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Young Children with Autism Spectrum Disorders

Imitate in the Context of others' prior intention

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Young Children with Autism Spectrum Disorders Imitate in the Context of others' prior intention

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Abstract:	<p>Many studies have shown that children with autism spectrum disorder (ASD) have some understanding of intentions behind other's goal-directed actions on objects. It is not clear whether they understand intentions at a higher level of abstraction reliant on the context in which the actions occur. The current study tested their understanding of others' prior intentions with typically-developing (TD) and developmentally-delayed (DD) children. We replicated Carpenter et al.'s (2002) test of the ability to understand prior intentions embedded in the social situation with an additional context of no prior intention. Results showed that when the experimenter's intention was made known before the demonstration, children without ASD performed not only better than the ASD children, but also better than themselves when there was no information about prior intention. No between-condition difference was found in the ASD group. It thus appears that children with ASD have difficulty decoupling intentions from the context of the situation. The present findings, together with previous evidence for the intactness of the ability to understand and to imitate goal-directed actions, suggest that asymmetrical imitation performance occurs at different levels of understanding of intention by children with ASD.</p>

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Abstract

Many studies have shown that children with autism spectrum disorder (ASD) have some understanding of intentions behind other's goal-directed actions on objects. It is not clear whether they understand intentions at a higher level of abstraction reliant on the context in which the actions occur. The current study tested their understanding of others' prior intentions with typically-developing (TD) and developmentally-delayed (DD) children. We replicated Carpenter et al.'s (2002) test of the ability to understand prior intentions embedded in the social situation with an additional context of no prior intention. Results showed that when the experimenter's intention was made known before the demonstration, children without ASD performed not only better than the ASD children, but also better than themselves when there was no information about prior intention. No between-condition difference was found in the ASD group. It thus appears that children with ASD have difficulty decoupling intentions from the context of the situation. The present findings, together with previous evidence for the intactness of the ability to understand and to imitate goal-directed actions, suggest that asymmetrical imitation performance occurs at different levels of understanding of intention by children with ASD.

Key words

Autism spectrum disorder, imitation, intention, prior intention

Introduction

Since Leo Kanner (1943) first described autism, imitation was for a long time thought to be impaired in children with autism (DeMyer et al., 1972; Rivo and Provence, 1953; Rogers et al., 1996; Smith and Bryson, 1998; Williams et al., 2004). However, more recent studies showed that imitation is not globally impaired in autism (see Hamilton, 2009; Vivanti and Hamilton, 2013, for reviews). For example, children with autism are able to imitate goal-directed actions on objects (e.g., Hamilton and Frith, 2007), but have more difficulty when copying meaningless actions (Stone et al., 1997) or unnecessary action styles with which goal-directed actions are performed (Hobson and Lee, 1999).

What might be implicated in the intact ability to imitate actions on objects? There is a growing consensus that this reflects unimpaired abilities in goal understanding. A number of studies capitalizing on the behavioral reenactment procedure (Meltzoff, 1995) have been influential in generating this consensus (Aldridge et al., 2000; Berger and Ingersoll, 2014; Carpenter et al., 2001; Colombi et al., 2009; D'Entremont and Yazbek, 2007). In the behavioral reenactment procedure, infants observe an adult model apparently attempting but failing to perform a specific target action. Like typical-developing infants, young children with autism produced a similar proportion of target acts following the behavioral reenactment procedure. Because the end state of the object is not observed, this effect has been interpreted as indicating the ability to understand and infer goal-directed intentions.

However, new evidence has challenged whether infants necessarily view others' failed attempts as being about intentions. Behavioral reenactment data may be interpreted as nonimitative learning. For example, Huang et al. (2002, 2006) showed that typically-developing infants and preschoolers reproduced as many target acts in the behavioral reenactment procedure (e.g., seeing a person unsuccessfully attempt to

1 drape a loop over a peg) as when confronted with end results only (e.g., seeing the loop on the peg).

2
3
4 According to Gibson (1988), children actively explore the environment with their discovery of the

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6
7 perceptual features specifying the properties of objects that elicit actions (i.e., affordances). Affordances

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9
10 provide information about what actions can be done with objects. When observing the end result, infants are

11
12 exposed to the affordance characterizing the object's end configuration (e.g., the peg affords supporting). It

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14
15 is likely that they recreate the end state by detecting the relevant affordance. Similarly, affordance learning

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18 could operate in the behavioral reenactment procedure where manipulation of the target-relevant parts of the

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21 object highlights the affordance to emulate. Huang and Charman (2005) showed 17-month-old infants a

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24 modified video that included only object movements extracted from a model's unsuccessful attempts (e.g.,

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27 seeing a self-propelled loop move toward then drop near the hook). Infants in this "ghost" condition

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29
30 reproduced the target act as often as infants who saw the target act fully presented by the model. This

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32
33 suggests that the object movement pattern displayed in the failed attempts shed light on the affordance

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35
36 relevant to the target act. Since infants could independently learn about the target act through affordance

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39 detection, it is open to challenge whether behavioral reenactment of intended acts depends on the model's

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42 bodily acts as clues to intentions.

