overcome failure evokes the attribution of the intention to reach the target at the top of the valley, regardless of where the agent comes to rest." (Castelli, p.3, 2006). Castelli found that children with ASD were equally as able to understand the intentions of the non-human agent as their typically-developing peers. However, participants were school-age children with high-functioning autism or Asperger's. Given their age and relatively less severe symptomology (as determined by their diagnoses), it is possible that these children either learned to compensate for early deficits in goal-directed intention understanding over time, or may not exhibit the same difficulties with intention understanding as more affected individuals. As such, Meltzoff's

(1995) behavioral reenactment paradigm remains the most established methodology for assessing basic goal-directed intention understanding in young children with ASD with limited language.

The tasks described above measure a child's ability to understand the experimenter's persistent pursuit towards a goal via 'trying'. That is, the agent is *trying* to complete the intended action, but is failing to do so. As noted by D'Entremont and Yazbek (2007), these tasks do not require the child to rely on social-communicative cues to infer intention. The child only needs to attend to the agent's persistent kinematic actions to successfully pass the task. This is consistent with Premack and Premack's (1994) postulate that in order to apply intentionality to another agent, the stimuli must have goal-directed action, repeated motion, and variable motion patterns.

In contrast, tasks utilizing 'accidental actions' also require children to attend to and interpret the agent's overall behavior in order to accurately infer intentionality (D'Entremont and Yazbek (2007). These tasks still meet Premack and Premack's (1994) perceptual triggering input requirements for the attribution of intentionality, but have the additional demand of incorporating the agent's relevant social-communicative cues. Importantly, Tomasello et al. (2005) suggest that 'trying' tasks and tasks utilizing 'accidental actions' provide alternate means for assessing the same construct (i.e., goal-direct intention understanding). In contrast to the findings reported above, when tested using 'accidental action' paradigms that require children with ASD to attend to, and incorporate, social-communicative cues to draw conclusions regarding intention, impairments in goal-directed intention understanding are often detected. For example, D'Entremont & Yazbek (2007) modeled accidental and purposeful actions on toys. In both conditions the action and outcome were the same (toy was manipulated and consequence produced, e.g., lights flashing or top spinning), but the verbal marker differed. Unlike their typically-developing peers, children with ASD were equally likely to activate the toy when the experimenter modeled an 'accidental' action

compared to a purposeful one. Based on this information the authors concluded that while their group of children with ASD did give some indication that they attended to the goal (by activating the toy), they failed to demonstrate an appreciation of the model's intentions.

In contrast to the findings reported by D'Entremont and Yazbek (2007), Schietecatte, Roeyers, and Warreyn (2012) suggest that children with ASD may be capable of understanding goal-directed intention based on social-communicative cues of the experimenter. Schietecatte and colleagues employed a modified version of Behne et al.'s (2005) unwilling/unable paradigm to assess whether young children with ASD differentiate between an experimenter's accidental versus purposeful actions. In the original study, Behne and colleagues (2005) assessed understanding of intentional actions in the context of a ball passing task in which the experimenter repeatedly handed balls to the child. Occasionally the pattern of passing toys was interrupted such that the child did not receive the toy either because the experimenter was unwilling to give it to the infant, or because the experimenter "accidentally" dropped the ball and was thus unable to complete the transaction. In the latter case, the goal of the experimenter (to hand the child the toy) did not match the outcome. In the unwilling condition, the experimenter smiled in a teasing way, whereas in the unable condition the experimenter's facial expression conveyed surprise and frustration. Thus, across the two conditions the object continually moved towards the child and then away again such that only the social-communicative cues of the experimenter differentiated purposeful actions from accidental actions. The primary outcome measure here was the differential behavioral response of infants across the two conditions. Behne et al. (2005) found that typically-developing infants at 9, 12, and 18 months generated more reaching and looking away behaviors when the adult was unwilling to provide the toy than when the experimenter tried, but was unable, to hand over the object. Behne and colleagues (2005) concluded that these infants 'do not just perceive other people's surface

bodily motions but rather they interpret their action as a function of their goal' (p. 336). Schietecatte and colleagues (2012) achieved parallel findings, such that children with ASD exhibited more impatient behaviors in the unwilling condition than in the unable condition. However, no comparison group was used in their study. As such, it is unknown how children with ASD perform on the Behne et al. (2005) task relative to their typically-developing peers.

The mixed results in the literature regarding the ability of young children with ASD to understand goal-directed intention understanding is somewhat problematic for Tomasello et al.'s (2005) conceptualization of the ontogeny of intention understanding. Tomasello and colleagues (2005) argue that goal-directed intention understanding emerges early in life, and combines with social motivation to produce triadic engagement and joint attention. The process they describe is additive, such that intention understanding develops separately from the social motivation that drives an individual to share psychological states with others. The authors go as far as to explicitly state that "the skills children with autism have for understanding intentional action and perception do not translate into motivations and skills for sharing psychological states with others" (Tomasello et al., p. 12, 2005). This suggests a sense of unidirectionality, such that social motivation does not influence the actual understanding of goal-directed intention. However, a difference between object-oriented intention understanding and social-communicatively cued intention understanding might indicate an overlap between intention understanding and social motivation, such that social motivation may influence one's ability to detect cues important for attributing intentionality accurately. If it is the case that children with ASD are uniquely impaired in the ability to effectively integrate social-communicative cues into an understanding of goal-directed intention, then perhaps the understanding of goal-directed intention is a more complex social-cognitive skill than originally thought. A specific difficulty with goal-directed intention understanding when it is conveyed using

social-communicative cues may also better explain the deficits in joint attention and theory of mind observed in this population.

