Published in final edited form as:

J Exp Child Psychol. 2008 October ; 101(2): 114–123. doi:10.1016/j.jecp.2008.05.004.

Imitative learning from a third-party interaction: Relations with self-recognition and perspective-taking

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Abstract

Young children's ability to learn something new from a third-party interaction may be related to the ability to imagine themselves in the third-party interaction. This imaginative ability presupposes an understanding of self-other equivalence, which is manifested in an objective understanding of the self and an understanding of others' subjective perspectives. The current study measured imitative learning of a novel action seen only in a third-party interaction, mirror self-recognition, and perspective-taking in a group of 48 children aged 18 to 20 months. Patterns of performance suggest that understanding self-other equivalence is related to third-party learning.

Keywords

imitation; self-other equivalence; perspective-taking; self-recognition

While there are numerous empirical studies of young children's imitation of new behaviors from adults they are engaged with, little is known about whether toddlers can imitate novel behaviors of adults who are not interacting with them. When engaged in interaction with an adult who demonstrates a novel and arbitrary action, children as young as 14 months (Gergely, Bekkering, & Kiraly, 2002; Meltzoff, 1988) will imitate that action. One question is whether toddlers can acquire a novel behavior that they observe in a third-party interaction. Gergely and Csibra (2005) argue that, at an early age, direct teaching interactions may be necessary for children to acquire novel (what they call "new and cognitively opaque," p. 463) behaviors, and there is reason to believe that the ability to learn from a third-party interaction (henceforth, third-party learning) may be related to changes in representational capacity that emerge in the second year.

Infants can form primary representations (i.e., representations of things as they really are) of what they perceive (Leslie, 1987; Perner, 1991), but in the middle of the second year they begin to coordinate these primary representations with secondary representations (Perner, 1991; Suddendorf & Whiten, 2001); that is, representations of hypothetical and pretend situations, as well as of the past and future. Secondary representation involves keeping one thing in mind while perceiving another. One type of secondary representation that may play a role in third-

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party learning involves simulating another's perspective, essentially maintaining a mental image of the other's perspective, even when it differs from one's own perception of the current situation.

More specifically, Moore (2007) has hypothesized that young children's third-party learning of arbitrary information (actions and words) depends upon their ability to imagine themselves as participants in the third-party interaction, simulating perhaps the perspective of the learner in the third-party interaction. Direct interactions may not require this type of imaginative ability as eye contact, contingency, and other ostensive-communicative cues that are characteristic of direct interactions allow infants to imitate novel actions without having to necessarily take the other's perspective (Gergely & Csibra, 2005; Moore, 2006). These cues may not be necessary for third-party emulation (copying end results without employing the same means as the demonstrator) or the reproduction of non-arbitrary actions seen in a third-party interaction (Moore, personal communication, October, 2007). But without ostensive cues, Moore's hypothesis is that children will not be able to imitatively learn novel behaviors (copying a novel and arbitrary means to an end) from a third-party interaction unless they are able to imagine themselves in that interaction.

The ability to imagine oneself as a participant in a third-party interaction may rely on children's understanding of self-other equivalence: that is, the understanding that they and others have both first- and third-person characteristics. Early in development it is only the third-person characteristics of others (e.g., what it looks like when others are behaving) and their own first-person perspective (e.g., what it feels like when I am behaving) that infants have access to because they are directly perceived (Moore, 2006). Self-other equivalence involves a specific type of secondary representation that is manifested in an understanding of the self as an objective entity (imagining a third-person perspective on the self), as well as an understanding of others' subjective experiences (imagining others' first-person perspectives).

These two manifestations of self-other equivalence -understanding the self and understanding others- both become apparent in the middle of the second year. Several studies have demonstrated that self-awareness (as assessed by a mirror self-recognition task) and other-awareness (as assessed by a synchronic imitation task) emerge in tandem (Asendorpf & Baudonniere, 1993; Asendorpf, Warkentin, & Baudonniere, 1996; Nielsen & Dissanayake, 2004). As synchronic imitation requires understanding the reciprocal roles of model and imitator as well as a desire to be like the other, it is considered an excellent indicator of other-awareness (Nielsen & Dissanayake, 2004). Toddlers demonstrating mirror self-recognition are more likely to evidence advanced other-directed pretend play than toddlers who do not demonstrate self-recognition (Lewis & Ramsay, 2004), and self-recognition is positively correlated with empathic responses to another's distress (Bischof-Kohler, 1991; also see Johnson, 1982). Thus, self-understanding and other-understanding appear to develop synchronously in the second year (Asendorpf, 2002). The question we address in this study is whether these developments are related to third-party learning of arbitrary actions.