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45 To clarify whether children see intentions as mental states in their imitation of other people's goals,

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48 developmentalists have recently shifted the focus of research to prior experiences that inform children about

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51 a model's mental plan to perform an action before seeing the demonstration. This notion of "prior intention",

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54 according to Searle (1983), differs from the notion of "intention in action" immanent in the model's ongoing

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57 act. There is evidence that young children benefit from others' prior intentions (Carpenter et al., 2002) when

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60 imitating how to solve a causal task. First, Carpenter et al. (2002) showed 2-year-olds how to open a box by

1 pulling out a pin and lifting a door. Before this demonstration, some children witnessed the already-opened
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3
4 box (Prior: End State condition); some watched the demonstrator attempt but fail to open the box (Prior:
5
6 Failed Attempt condition); and some saw her open three different containers (Prior: Context condition).
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10 These three groups of children solved the task more successfully than those who watched the demonstrator
11
12 manipulate the box with irrelevant actions as the prior event (No Prior: Irrelevant Action condition) or
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14 simply saw the demonstration only (No Prior: No Predemo condition). A recent study by Huang (2013)
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16 expanded the Prior: Context condition of the Carpenter et al. (2002) study by presenting the end state of a
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18 substantially different box as information about prior intention and found the facilitating effects of prior
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20 intention were not reliant on the perceptual similarity between the predemonstration and demonstration
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22 apparatuses. The author also ruled out the possibility that the predemonstration apparatus afforded an idea
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24 that boxes open. Young children continued to benefit from prior intention when the predemonstration
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26 apparatus was replaced with a functionally different task (using a stick to retrieve the reward from a trap
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28 tube).
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39 In this study, we set out to replicate and extend the Prior: Context condition used by Carpenter et al.
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41 (2002) with ASD children and comparison peers of developmentally-delayed and typically-developing
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43 children. We consider this condition to be a more stringent test of young children's ability to consider
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45 intentions as mental states in the social learning of a problem-solving task, as they are required to transfer
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47 their understanding of a person's intention shown in the predemonstration to a new task that differs in
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49 appearances and the mechanism for retrieving the reward. A second extension was to modify the No Prior:
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51 Irrelevant Action condition of the Carpenter et al. (2002) study based on the context of the situation. This
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53 condition exposed children to a predemonstration consisting of unintentional object-oriented actions.
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1 Following the experimenter's prior behavior, children in both conditions watched the actor demonstrate a
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3 two-step action to complete the goal of the target task. If the ability to imitate goal-directed actions in autism
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5 reflects some understanding of goals in relation to mental states, children with ASD should be more
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7 successful in retrieving the reward in the Prior Intention than in the No Prior Intention condition as do
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9 children without ASD. However, if children with ASD are able to understand intentions immanent in a
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11 person's behavior but have specific difficulty in understanding prior intentions as was shown in previous
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13 research using a verbal judgment method (Misailidi, 2005; Phillips et al., 1998), they should perform more
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15 poorly than children without ASD in the Prior Intention condition, with no difference between groups in the
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17 No Prior Intention condition.
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27 **Methods**

28 *Participants*

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31 Three groups of children took part in the present study: (a) 24 children with ASD (19 male) comprising 17
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33 children with autistic disorder and 7 children with pervasive developmental disorder not otherwise specified
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35 (PDD-NOS) diagnosed according to DSM-IV criteria (American Psychiatric Association, 2000); (b) 16
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37 children with DD without autism (12 male) including 9 children with idiopathic developmental delay and 7
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39 children with speech delay; and (c) 24 typically-developing children (15 male). This study was conducted
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41 under the approval of the institutional review board at the Chang Gung Hospital in Taiwan. Parents gave
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43 written consent for their children's participation after being informed about the purpose of the study.
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54 Recruitment was carried out through internet advertising, by word-of-mouth, or through referral from child
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56 psychiatric or pediatric physicians. All participants were ethnic Chinese living in northern Taiwan. Two
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58 additional children with ASD were tested but not included in the final sample due to a lack of interest in the
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1 task.