This study addresses this issue by assessing object-oriented and social-communicatively cued goal-directed intention understanding in the same population of young children with ASD. We have selected Behne et al.'s (2005) unwilling/unable task to assess understanding of goal-directed intention using social-communicative cues in young children with ASD. This task does not allow for the child to determine the experimenter's intention by attending only to kinematic actions on an object, but rather requires attention to social-communicative cues in order to succeed. In addition, it is non-imitative and does not require the child to provide a verbal response; thus it is appropriate for examining goal-directed intention understanding in young, nonverbal children with ASD (D'Entremont & Yazbek, 2007). Meltzoff's behavioral reenactment procedure will be used to asses object-oriented goal-directed intention understanding as it is the most established methodology for assessing goal-directed intention understanding (independent of social-communicative cues) in young, nonverbal children with ASD. Following Carpenter and colleagues (2001), we have included Meltzoff's *manipulatio*n condition to control for any potential effects of stimulus enhancement. To our knowledge, this is the first study that directly compares performance on Meltzoff's behavioral reenactment paradigm with a separate measure of goal-directed intention in the same children with ASD. By including this paradigm in the present study, we can clearly assess children with autism's performance in an object-oriented task relative to their ability to understand goal-directed intention in a social-communicatively cued task. Based on previous findings, we expect that, relative to matched controls, children with ASD will not exhibit deficits in understanding object-oriented intention as measured by the behavioral reenactment paradigm. Specifically, we expect a greater number of target actions produced in the *Intention Condition*

compared to the *Manipulation Condition* across the two groups. Given findings reported in Schietecatte, Roeyers, and Warreyn (2012), children with autism may indeed exhibit differentiated behaviors across the *unwilling* and *unable* conditions on the Behne et al. (2005) task. However, based on the results of D'Etremont and Yazbek (2007), we expect that, relative to typical controls, children with ASD will demonstrate impairment when required to attend to social-communicative cues to infer intention.

Social cognitive models of development hold that children develop joint attention skills only after they understand that other people are intentional agents and that they can engage in goal-directed behavior (Tomasello et al., 2005). Thus, based on this model, the impairments in joint attention observed in children with ASD may represent downstream effects of deficits in intention understanding. This relationship between joint attention and intention understanding in ASD was recently investigated by Schietecatte, Roeyers, and Warreyn (2011) using Behne et al.'s (2005) social-communicatively cued intention understanding task. While they were unable to assess the directionality of the relationship, they identified a positive correlation between response to joint attention (RJA) and performance on the Behne et al. (2005) task in young children with ASD. Therefore, while there is some research directly investigating the relationship between joint attention and social-communicatively cued intention understanding, this finding has not been replicated, extended to typically-developing children, or explored in terms of object-oriented intention understanding. Thus, a secondary aim of this study is to explore the relationship between joint attention and goal-directed intention understanding in children with ASD and their typically-developing peers. Based on findings reported by Schietecatte et al. (2012), we hypothesize that RJA will be related to performance on the social-communicatively cued goal-directed intention understanding task for both groups, but the relationship with IJA will be non-significant. The extant

literature is less clear on what to expect regarding the relationship between object-oriented goal-directed intention understanding and joint attention, but given Tomasello et al.'s (2005) model relating joint attention and intention understanding, it is hypothesized that both RJA and initiation of joint attention (IJA) will be correlated with performance on the behavioral reenactment task for both groups.

METHODS

Participants

Participants were 15 children with a community diagnosis of ASD (13 male) and 15 typically-developing children (6 male), matched groupwise on total language abilities and nonverbal mental age (see Table 1 for participant characteristics). All participants were recruited by advertisements to local agencies serving children with autism, community events, and local preschools. ASD diagnoses were confirmed using the *Autism Diagnostic Observation Schedule – Generic* (ADOS-G; Lord et al., 2000). All children scored above the cut-off for either Autism or Autism Spectrum Disorder on the revised ADOS algorithm (Gotham, Pickles, & Lord, 2009). Typically-developing children were screened for developmental concerns using the *Communication and Symbolic Behavior Scales-Developmental Profile Infant-Toddler Checklist* (CSBS-DP; Wetherby & Prizant, 2002). Parents of our typically-developing children reported no developmental concerns, and thus no children were excluded from participation.

Design and Procedure

Parents provided written consent for their child's participation, and each child was provided a $20 gift card to a local toy store. Children were tested individually in a quiet room either at the MSU Autism Laboratory or at their schools over a period of three to four days (approximately 3-4 hours in total). All behavioral testing was videotaped for later primary and inter-rater reliability scoring.

Participants were administered standardized measures of nonverbal mental age, ASD symptomology, language, and joint attention.