Moore (2007) suggests that when children understand self-other equivalence, they are able to imagine themselves in the place of one of the participants in a third-party interaction. A strong version of his hypothesis then is that until children achieve this understanding they will be unable to engage in third-party learning. This hypothesis is indirectly supported by studies showing that 14-month-old toddlers were unlikely to imitate a novel action of a person who was not interacting with them (Kiraly, Kreko, Kupan, Csibra, & Gergely 2004), but at 18 months -the age when self-other equivalence is emerging- children are able to learn a novel word from a third-party interaction (Floor & Akhtar, 2006).

The present study examined a weaker version of Moore's hypothesis: that understanding self-other equivalence is related to third-party learning of novel actions. We anticipated, on the basis of Floor and Akhtar's (2006) findings, that some percentage of children aged 18 to 20 months would be able to imitatively learn a novel (arbitrary) action from a third-party interaction. Our primary purpose was to test whether imitative learning of a novel action seen in a third-party interaction is related to children's knowledge of self-other equivalence, as assessed by their self-understanding (imagining a third-person perspective on the self) and their ability to take another's perspective (imagining another's first-person perspective). Thus, the hypothesis was that participants who did imitatively learn from a third-party interaction would be more likely to pass a test of mirror self-recognition (Amsterdam, 1972), and would be more likely to engage in level 1 perspective taking (Flavell, 1992).

Method

Participants

Forty-eight 18- to 20-month-old children (M age = 19.00, SD = 1.07; $Range$ = 17.63 – 20.60) participated. Half were female. Six additional children participated but were excluded (one for noncompliance, and five for not completing the perspective-taking task). Demographic data were available for 45 of the participants: one was African-American, 3 were Asian-American, 35 were White, and 6 were of mixed ethnicity. A majority of participants' parents were college graduates (79%).

Study Design

There were three tasks: imitation, self-recognition, and perspective taking. Order of tasks was counterbalanced across participants. There were two novel actions demonstrated in the imitation task; order of these actions was counterbalanced.

Materials

Imitation—Two novel objects were constructed. One was a blue circular box with a smaller circular light on top that was activated by applying pressure to it. The second was a rectangular doorbell covered in pink tape and mounted on a square yellow box (each box was approximately 25 cm in width/diameter and 15 cm high). To activate the light, the experimenter sat on her knees and bent over to touch it with her forehead. To activate the doorbell, the experimenter sat on her knees and touched one elbow to the top of it, concealing the doorbell remote control in her other hand.

Self-recognition—A full-length mirror (approximately 1.30 m by 40 cm) and a bright pink unscented lipstick were used to assess self-understanding (Bertenthal & Fischer, 1978).

Perspective-taking—To assess perspective taking, a modified version of Moll and Tomasello's (2006) hiding task was used. Instead of novel objects, six pairs of familiar objects were used: cups, spoons, washcloths, bowls, boats, and balls. Items in a pair were identical except for color. A colorful cube-shaped occluder (approximately 35 cm on each side) was also used.

Supplementary materials—Parents were asked to complete the MacArthur Communicative Development Inventory (CDI) short-form vocabulary checklist (Fenson, Pethick, Renda, Cox, Dale & Reznick, 2000), a pronoun comprehension and production checklist, and a demographic information form.

Procedure

All tasks were administered in a playroom on a university campus, and were videotaped through a one-way mirror. Parents were given vocabulary and demographic forms to fill out, and were asked to not communicate with their child during the procedure. The experimenter first engaged children with warm-up activities designed to encourage them to hand her toys on request, as they would later be asked to do so in the perspective-taking task.