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4 ASD diagnoses were confirmed by a research team conducting a comprehensive assessment procedure,
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6 including the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000, 2002), Autism Diagnostic
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8 Interview-Revised (ADI-R; Lord et al., 1994) and clinical judgement. The children's verbal mental age
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10 (VMA) and non-verbal mental age (NVMA) were calculated from their scores on the Mullen Scales of Early
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12 Learning (MSEL; Mullen, 1995): VMA consisted of the average of their scores on the Language Expressive
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14 and Language Receptive Organization Scales; NVMA consisted of the average of their scores on the Visual
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16 Receptive Organization and Fine Motor Scales (see Rogers et al., 2003). Table 1 summarizes the
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18 characteristics of participants from each group by condition. Although the CA of typically-developing
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20 children was relatively young, there were no significant differences in either NVMA or VMA as a function
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22 of group and condition. All children with ASD scored above the cut-off for either Autism (12) or Autism
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24 Spectrum (8-11) from Module 1 or 2 of the ADOS based on the child's expressive language level. All
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26 children with DD scored below 7 on the ADOS. In addition, they either had a T score below 40 on any
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28 subscale from VMA or had an overall MSEL DQ score below 85. Typically-developing children were
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30 screened for ASD concerns using the Social Communication Questionnaire (SCQ; Rutter et al., 2003).
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45 *Materials*

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48 Three opaque containers, each of which had a toy inside, were used to present the experimenter's goal
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50 before the demonstration in the Prior Intention condition. The first was a bucket with a lid (10 cm high and
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52 9.5 cm in diameter) that could be opened by pressing a pedal extending from its bottom. The second was a
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54 ring-shaped receptacle (9.5 cm high and 22 cm in diameter) that could be opened by pulling the upper lid
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1 apart. The third was a meal box ($12 \times 10 \times 5.5$ cm) that could be opened by unlocking the side latches.

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4 Three objects, all of which had no lid, were used to present unintentional irrelevant actions before the
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6 demonstration in the No Prior Intention condition. They were: a cube storage bin ($6 \times 6 \times 7$ cm), a flying
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8 disk (11 cm in diameter) and a rectangular block ($16 \times 8 \times 4$ cm).
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13 The apparatus (Figure 1) used in the demonstration was a replica of the birdhouse (Huang, 2013),
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15 which was adapted from the one originally developed by Carpenter et al. (2002). It measured $30 \text{ cm} \times 30 \text{ cm}$
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17 $\times 45$ cm, consisting of an exterior door and an interior door. The exterior door could be opened by pulling up
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19 a knob at the bottom; the interior door could be opened by pulling out a wooden pin on the left side of the
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21 birdhouse. A small toy was placed behind the interior door unseen by children. The toy could be reached
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23 when both doors were open.
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32 -----Figure1 about here-----
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35 *Design*

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38 Participants from each of the three groups were randomly assigned to either the Prior Intention or the No
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40 Prior Intention condition. In both conditions, all participants were allowed to watch the experimenter
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42 demonstrate how to reach the reward from the birdhouse, but they were situated within different contexts
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44 before watching this demonstration. A between-subjects design was a stronger experimental test because the
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46 children had only one chance to retrieve the reward. In a within-subjects design, anything the experimenter
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48 produced intentionally before the demonstration could be potentially informative about prior intention.
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54 Although a between-subjects design helped to eliminate carryover effects, it resulted in a reduced sample
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56 size within a condition. In order to increase the power of the analysis, the data for the DD and TD groups
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1 were collapsed into a combined comparison group if they did not differ in the measurement of concern.
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4 *Procedure*
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8 All participants were tested in a quiet room in a university laboratory or in their daycare. In order to avoid
9 potential cues about prior intention arising from the context of the situation, the assessment measures and
10 experimental task were completed in two separate days. The experimental session was videotaped for later
11 scoring.
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18 In the Prior Intention condition, children watched the experimenter interact intentionally with three
19 containers and then with the birdhouse. This condition was designed for children to attribute a general goal
20 to the experimenter before seeing how to open the birdhouse. The three containers were arranged in a row.
21 She first went to the bucket, said “Look!” to engage the child, opened the lid, and ended up extracting the
22 toy. After a brief display, she put the toy back in the bucket and closed it. She dealt with the ring-shaped
23 receptacle and the meal box using the same procedure. After the prelude, she went on to the birdhouse and
24 proceeded to present the demonstration. She pulled up the door knob so that the exterior door was opened.
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Next, she opened the interior door by pulling out the wooden pin. When the experimenter was pulling out the pin, the child could see the interior door slide aside through the opening at the front. She took out the toy, displayed it briefly, put it back in the birdhouse, and reset the apparatus unseen by the child (using a tablecloth). Finally, she invited the child to play with the birdhouse by saying, “Now, it’s your turn.”