Nonverbal Mental Age. The *Bayley Scales of Infant Development, 3rd Edition* (BSID-III; Bayley, 2006) is a standardized developmental assessment for children ages 1–42 months. For the purposes of this study, only the cognitive scale of the BSID-III was administered. Age equivalent

was used as a measure of nonverbal mental age in the analyses. Nonverbal mental age for six children with ASD was assessed using the *Mullen Scales of Early Learning* (MSEL; Mullen, 1995) instead of the BSID-III. The MSEL (Mullen, 1995) is a standardized developmental assessment for children up to 68 months of age. Average age equivalent across the Visual Reception and Fine Motor subscales was used as a measure of nonverbal mental age for these children.

Language Skills. The *Preschool Language Scales, 4th Edition* (PLS-4; Zimmerman, Steiner, & Pond, 2002) is a standardized assessment used to measure language ability in children from birth to 6 years, 11 months. Total language age equivalent (representing combined expressive and receptive skills) was used as a measure of language ability. Language abilities for six children with ASD were assessed using the *Mullen Scales of Early Learning* (Mullen, 1995) instead of the PLS-4. Average age equivalent across the Expressive and Receptive subscales was used as a measure of language abilities for these children.

ASD Symptomatology. The *Autism Diagnostic Observation Schedule-Generic* (ADOS-G; Lord et al., 2000) is a standardized observational assessment used to examine autism symptomatology. Calibrated severity scores derived from the ADOS-2 algorithm were used as a measure of symptom severity (possible range = 1-10) (Gotham, Pickles, & Lord, 2009). To be included in our ASD sample, children were required to have a calibrated severity score of at least 4.

Joint Attention. The *Early Social Communication Scales* (ESCS; Seibert, Hogan, & Mundy, 1982) examines the child's ability to engage in social interaction and communication with an experimenter. Percent of correct responses to 8 distal points and 6 proximal points was used as a measure of RJA. Number of coordinated gaze shifts, shows, and points was used as a measure of IJA.

Intention Tasks. Each child participated in two intention tasks, one of which assessed understanding of goal-directed intention by attending to kinematic actions on objects (Meltzoff's *behavioral reenactment paradigm*: Object-oriented goal-directed intention understanding) and the other of which necessitated attending to social-communicative cues to derive intention (Behne et al.'s *unwilling/unable task*: Social-communicatively cued goal-directed intention understanding). Task order was counterbalanced across participants.

Object-Oriented Goal-Directed Intention Task. Five object sets constructed to replicate Meltzoff's (1995) objects served as test stimuli (Figure 1). Performance of target actions across three conditions was assessed. The *Baseline Condition* assessed whether the object sets have particular demand characteristics lending themselves to particular actions. The experimenter handed the child an object set one at a time and the child had 20s to play with the object. Following the procedure utilized by Carpenter, Pennington, and Rogers (2001), if the target act was performed during baseline an alternate target action was used for the demonstration and response period. One trial was excluded for one child with ASD because both potential actions were performed during the baseline period.

The *Intention Condition* assessed how participants responded to an experimenter's attempt to complete a specific target action. The experimenter tried, but failed, to complete a specific action (target action) using the object sets, such that the final end state was not demonstrated. The *Manipulation Condition* assessed how participants respond to demonstration of a completed action, and acted as an additional control assessing whether watching the experimenter manipulate the objects highlighted the function of the object sets. In this condition, the experimenter used the same objects as in the *Intention Condition*, but modeled a different, complete, action. For the *Intention* and *Manipulation* conditions, the demonstration with each object set was repeated three times, in

approximately 20s. During the demonstration period, the experimenter did not provide any facial expressions or vocal cues (except to redirect child attention to the demonstration as needed). A 20s response period began as soon as the child touched either component of the object set. At the end of this response period, the object set was removed, and the next object set presented to the child. All demonstrations were presented out of reach of the children so that they were only able to view the event. Positive feedback was non-contingent on child performance. The order of the five objects was randomized across participants for each condition, and the order of the *Intention* and *Manipulation* conditions was counterbalanced. The *Baseline Condition* was always presented first.

Our primary outcome measure was the number of completed target actions produced across each condition. Production of the target action was scored if the child performed the *end state* of the target action at least once. Greater target action production in the *Intention Condition* represents recognition of the experimenter's intentional action whereas similar target action production in the *Intention Condition* and *Manipulation Condition* represents the influence of a spotlighting effect.

Social-Communicatively Cued Goal-directed Intention Task. We administered an abridged version of Behne et al.'s (2005) task (using only their "Tease" condition) to assess children's understanding of intention using social-communicative cues. The experimenter handed the child a series of 30 balls of varying sizes, shapes, colors, and textures, one at a time. For each non-test trial the child was allowed to play with the ball if interested, before being prompted to put the ball in the "All Done Bucket" after 30s. There were six test trials, in which the child was shown a new ball but did not receive it for one of two reasons (described below). Three test trials were conducted for each of the two test conditions. During each condition, the ball continually moved towards the child then away again, approximately 3 times. In the *Unwilling Condition*, the experimenter extended the ball towards the child and withdrew it in a teasing manner as the child reached for it. The experimenter

smiled in a teasing way and accompanied the action with a gasp or other appropriate vocalization. In the *Unable Condition*, the experimenter extended the ball towards the child and then 'accidentally' dropped it as the child reached for it. The ball rolled back towards the experimenter via a wooden ramp on the table. The experimenter's facial expression conveyed surprise and frustration, and each 'accidental' action was followed by "hmmm" vocalized in a confused tone. Four control trials, in which the experimenter did give the ball to the child, were administered between each test trial, until all six test trials had been completed. The six balls used during the test trials were counterbalanced across conditions. The order of presentation of the test trials alternated, with the first condition presented counterbalanced across participants.