Before describing each task in detail, we would like to note that the current study employed only one measure of self-understanding (the standard mirror self-recognition task) and one measure of other-understanding (a visual perspective-taking task), each of which has its shortcomings (see Discussion). We decided against using synchronic imitation as a measure of other-awareness because any resulting correlation between that and our measure of imitative learning might have been due to some general “imitativeness” on the part of our participants. Our rationale for choosing the current tasks was that they required active responses, were distinct from the skill they were being used to predict, were possible to complete in one session with this age group, and had resulted in variable performance in this age range in past studies.

Imitation

The experimenter turned to the confederate (who had been present during the warm-up activities) and said, “I’m going to play with my friend (confederate’s name) now.” The experimenter proceeded to ignore the child (i.e., did not look in the child’s direction or respond to anything the child said or did) until after both actions had been demonstrated. The child was left sitting on the floor or on a couch approximately one meter away from the experimenter. The experimenter approached the confederate and said, “Look, (confederate’s name), I’m going to show you something.”¹ She then pulled the first object (the light or the doorbell) out from behind a barrier, placed it on the floor, made eye contact with the confederate, said, “Watch this,” and performed the target action. The experimenter then slid the object over to the confederate saying, “Now it’s your turn.” After the confederate performed the target action, the experimenter performed it one more time. This procedure was then repeated with the second object.

After both action demonstrations, the experimenter placed a disabled replica of the first object (identical to the demonstration object except that batteries had been removed) on the floor in front of the participant and said, “Can you show your mother (father) how this works?” (A disabled replica was used because we reasoned that if children first attempted to produce the end result by their own means -e.g., using their hand to turn the light on without success, they might subsequently try to imitate the novel action. In practice, however, all children who imitated the novel actions did so prior to using other means to activate the props.) The parent was instructed to not direct the participant’s play with the object. Children were given one minute to play with each novel object.

The imitation task was scored on a scale of zero to two, with one point for each novel action performed. Using the back of the hand, or the back of the forearm in attempts to activate the doorbell was scored as imitating as these actions were coded as attempts to replicate the elbow action. Using any part of the head or face (forehead, mouth, nose, or cheek) was scored as imitating the head touch action.

¹At the time, the experimenter and confederate could not tell if the child was paying attention or not, but subsequent viewing of the videotapes (by the first author) indicated that all of the children watched the two experimenters during both action demonstrations.

Self-recognition

Children were shown the mirror and given a chance to look at their reflections. The experimenter made sure that the children noticed their reflections (by making eye contact with it for a few seconds), then instructed the parent to surreptitiously apply a spot of lipstick to the child's nose. Parents typically put the lipstick on a tissue or their finger and then quickly wiped their child's nose so the lipstick left a mark. The experimenter called the children back to the mirror and encouraged them to look in it again, pointing and saying, "Look in here." Children were given approximately one minute to observe their reflection. Children were scored as passing this task if they touched their nose while gazing at their reflection.

Perspective taking

The confederate brought out a bag containing six pairs of familiar objects, removed the first pair from the bag, and played with them with the experimenter and child. Then the experimenter left the room, saying "Bye-bye" to the child to ensure the child noticed her departure. The confederate then brought out the occluder and placed it on a designated spot on the floor. The confederate put one object behind the occluder and the other on a predetermined spot, 60 cm to the right or left of the occluder. The confederate brought the child in front of the occluder and said, "Look, you can see one cup but not the other one. See that?" The confederate then moved the cup that was occluded by the block to the side and said, "Now we can see both cups. See that?" This part of the procedure ensured that the child could see the experimenter's perspective, and it was done only with the first pair of objects. After the confederate ensured that the child understood that the block hid what was behind it, she instructed the child to sit on the floor (or on her parent's lap) in a designated spot midway between the two objects (approximately 60 cm away from each) from which the child could see both objects.

After the child was settled, the experimenter entered the room and stood in a designated spot, 1.2 m in front of the child, from which she could see only one of the objects. She first looked to her left and then to her right. The side on which the object was occluded was counterbalanced, so that on Trial 1 for half the children the experimenter looked at the occluded object first and for half she looked at the visible object first. The experimenter said, "Where's the other one? I can't find it! Where is it?" The experimenter repeated these phrases, while looking back and forth between the objects, looking in each direction three times for approximately two seconds. The experimenter then looked at the child and said, "Where's the other one? Can you give it to me?" If the child did not point or respond by retrieving one of the toys within 10 seconds, the experimenter continued prompting by asking, "Where is it? Can you show me?" After the child brought the experimenter an object (or pointed to one), or did nothing after multiple prompts, the confederate called the experimenter and the child over to play with the next pair of objects. Positive feedback ("Thank you" in a happy voice) was provided regardless of which object the child chose. This procedure was repeated five more times, with the location of the hidden object alternating from trial to trial (for a total of six trials, as in Moll & Tomasello, 2006).