Children were given 30 s to explore the birdhouse, timed from when they first touched it.

In the No Prior Intention condition, by contrast, the experimenter showed children the predemonstration in an unintended manner. She manipulated three objects using actions unrelated to opening

1 the birdhouse. She said “Look,” raised the cube bin, rotated it 90 degrees counterclockwise, and placed it on
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4 the floor. Next, she knocked the disk three times using her index finger, then dragged the block along the
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7 floor twice. Finally, the experimenter moved onto the birdhouse, and demonstrated the task solutions to
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10 which the children in the Prior Intention condition were exposed.
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12 13 Scoring

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17 The third author coded each videotaped session. An undergraduate student blind to the hypotheses of this
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20 study coded 30% of the videotapes. Both coders noted whether or not children reproduced two demonstrated
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23 components during the 30-s period: (1) open the exterior door by pulling up the knob; and (2) open the
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26 interior door by pulling out the pin. Agreement was 100% for both pull-pin and pull-knob components.
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32 33 Results

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36 Figure 2 shows the percentages of children who successfully retrieved the reward from the birdhouse within
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39 a 30-s response period. Preliminary analyses showed that the DD and TD groups did not differ in either
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42 condition, both Fisher tests, *ns*. The data for the two groups were thus collapsed into a combined comparison
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45 group in each condition. A 4×2 contingency chi-square test comparing the number of participants who
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48 succeeded or failed showed significant differences among children with ASD and children without ASD in
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51 the Prior Intention and No Prior Intention conditions, Fisher test, $p = .026$. Planned comparisons for
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54 between-group differences within each condition indicated that children without ASD (19 of 20)
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57 outperformed children with ASD (7 of 12) in the Prior Intention condition, Fisher test, $p = .018$, one-tailed,
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60 but they did not differ in the No Prior Intention condition, Fisher test, *ns*. That the facilitating effect of prior

1 intention was specific to the performance of children without ASD was confirmed by planned comparisons
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3 showing their better performance in the Prior Intention condition than in the No Prior Intention condition (13
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5 of 20), Fisher test, $p = .022$, one-tailed, but no between-condition difference for children with ASD, Fisher
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7 test, *ns*. The mean latencies to success (and *SDs*) in the Prior Intention and No Prior Intention conditions
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9 were respectively as follows: ASD, 13.42 s (3.69) and 14.58 s (6.06); TD and DD combined, 14.58 s (5.72)
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11 and 13.61 s (6.28). A Kruskal-Wallis test of the mean latencies yielded no differences as a function of group
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13 and condition, $\chi^2(3, N = 46) < 1$.
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22 -----Figure 2 about here-----
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25 We next examined whether success resulted from reproducing a particular kind of solution component.
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27 Figure 3 presents the percentages of children who reproduced the pull-pin or pull-knob component.
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29 Preliminary analyses showed that the DD and TD groups reproduced either of the two components at similar
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31 rates in each condition, all Fisher tests, *ns*. We thus collapsed the data for the two groups, respectively, in
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33 each condition. There were no significant differences in the rate of reproductions with pull-pin among
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35 children with ASD and children without ASD in the Prior Intention and No Prior Intention conditions, Fisher
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37 test, *ns*. Although children with ASD appeared to have a relatively low rate of reproductions with pull-knob
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39 in the Prior Intention condition, differences fell just below significance, Fisher test, $p = .074$.
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50 -----Figure 3 about here-----
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53 It should be noted that, when children first pulled the exterior door open, they could open the interior
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55 door either by imitation (pulling the pin) or by emulation (sliding aside the door by using their fingers).
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59 Twenty-two of the 32 successful children from the combined comparison group and 10 (of 14) from the
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1 ASD group began with the exterior door. Figure 4 presents the numbers of these children who, after opening
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3
4 the exterior door, used an imitation or emulation strategy to open the interior door. Although relatively few
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6 children with ASD succeeded in the task, they all used the emulation strategy in the No Prior Intention
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8 condition. To explore any potential effects of the group, we combined the data across conditions to
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10 compensate for the modest sample size. Overall, children from the ASD group (8 of 10) were more likely to
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12 use fingers to slide the interior door than children from the combined comparison group door (5 of 22),
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18 Fisher test, $p = .005$.

21 -----Figure 4 about here-----
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29 Discussion

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33 Previous research has shown that a model's prior intention facilitates 2-year-olds' observational learning of
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35 a causal task (Carpenter et al., 2002). In this study we investigated whether children with autism can make
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37 sense of others' prior intentions by replicating Carpenter et al.'s (2002) Prior: Context condition with
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39 typically developing and developmentally delayed children. The results found that when given a chance to
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41 know the experimenter's intention before the demonstration, the comparison children not only performed
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43 better than the ASD group, but also outperformed themselves when the prelude consisted of meaningless
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45 irrelevant actions. By contrast, the ASD group exhibited similar performance on the task across conditions.
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53 Here we explore some possible explanations for this result.