Child behavior during each 30s test trial period was scored from videotape using 5-second interval scoring. Based on response measures outlined in Behne et al. (2005) and Schietecatte, Roeyers, and Warreyn (2011), a number of variables were initially coded (i.e., banging, reaching, turning away, and looking at the experimenter). Positive and negative affect was also coded. While Behne et al. (2005) identified significant differences in both looking away and reaching behaviors, reaching behavior was the only discriminatory behavior in Schietecatte, Roeyers, and Warreyn (2011). Here, looking / turning away was the only measure that differed significantly across the unwilling and unable conditions in the typically-developing controls. As such, duration of disengagement from the game (i.e., looking or turning away) acted as our primary response measures for both groups and is the only variable included in further analyses. More looking away during the *Unwilling Condition* compared to the *Unable Condition* indicates appropriate understanding of intention (Behne et al., 2005).

Reliability. To assess inter-observer reliability, 33% of children were chosen at random from each group and an independent coder coded their object-oriented and social-communicatively cued

task sessions. Cohen's kappa for number of target actions completed in the object-oriented task was 0.87 and 0.86 for the intention condition and manipulation condition respectively, and was 0.68 and 0.78 for percent of intervals with behaviors representing disengagement across unwilling and unable conditions respectively in the social-communicatively cued task. These values represent substantial to almost perfect agreement (Landis & Koch, 1977).

Data Analysis

Data collected did not violate assumptions of independence or sphericity, and was not significantly skewed, platykurtic, or leptokurtic. As such, all analyses conducted were parametric. A series of two-factor mixed-model ANOVAs with group as a between-subjects factor and experimental task as a within-subjects factor were conducted. Within-subject factors consisted of the number of target actions completed in the *Manipulation* and *Intention* conditions in the object-oriented goal-directed intention task and the percent of time spent disengaged from the task across the two conditions for the social-communicatively cued goal-directed intention task. Follow up t-tests were conducted to explore significant ANOVA results.

To investigate the potential relationship between joint attention and intention understanding in our sample, bivariate correlations were performed. This analysis allowed us to examine whether IJA or RJA are predictive of performance on either of the intention tasks for typically-developing children and / or children with ASD.

RESULTS

Object-oriented goal-directed intention understanding

A repeated measure two factor ANOVA treating group as a between-subjects variable and condition (i.e., intention vs. manipulation) as a within-subjects factor was conducted. Because there were only two conditions, all reported within-subjects test results are assuming sphericity. The ANOVA was significant for condition [$F(1,28) = 67.55$, $MSE = 0.77$, $p < .001$], such that collapsing across groups, individuals performed the target action more in the intention condition ($M = 3.60$ and $SD = 0.22$) than in the manipulation condition ($M = 1.73$ and $SD = 0.22$). We did not identify a significant main effect for group [$F(1,28) = .12$, $MSE = 2.15$, $p = 0.73$], indicating that typically-developing children and children with ASD performed similarly on this task (see Figure 2.). The interaction between condition and group was also non-significant [$F(1,28) = 1.38$, $MSE = 0.77$, $p = 0.25$].

Social-communicatively cued goal-directed intention understanding

A repeated measure two-factor ANOVA treating group as a between-subjects variable and condition (i.e., unwilling vs. unable) as a within-subjects factor was conducted. Because there were only two conditions, all reported within-subjects test results are assuming sphericity. The ANOVA was significant for condition [$F(1,28) = 40.42$, $MSE = 0.03$, $p < 0.001$], such that collapsing across groups, children looked away more in the unwilling condition ($M = 0.68$ and $SD = 0.05$) than in the unable condition ($M = 0.43$ and $SD = 0.04$). Again, we did not identify a significant main effect for group [$F(1,28) = 2.81$, $MSE = 0.07$, $p = 0.10$].(see Figure 3.). However, a significant group by condition interaction emerged [$F(1,28) = 5.71$, $MSE = 0.03$, $p = 0.05$].

To examine the interaction between condition and group, simple main effects of condition using local error terms were computed separately for each group. For typically-developing children,

the simple main effect of condition was significant [$F(1,14) = 37.79$, $MSE = 0.03$, $p < 0.01$] such that they looked away significantly more in the unwilling condition ($M = 0.67$ and $SD = 0.18$) than in the unable condition ($M = 0.32$ and $SD = 0.20$). Children with ASD also looked away significantly more in the unwilling condition ($M = 0.70$ and $SD = 0.20$) than in the unable condition ($M = 0.53$ and $SD = 0.29$) [$F(1,14) = 7.97$, $MSE = 0.03$, $p < 0.05$]. However, while groups did not differ in amount of time spent looking away in the unwilling condition ($t(28) = -0.32$, $p = 0.75$), children with ASD looked away significantly more than their typically-developing peers in the trying condition ($t(28) = -2.38$, $p < 0.05$). Thus although the behavior of each group indicated understanding of the experimenter's intention, typically-developing children expressed a greater difference between conditions than their peers with ASD. Examination of the individual data supported this conclusion (see Figure 4).