The perspective-taking task was scored on a scale of zero to six, with one point given each time the child pointed to or selected the hidden toy. As not all children completed all six trials, the proportion four of the six trials and were dropped from the study. Of the 48 remaining, five children responded on four of the six trials, 12 children responded on five of the six trials, and 31 children responded on all six trials. Chance responding resulted in a score of .50 (3 out of 6 choices); therefore only scores of .65 (approximately 4 out of 6 choices) and higher were considered evidence of passing this task.

Reliability

The person filming the experimental sessions coded on-line, and an independent coder coded videos of a randomly selected 20% of the sessions. Different coders coded the three different tasks from separate DVDs, and did not have access to children's performance on the other tasks. Thus coders of perspective-taking and mirror self-recognition were blind to the children's imitation status. Agreement was 92% ($k = .86$) for imitation coding, 96% ($k = .94$) for self-recognition, and 91% ($k = .88$) for perspective-taking.

Results

Fifty percent of participants scored at least 1 on the imitation task²; 60% passed the mirror self-recognition task; and 29% passed the perspective-taking task. The latter two percentages are similar to those found for this age range on these tasks (Moll & Tomasello, 2006; Nielsen & Dissanayake, 2004). There was a gender difference on the self-recognition task with more girls (18) evidencing recognition than boys (11), $\chi^2(1, N=48)=4.27, p = .04$. There were no gender differences on the imitation task or the perspective-taking task.

To address whether imitation was related to understanding self-other equivalence, participants were divided into two groups: children who imitated at least one of the novel actions (imitators), and children who did not (non-imitators). (Note that all non-imitators attempted to achieve at least one of the novel actions by using their hand; thus, all children were motivated to achieve the end results of turning on the light or making the doorbell sound.) Table 1 shows that imitators scored higher on perspective-taking ($M = .57, SD = .27$) than non-imitators ($M = .37, SD = .19$), $t(46) = -2.92, p = .005$, and that more imitators (20) passed the self-recognition task than non-imitators (9); $\chi^2(1, N=48) = 10.54, p = .001$. Imitators had higher vocabulary production scores than non-imitators, but imitators and non-imitators did not differ on age, gender, or pronoun production.

The primary hypothesis was that participants who imitated would be more likely to demonstrate self-recognition and/or perspective-taking. Table 2 demonstrates that imitators were more likely than non-imitators to demonstrate self-recognition, perspective-taking, or both; 96% (23 of 24) of imitators passed one or both tasks, whereas only 42% (10 of 24) of non-imitators passed one or both tasks, $\chi^2(1, N=48) = 16.39, p < .001$.

Table 3 presents correlations among the three tasks and the vocabulary measure. As would be expected from the data presented in Table 1, imitation was significantly correlated with all three other measures. The correlation between imitation and perspective taking remained significant even when controlling for self-recognition and vocabulary, $r(44) = .35, p = .02$, and the correlation between imitation and self-recognition remained significant even when controlling for perspective-taking and vocabulary, $r(44) = .35, p = .02$. However, the correlation between imitation and vocabulary did not remain significant when controlling for self-recognition and perspective-taking, $r(44) = .20, p = .18$.

Finally, we tested whether overall engagement in the self-other equivalence tasks differed between imitators and non-imitators. To do so, we coded the length of time it took each child to complete the perspective-taking and self-recognition tasks. We used time as an indirect measure of engagement, as children who were not engaged by a given task took longer to complete that task. There was no difference between imitators and non-imitators in time taken to complete either task. Imitators took 16 min, 58 sec ($SD = 6$ min, 9 sec) on average to complete the perspective-taking task, while non-imitators took an average of 16 min, 31 sec ($SD = 4$

²The other 50% of participants (non-imitators) all attempted to achieve the end result of at least one of the actions using an action other than the target action. In most cases this involved pressing the palm of the hand on the action prop.

min, 10 sec); $t(46) < 1$. Imitators took an average of 2 min, 37 sec ($SD = 1$ min, 27 sec) to complete the self-recognition task, whereas non-imitators took an average of 2 min, 31 sec ($SD = 1$ min, 27 sec); $t(46) < 1$.