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56 First, we can rule out either verbal or non-verbal MA as explanations, given that the groups were
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59 matched on these variables. It should be noted that the DD group was actually superior on the Fine Motor
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1 subscale of the MSEL to the TD group, but not to the ASD group. Given that the two comparison groups
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3 showed similar levels of success, if difference in fine motor skills serves as a general explanation, they
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5 should have performed better than the ASD group across conditions and not just in the Prior Intention
6
7 condition. Similarly, there were no group differences in reproduction of each solution component, and
8
9 memory problems alone cannot account for the poorer performance of the ASD group. The difference is also
10
11 unlikely to be due to affordance learning, because the appearances of the containers and the actions used to
12
13 present the predemonstration differed greatly from those involved in the target demonstration. This did not
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15 permit children to explore the mechanics of the main task or relevant motor patterns before the
16
17 demonstration. Children with ASD actually displayed some evidence of emulation. Instead of imitating
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19 pull-pin, they were overall more likely than the comparison children to move the interior door with fingers,
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21 suggesting a susceptibility to the affordances of the task. Nonetheless, they did not benefit from the use of an
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23 emulation strategy despite it being even stronger in the No Prior Intention condition.
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36 Could overimitation account for the current results? In overimitation, children faithfully copy causally
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38 irrelevant actions in goal-directed action sequences (e.g., Horner and Whiten, 2005; Lyons et al., 2007),
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40 indicating a social affiliation with another person (Marsh et al., 2014; Nielsen and Blank, 2011; Over and
41
42 Carpenter, 2012). Given that children with autism do not overimitate (Marsh et al., 2013), it may be that
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44 children without ASD tested here were overimitating without understanding of the model's prior intention.
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46 We deem this explanation unlikely, because the demonstration of opening the box did not include any
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48 unnecessary components. Overimitation could not be adequately addressed in the current study. In addition,
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50 there is already some evidence showing that when a style component was added to the demonstration,
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52 children who knew the model's prior intention were more likely to skip the unnecessary style than those who
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1 did not (Carpenter et al., 2002). Similarly, when children knew the goal of action sequences before the
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4 demonstration, they were more likely to exhibit a reduction in overimitation (Williamson and Markman,
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7 2006). If the superior performance by children without ASD in the Prior Intention condition was due to
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10 overimitation, they should have also performed equally well in the No Prior Intention condition.

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13 It might be argued that the good performance of the comparison group in the Prior Intention condition
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16 did not require the understanding of the experimenter's prior intention—that seeing the containers open
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19 might simply lend themselves the idea that boxes open. In other words, although the predemonstration did
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22 not familiarize children with the affordances involved in opening the birdhouse, it is possible that being
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25 aware of the general affordance allows them to generalize their learning about outcomes (rather than
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28 intentions) across different task materials. **Contrary to this**, there is now evidence that children continue to
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31 benefit from prior intention even if the predemonstration apparatus is not box-shaped and the method of
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34 accessing the reward is not based on opening systems (Huang, 2013). This finding leads us to believe that
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37 children without ASD were not merely guided by the physical outcomes of the predemonstration but were
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40 engaged in interpreting the experimenter's previous actions with the containers as her general goal within
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42
43 the context.

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46 However, it is less clear why children with ASD performed less well in the Prior Intention condition.
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49 One possibility immediately suggesting itself is that they have difficulty in understanding the concept of
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52 prior intention as mental entities. Consistent with this explanation, previous research has reported similar
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55 deficits for older children with ASD patients when they need to answer explicit verbal questions (Misailidi,
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58 2005; Phillips et al., 1998). It should, however, be noted that, given the well-documented problems in
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61 generalization, it remains to be shown whether their strong tendency to focus on **episodic details** might