Joint attention across groups

A single factor between-subjects ANOVA was conducted to test whether RJA and IJA differed as a function of group membership (ASD compared to typically-developing). The ANOVA indicated overall mean differences for both RJA [$F(1,28) = 13.09$, $MSE = 342.89$, $p < 0$ .001] and IJA [$F(1,28) = 16.01$, $MSE = 27.06$, $p < 0$ .001], such that children with ASD exhibited lesser amounts of both IJA and RJA compared to their typically-developing peers. The means and standard deviations for participants RJA and IJA are presented in Table 2.

Relationship between goal-directed intention understanding and joint attention

Difference scores were used to examine the associations between object-oriented and social-communicatively cued goal-directed intention understanding and initiations of and response to joint attention (Table 2). For both typically-developing children and children with ASD, no significant relationships emerged.

An immediate issue of consideration here is our small sample size for each group. Correlations with only 15 individuals are highly susceptible to differences in individual data. Given that both groups exhibited social-communicatively cued goal-directed intention understanding, and both groups had a positive relationship with RJA, we decided to collapse across groups and explore the relationship between RJA and social-communicatively cued goal-directed intention understanding with greater power. Collapsing across groups, RJA became significantly positively related to performance on the social-communicatively cued goal-directed intention task ($r = .31$, $p < .05$). Collapsing across groups did not significantly influence any other relationship.

DISCUSSION

The purpose of this study was to examine performance on two measures of intention understanding in typically-developing children and children with ASD. To our knowledge, it is the first study comparing object-oriented and social-communicatively cued goal-directed intention understanding in the same sample. Given previous work suggesting links between intention understanding and social-cognitive skills, we also explored the relationship between both measures of intention understanding and joint attention abilities. The study was specifically designed to assess Tomasello et al.'s (2005) conceptualization of goal-directed intention understanding and to compare and contrast object-oriented and social-communicatively cued goal-directed intention understanding. Behne et al.'s (2005) unwilling/unable task for TD children was selected as the ideal task for assessing young children with autism's ability to understand intention using social-communicative cues as it does not allow for the child to determine the experimenter's intention by attending only to actions on an object, is non-imitative, does not require the child to provide a verbal response, and requires attention to social emotional cues in order to succeed. While both Meltzoff's (1995) behavioral reenactment procedure and Behne et al.'s (2005) social-communicatively cued task assess goal-directed intention understanding, the different task demands allow us to develop a more nuanced understanding of how children with ASD understand the goal-directed intentions of others.

Results of this study parallel previous findings indicating that children with ASD do not exhibit a deficit in goal-directed intention understanding as measured by Meltzoff's behavioral reenactment paradigm (Aldridge et al., 2000; Carpenter et al., 2001; Colombi et al., 2009). However, we have extended previous work with this paradigm to include both a larger number of children and a condition controlling for issues of stimulus enhancement. The present study found

that children with ASD and their typically-developing peers did not differ in the average number of target actions produced in either the intention or manipulation conditions. Similarly, both groups produced significantly more target actions in the unfulfilled intention condition than in the manipulation condition. This pattern of results seemingly indicates that children with ASD have intact object-oriented goal-directed intention understanding abilities. These finding are also consistent with Castelli's (2006) work assessing goal-directed intentionality in older, higher functioning children with ASD. Paralleling the results reported here, Castelli (2006) also failed to identify a difference between children with ASD and typically-developing children on a task requiring the inference of intentionality based on repeated, effortful attempts (i.e., trying) as indicated by kinematic motion.

Several researchers have pointed out that the Meltzoff task may not provide a true measure of the ability to infer the intentions of others. More specifically, Huang and colleagues (2002; 2006) conclude that target act production may simply be the result of expanded imitation and / or detection of object affordances. Across several studies investigating the theoretical and methodological foundations of the Meltzoff task, Huang and colleagues argue that it is unclear whether children succeed in the behavioral reenactment paradigm solely because of an understanding of intentionality, or through a combination of spatial contiguity, intentional imitation, emulation, and mimicry. These findings challenge previous conclusions that children in the intention condition produce the target action because they have an understanding of the experimenter's intended action. Thus, Meltzoff's task may indeed assess aspects of intentionality, but the relative contribution of different social-cognitive processes to performance on this paradigm is unknown. While this procedure has been used extensively to explore goal-directed intention understanding (Aldridge et al., 2000; Bellagamba and Tomasello, 1999; Carpenter, Pennington, & Rogers, 2001; Colombi et

al., 2009; Johnson, Booth, & O'Hearn, 2001), additional work is needed to clarify the constructs directly assessed by this task.