Discussion

The results support the weaker version of Moore's (2007) hypothesis that toddlers' understanding of self-other equivalence is related to their ability to learn a novel action from a third party interaction. Children who imitated at least one of the novel actions were more likely to succeed on the self-recognition task and/or the perspective-taking task than those who did not. These findings suggest that an understanding of self-other equivalence may play a role in third-party learning. Given that the data are correlational, however, it is worth considering whether the relations among these tasks are general (e.g., due to children who are more cognitively advanced performing well on all three) or specific.

It is possible that children who succeeded on the imitation task were simply more developmentally advanced, and that is why they were also more likely to succeed on the other two tasks. Age, which generally serves as a primary marker of development, did not differ between imitators and non-imitators, but the age range was limited so it would have been difficult to find age effects. Vocabulary size can also be used as a proxy measure of development. Children who imitated had significantly higher scores on the vocabulary production measure than children who did not imitate, but the partial correlations controlling for vocabulary size are informative. Specifically, the relation between imitation and self-recognition remained significant even when controlling for perspective-taking and vocabulary, and the relation between imitation and perspective-taking remained significant even when controlling for self-recognition and vocabulary, but the relation with vocabulary disappeared when variability in the self-equivalence measures was controlled for. This pattern suggests that the relation between self-other equivalence and third-party learning is not due only to developmentally advanced children performing well on all three tasks.

While imitators were more likely to succeed on the perspective-taking task than non-imitators, we must note that the perspective-taking task was particularly difficult for this age group, and may have resulted in some false negatives. Moll and Tomasello (2006) also found that 18-month-old children as a group were not able to perform well on the hiding task we used. We had modified the task (using familiar instead of novel objects) to make it easier, but still only a few children performed well on it. Consequently, it may be too stringent a measure of perspective-taking for this age range, and it is possible that different results may have been found with another, less difficult perspective-taking task. What is most pertinent, however, is that all but two of the children who succeeded on the current perspective-taking task imitated as well (Table 2). Therefore, while the perspective-taking task may have been difficult for a majority of the children, those who succeeded on it were almost certain to evidence third-party imitation.

Half of the children did not imitate either of the two novel actions they observed, which is notable because younger toddlers (14 months) seem to have little difficulty imitating an arbitrary action of someone who is directly interacting with them (Gergely et al., 2002; Meltzoff, 1988). While we now know that 18-month-olds will attend to emotions directed at others (Repacholi & Meltzoff, 2007), it appears that third-party imitation is an emerging skill at 18 months (Floor & Akhtar, 2006). Secondary representational skills that allow for an understanding of self-other equivalence also emerge around the same time (i.e., during the middle of the second year of life; Asendorpf, 2002). Our data suggest understanding self-other equivalence may play a role in young children's ability to learn a novel behavior from a third-party interaction, but it is possible that a more general change in representational skill is what

is responsible for the imitators' ability to learn from a third party. As we did not include a non-social measure of secondary representation, we are unable to rule out this possibility. It is possible that a non-social measure would yield different results, and that is a question for future study.

To our knowledge, only a handful of prior studies have examined learning in non-interactive settings in children under two; they yielded different results, but they differed in important ways. Two examined learning of a novel action, while the other examined learning of a novel word. Kiraly et al. (2004) found that 14-month-old toddlers who were not directly engaged with an experimenter when witnessing her perform a novel action (turn on a light with her head) were unlikely to imitate that action. Nielsen (2006, Experiment 3) showed that 18-month-old children were less likely to copy a novel action produced by a demonstrator who did not interact with them. However, a majority of 18-month-old children were able to learn a novel word from an adult who was not interacting with them (Floor & Akhtar, 2006).