1 detract from generalizing between the predemonstration and the main task. That is, children with ASD did
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4 not benefit from the model's prior intention, perhaps because they had difficulty generalizing the model's
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7 goal across various containers and perceptually distinct actions. The natural pedagogy theory proposed by
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10 Csibra and Gergely (2009) lends support to this idea. The claim is that ostensive social cues (such as gaze,
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13 pointing gesture, infant-directed speech, etc.) lead children to generalize specific actions and interpret the
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16 information as generalizable and kind-relevant. Since children with ASD have difficulties with social
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19 processing (e.g., Dawson et al., 2004; Dalton et al., 2005; Tager-Flusberg, 2010), they may find it more
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22 difficult to see relationships between contexts and abstract something generalizable such as prior intention.
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25 We do not wish to overextend the facilitating effect of prior intention on imitation to an explicit
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28 representation of intention. Rather, it is notable that imitation does not require making explicit conceptual
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31 and linguistic knowledge that might be already represented but less accessible, and thus provides an implicit
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34 nonverbal test that can be used to pose such questions in young children. However, there appears to be a gap
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37 between explicit and implicit understanding of others' intentions. Whereas the current study and others
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40 (Carpenter et al., 2002; Huang, 2013) suggest that understanding of prior intentions might be present in
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43 2-3-year-olds in social-learning situations, children cannot answer explicit verbal questions about prior
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46 intentions until 5-6 years of age (Astington, 1991). Similarly, while there is evidence that 14-18-month-old
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49 infants preferentially imitate intentional over accidental actions (Carpenter et al., 1998), 4-year-olds have
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52 difficulty judging intentions when actions produce unintended (by accident) but desirable outcomes (Liao et
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55 al., 2011). Therefore, we must be cautious about extending the superior performance by children without
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58 ASD in the Prior Intention condition to a full-fledged concept of intention.
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The finding that children with ASD have difficulty decoupling intentions from the context of the

1 situation does not necessarily conflict with the substantial literature on their ability to understand
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3 object-oriented goal-directed intentions (e.g., Aldridge et al., 2000; Berger and Ingersoll, 2014; Carpenter et
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5 al., 2001). We interpret these findings as their asymmetrical understanding of ‘intention in action’ and ‘prior
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7 intention’ (Searle, 1983). It is plausible that, for example, autistic children are capable of comprehending
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9 intentions behind the model’s actions in the behavioral reenactment task, because during observation of the
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11 failed attempts, they also watch the object movements that evoke the object affordances to emulate (Huang
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13 and Charman, 2005; Huang et al., 2002, 2006), whereas prior intention requires them to consider the
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15 model’s goal in relation to the context (rather than the goal or outcome of the action per se). Although there
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17 is a debate over whether the behavioral reenactment data may well be characterized better as a
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19 non-intentional understanding of objects, learning about affordances, for our part, does not always divert
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21 from the use of intentions to guide imitation. Some recent evidence indicates that the clarity of the
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23 affordances of a task can guide infants to attribute goals to the model’s bodily changes and allow them to
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25 emulate the objects’ end results (Huang, 2012). In the Prior Intention condition of the present study where
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27 object affordances are not counted as assets, children with autism do not benefit from contextual information.
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29 We interpret this as showing that they do not look beyond the action itself and see it as something that sheds
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31 light on one’s general purpose in the context of the situation. In support of this, a recent study (Somogyi et
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33 al., 2013) has found that children with ASD do have difficulties in identifying the same action embedded in
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35 different contexts as associated with different intentions. Unlike their typically-developing peers, who copy
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37 the novel head-touching action after seeing the model deliberately perform it (by placing her free hands
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39 visibly on the table) rather than after seeing her have to use the head because of some constraints (hands
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41 occupied with a blanket), children with ASD reproduced this unconventional action with relatively high
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1 frequency in both contexts. This suggests that they did not consider the hands-free context as signaling to
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3 them that the model intended and expected them to act in such a manner.
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7 The current results provide some insight into a recent model that views the failure to imitate in autism
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9 as deficits in top-down selection and control processes (Southgate and Hamilton, 2008). Their claim is that
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11 imitation requires not only an understanding of goals based on visual analyses of the observed actions, but
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13 also the use of social and communicative cues to decide when and what to imitate. In other words, the notion
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15 of goal immanent in imitation implements a motivation to reproduce and share the same goal of the
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17 communicative partner. The findings reported here suggest that the failure to benefit from prior intention
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19 reflects not only their insensitivity to these cues but also a lack of motivation to know what one wants to do
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21 in the future.
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31 In conclusion, the present study suggests the need for caution in interpreting the ability to understand
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33 others' intentions in autism. Our design does not allow us to tease apart whether their failure to benefit the
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35 model's prior intention is due to a lack of attention to social-communicative cues or impaired intention
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37 mentalizing at a higher level of abstraction. This should be an agenda for future research. One avenue for
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39 future work will be to see what factors are crucial in facilitating or hindering the transfer of a person's goal
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41 learned in one context to another context. Indeed, if atypical patterns of imitation are related to a reduced
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43 sensitivity to social-communicative cues, should an increased sensitivity not go into reverse and enhance
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45 imitation? It is also helpful to clarify the extent to which imitative proclivity in autism is susceptible to a
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47 variety of social cues recently discussed in the literature on social learning (Koenig and Sabbagh, 2013). The
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49 value of prior experience is to provide a promising paradigm for parsing different levels of intention reading
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51 in social learning contexts.
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For Peer Review

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Table 1. Characteristics of participants in each group by condition.