Based on our findings, children with ASD can demonstrate an understanding of goal-directed intention when required to attend to the experimenter's social-communicative cues. This replicates recent work reported by Schietecatte et al. (2012), whose findings also indicated that young children with ASD could successfully discriminate intentional from unintentional (i.e., accidental) behavior in Behne et al's (2005) paradigm. It is also consistent with results of Vivanti et al. (2009), such that children with ASD were able to use facial expressions of an actor in the attribution of goal-directed intentionality. However, we also found that the level of discrimination between unwilling and unable conditions differed between typically-developing and ASD children. Both groups exhibited behavior indicating an understanding of goal-directed intention, but children with ASD discriminated significantly less between conditions.

The ability of young children with ASD to understand social-communicatively cued intention is in contradiction to findings of D'Entremont and Yazbek (2007), who found that children with ASD failed to show an appreciation of a model's goal-directed intentions when reliance on social-communicative cues was necessary. This was in contrast to typically-developing children and developmentally delayed children. However, this was not necessarily the case for all children across all conditions. For example, like the children with ASD, older participants and developmentally delayed participants were equally likely to imitate the intended and accidental actions when only one action was modeled. Differences only emerged when children with ASD were compared to younger children or older children and developmentally delayed children in the two-action sequences. This unusual pattern of results may be driven by lack of control in participant selection. D'Entremont and Yazbek (2007) failed to control for developmental level of their

participants, and only partially controlled for verbal abilities. In fact, neither cognitive nor language abilities were assessed for younger typically-developing children, and not all children in the other groups received language testing. Thus it is possible that the differences observed were driven by factors other than goal-directed intention understanding abilities. As such, we believe the methods used here provide for a more controlled view of the goal-directed intention understanding abilities of children with ASD. Based on our findings, children with ASD indeed are able to incorporate social-communicative cues to develop an understanding of intention. However, they appear to do so to a lesser degree than their typically-developing peers. This underscores the importance of using methods for assessing goal-directed intention understanding that capture subtle changes in behavior as opposed to more complex responses such as imitation.

Tomasello et al.'s (2005) theory is only partially supported by our findings. Tomasello and colleagues (2005) have argued that goal-directed intention understanding emerges as a function of cognitive understanding of goal-directed action. They argue that the understanding of goal-directed action is separate from the social motivation to share psychological states, and together they form the foundation for joint attention. While children with ASD's success in the Behne et al. (2005) task demonstrate that this population can derive successful understanding of goal-directed intentionality regardless of task demands (supporting Tomasello et al's (2005) conceptualization of the ontogeny of intention understanding), children with ASD are less successful than their typically-developing peers when the goal-directed intention understanding paradigm requires integration of social-communicative cues. The difference in performance of children with ASD compared to their typically-developing peers on the social-communicatively cued task indicates that there may be additional factors influencing the attribution of intentionality independent of a cognitive understanding of goal-directed action. In contrast to Premack and Premack's (1994) outline of the

perceptual features necessary for the attribution of intentionality, we would suggest that the proposed features may be influenced by the presence of social-communicative information. Based on our results, when social-communicative cues are available, they are an additional necessary input for the appropriate understanding of goal-directed intention in another.

The ability of typically-developing children to use social-communicative cues more effectively than children with ASD helps explain findings indicating relative impairment in intention understanding on tasks with greater demands (e.g., Phillips, Baron-Cohen, & Rutter, 1998; D'Entremont & Yazbek, 2007). As demands increase or the salience of cues decrease, children with ASD may be unable to utilize social-communicative cues at a level necessary to benefit task performance. This is consistent with recent findings by Vivanti and colleagues (2011), such that children with ASD performed as well as controls in sorting objects into groups based on intentions conveyed by strongly emotional facial expressions, but the same children exhibited a marked impairment relative to controls in their ability to utilize more subtle social-communicative cues such as head turning. This potential distinction between understanding goal –directed action and the social-communicative function of intention understanding would predict that children with ASD would demonstrate unimpaired performance relative to controls on intention understanding tasks where social-communicative cues are not present. Indeed, this is appears to be the case (Castelli, 2006). Thus rather than representing separate, additive entities, our results suggest that cognitive understanding of goal-directed actions and social motivation overlap and work in tandem to allow an individual to fully understand goal-directed intention.

It has been suggested that the understanding of intention is a foundational skill for the development of joint attention (Tomasello, 1999; Tomasello et al., 2005). While our results suggest that children with autism are not fundamentally impaired in the understanding of either object-

oriented or social-communicatively cued goal-directed intention, extant research indicates that this population experiences significant difficulties with both initiation of and response to joint attention (Dawson, Toth, Abbott, Osterling, Munston, Estes, & Liaw, 2004). This was replicated in our sample. We did not identify a significant relationship, for either typically-developing children or children with ASD, between performance on either measure of intention understanding and joint attention. This is in contrast to Schietecatte, Roeyers, and Warreyn's (2012) finding that RJA is significantly correlated with performance on the Behne et al., (2005) task in children with ASD. However, when we collapsed across groups to increase our ability to detect significant relationships, we also found a positive relationship between RJA and performance on the social-communicatively cued goal-direct intention understanding task.

While we had anticipated relationships between object-oriented goal-directed intention understanding and IJA and RJA based on Tomasello et al.'s (2005) ontogeny of intention understanding (i.e., intention understanding forms the basis for joint attention), upon closer examination it is unsurprising null relationships were identified. By design, success on Meltzoff's behavioral reenactment procedure was independent of experimenter social-communicative behavior. Thus joint attention, either RJA or IJA, would not necessarily help or hinder a child on this task. A similar explanation can be made for the null relationship between IJA and social-communicatively cued intention understanding, such that the task required participants to attend to the experimenter's social-communicative cues only. Initiation of joint attention would not influence performance on the task. While intention understanding may indeed form the foundation for joint attention as argued by Tomasello et al. (2005), the measures used to assess goal-directed intention understanding in this study do not directly relate to joint attention skills as measured by the ESCS (with the exception of Behne et al.'s (2005) social-communicatively cued task and RJA).

It is important to note that this study does not indicate that children with ASD (or even typically-developing young children) understand all aspects of attributing intention to actions. Rather, results reported here are consistent with developmental considerations around the ontogeny of intention. Tomasello and colleagues (2005) report that the first step in intention understanding is the conceptualization of intention as the persistent pursuit of goals. As children develop, they begin to understand the rational dimension of the intention process. Similarly, Leslie's (1994) tripartite theory of agency holds that at a "lower" cognitive level, there might be a system concerned with goal-directed action, whereas at a "higher" cognitive level, systems are concerned with propositional states (e.g., 'hoping that'). There is nothing in the current study to suggest that children with autism have developed an understanding of higher level intentional understanding as operationalized across either of these cognitive frameworks. Nevertheless, results presented here indicate that the more basic conceptualization of intention understanding in others, thought to emerge around 6-9 months of age in typically-developing children, is intact in children with ASD (Behne et al., 2005; Marsh et al., 2010).

Future research would benefit from methods assessing object-oriented goal-directed intention understanding that avoid issues of spatial contiguities and expanded imitation (e.g., emulation learning and mimicry) and simultaneously reduce imitation and language as task demands. While Castelli (2006) has developed such a procedure for use with adolescents with high functioning autism and Asperger's, to our knowledge there is no existing paradigm for young children who may be more severely impacted. Additionally, our exploratory analyses investigating the relationships between intention understanding and joint attention skills were limited by our small sample size. Indeed, some of the correlations identified were in the moderate range. As such, failure to identify significant relationships may have been due to lack of power. More research

investigating the relationship of goal-directed intention understanding and higher level social cognitive skills is called for.

APPENDICES

APPENDIX A

Tables

Table 1. *Participant Characteristics.*

Participants (*n*=30)	**CA (mos.)**		**NVMA**[a] **(mos.)**		**VMA**[b] **(mos.)**		**Autism Severity**[c]	
	ASD	**TD**	**ASD**	**TD**	**ASD**	**TD**	**ASD**	**TD**
Mean	54.93	23.93	26.67	25.13	25.47	30.45	7.2	-
SD	13.87	4.26	5.12	3.91	8.77	7.16	1.61	-

[a]BSID-3 / MSECL ; [b]PLS-4 / MSECL; [c]ADOS CSS

Table 2. *Means, Standard Deviations, and Bivariate Correlations between Performance on Goal-Directed Intention Understanding Tasks and Joint Attention.*

	Mean (SD)		Object-Oriented Intention Understanding			Social-Communicatively Cued Intention Understanding		
	ASD	Typically-developing	ASD	Typically-developing	All participants	ASD	Typically-developing	All participants
RJA	72.87[a] (25.40)	97.33[a] (6.37)	-0.11	0.34	-.14	0.27	0.10	.38*
IJA	3.40[b] (3.78)	11.00[b] (6.31)	-0.19	-0.22	-.29	0.14	-0.30	.15

Note. *$p < .05$. Numbers with the same superscript are significantly different from one another.

APPENDIX B

Figures

Figure 1. Objects used in object-oriented goal-directed intention task.

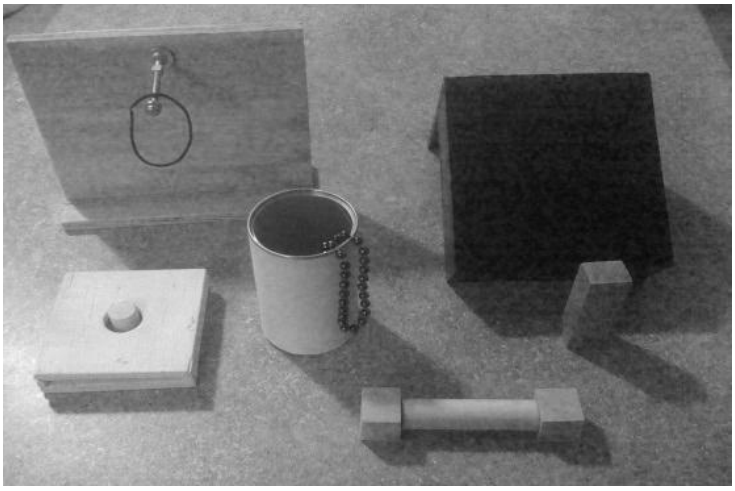


Figure 2. Number of target actions completed in each condition of the object-oriented goal directed intention understanding task.