Participants	ASD		DD		TD		Significance (Kruskal-Wallis)
	Prior Intention (<i>n</i> = 12)	No Prior Intention (<i>n</i> = 12)	Prior Intention (<i>n</i> = 8)	No Prior Intention (<i>n</i> = 8)	Prior Intention (<i>n</i> = 12)	No Prior Intention (<i>n</i> = 12)	
CA (mos.)	47.08 (7.55)	44.75 (10.86)	43.63 (13.51)	44.38 (16.72)	26.92 (2.68)	27.00 (3.36)	<i>p</i> < .001
NVMA (mos.)	31.29 (7.59)	30.33 (7.50)	39.31 (10.85)	35.06 (17.02)	29.79 (3.65)	32.38 (6.82)	<i>p</i> = .335
VMA (mos.)	29.63 (7.51)	25.29 (7.80)	31.00 (7.54)	29.25 (9.82)	30.75 (3.90)	32.08 (7.99)	<i>p</i> = .382
Autism severity	14.08 (3.50)	14.00 (3.02)	3.25 (2.19)	2.88 (1.55)	-	-	<i>p</i> < .001



Figure 1. The experimental apparatus

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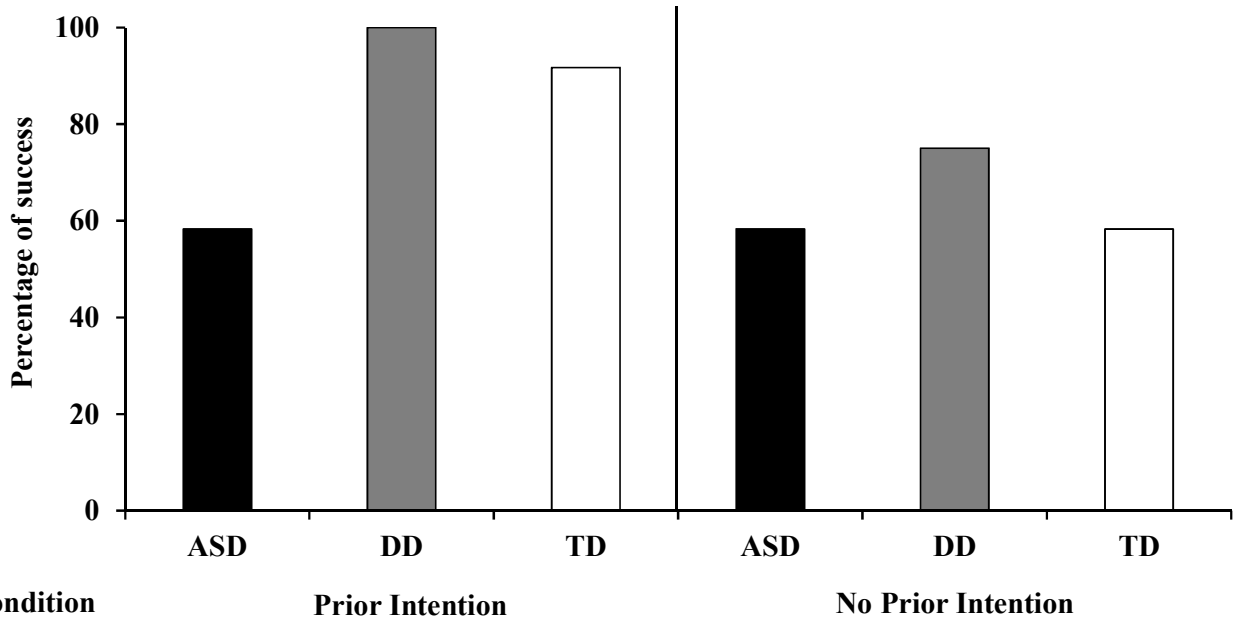


Figure 2. Percentages of children from each group who succeeded at retrieving the reward in each condition.