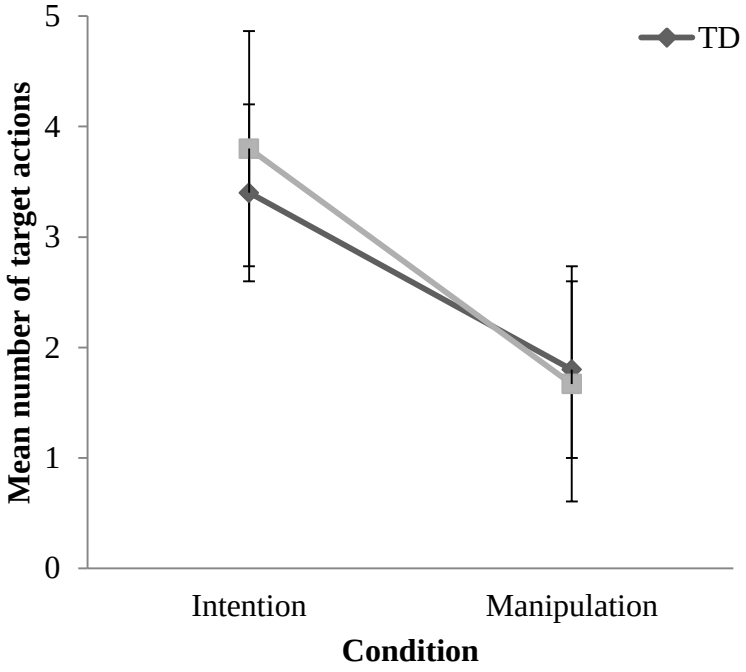


Figure 3. Percent of intervals with 'looking away' behavior in each condition of the unwilling / unable goal-directed intention understanding task.

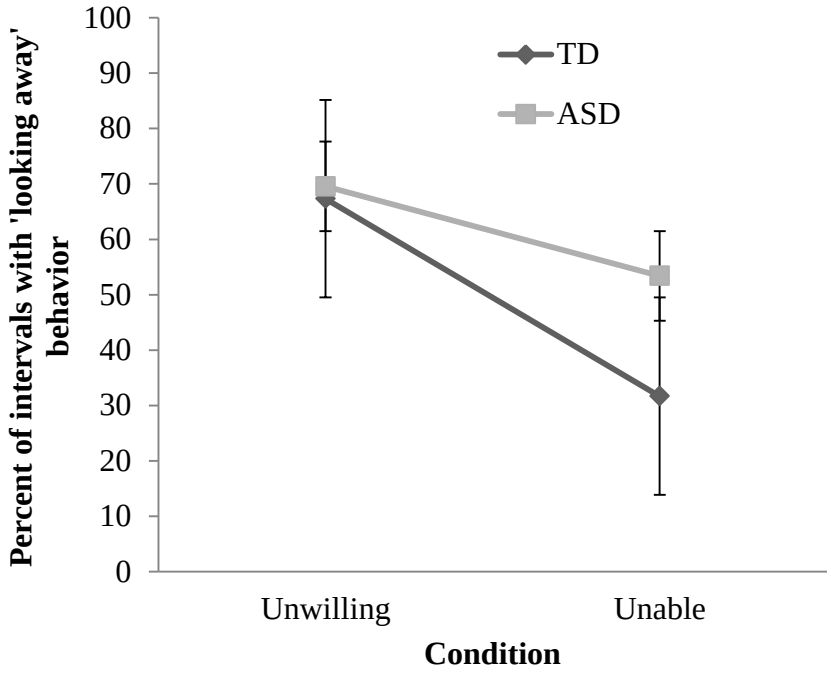
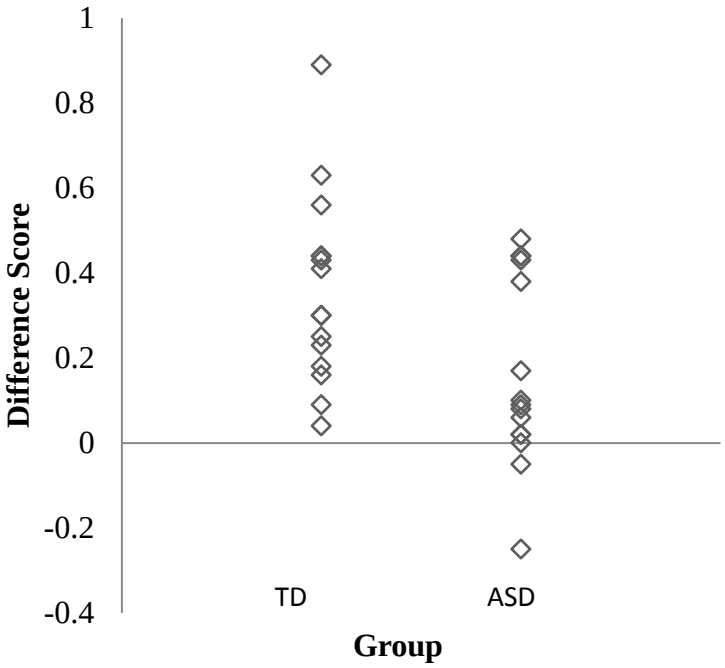


Figure 4. Scatterplot illustrating the difference in time spent looking away between conditions in the unwilling / unable goal-directed intention understanding task. Higher difference scores indicate greater intention understanding.



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