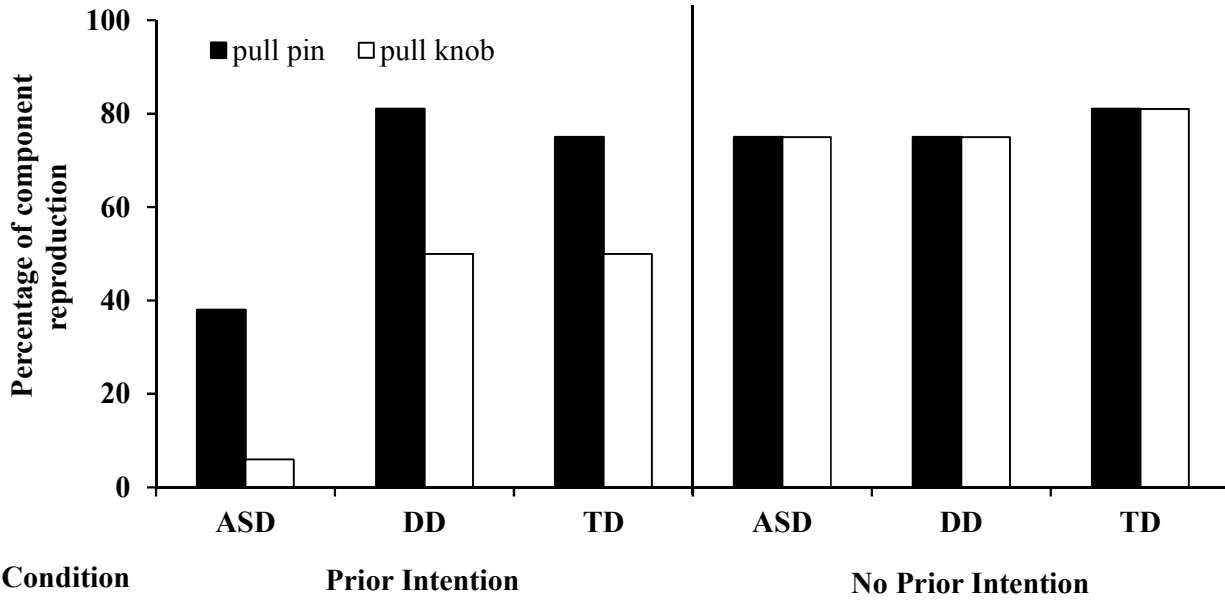


Figure 3. Percentages of children from each group who reproduced each solution component as demonstrated in each condition.

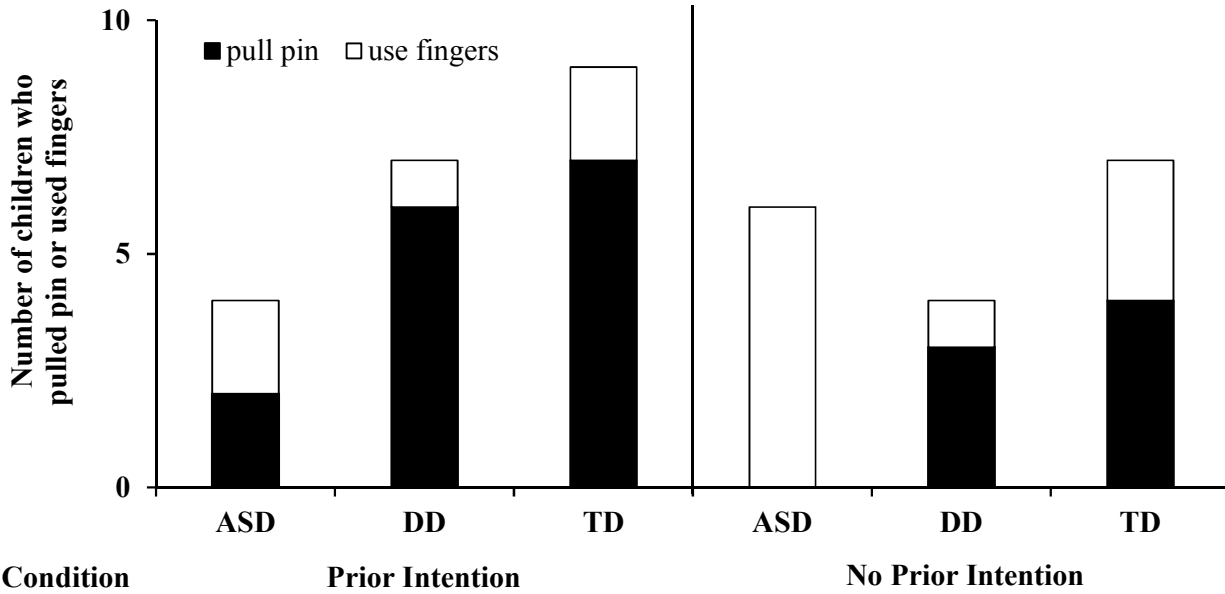


Figure 4. Numbers of children who, after opening the exterior door, opened the interior door by reproducing pull-pin or sliding the door with their fingers.