It is possible that the children in the Kiraly et al. (2004) study were unlikely to imitate the novel action because they were four months younger than Floor and Akhtar's (2006) participants and, consistent with literature on the emergence of secondary representation (Asendorpf, 2002), did not have the requisite representational ability in place. In addition, the action demonstrations in both Kiraly et al. and Nielsen (2006) did not involve demonstrators showing their novel actions *to* anyone. In contrast, participants in Floor and Akhtar heard the novel words as they were directed to someone else. The presence of communicative cues, even if the cues are not directed to the child, may play a role in whether a child will imitate the behavior of a person who is not interacting with them (Csibra & Gergely, 2006; Gergely & Csibra, 2005; 2006). Task demands may also play a role: children in the present study (as well as in Kiraly et al. and Nielsen) were required to *reproduce* the novel action to demonstrate imitative learning, while the children in the Floor and Akhtar study needed only to *comprehend* the novel word (but it must be noted that reproducing arbitrary actions in interactive contexts does not seem particularly taxing for young toddlers).

Toddlers' relative experience with arbitrary words versus arbitrary actions may also play an important role in their third-party learning. Young children often overhear the conversations of others, and they most likely hear different people use the same words for the same objects. Based on these experiences, they may develop an understanding of the conventional nature of words; that is, that word meanings are shared. This may make them more willing to adopt a novel word they observe being used by a stranger, than to adopt an idiosyncratic action, particularly one demonstrated by someone they do not know well. While most research on imitation in young children focuses on its cognitive function, imitation also serves an important interpersonal function (Carpenter, 2006; Nielsen, Suddendorf, & Dissanayake, 2006; Uzgiris, 1981). Because the actions used in the present study were arbitrary, children needed a reason to use them rather than a simpler action; e.g., touching the light with their hand rather than their head (Gergely, et al., 2002). It is possible that in order for children to copy these novel actions, they must not only see the experimenter as "like me" (Meltzoff, 2005)³, but they may also need to be motivated to "be like" the experimenter (or the confederate). Future research on third-party learning should explore whether children are more likely to imitate novel actions

³Moore's (2007) notion of self-other equivalence is quite different from Meltzoff's (2005) "like me" hypothesis. Moore's notion refers to conceptual developments in the second year that he contends allow children to imagine themselves in another's place and thereby comprehend why that other person (who is not interacting with them) is behaving in a particular way. Meltzoff (2005) on the other hand, argues that from birth infants recognize equivalences across observed (what it looks like when others are behaving) and executed (what it feels like I am behaving) acts which allows them to imitate behaviors such as mouth openings and tongue protrusions. Meltzoff does not argue that young infants have a conceptual understanding of self-other equivalence and they do not imitate the kinds of arbitrary behaviors we examined in the present study – even in interactive contexts – until late infancy.

demonstrated by familiar individuals, and should directly compare third-party learning of novel actions and novel words.

Future studies should also directly compare interactive learning and third-party learning. One limitation of the current study is that there was no measure of interactive learning, which Moore (2007) would predict would not be related to measures of self-other equivalence. Similarly, a non-social measure of secondary representation would also be helpful in determining the extent to which general representational developments in this age range versus the more specific understanding of self-other equivalence should be used to explain variability in third-party learning. Finally, future studies should include multiple measures of self-other equivalence as mirror self-recognition is not universally accepted as a measure of self-awareness (Nielsen, Suddendorf, & Slaughter, 2006), and visual perspective-taking may not be an optimal measure of other-understanding.

In summary, we have provided some initial support for Moore's (2007) hypothesis that an understanding of self-other equivalence is related to third-party learning of arbitrary actions, but future studies -in particular, longitudinal studies- will need to explicitly examine the stronger hypothesis that self-other equivalence is *required* for this type of learning. We would like to caution, however, that even if understanding self-other equivalence plays a causal role in third-party learning, it may not be sufficient to ensure learning. Motivation --both to achieve the goal demonstrated, as well as to "be like" the person demonstrating it-- probably also play important roles in whether children will imitate arbitrary actions they observe others perform.

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Table 1

Mean Scores (with Standard Deviations in Parentheses) or Frequencies as a Function of Imitation Status

	Imitators (N=24)	Non-imitators (N=24)	<i>t</i>(46) or χ^2 (1, N=48)
Age in months	18.96 (1.04)	19.29 (1.04)	0.27 ^{<i>b</i>}
Gender ^{<i>a</i>}	14	10	1.33 ^{<i>c</i>}
Self-recognition	20	9	10.54 ^{<i>**c</i>}
Perspective-taking	.57(.27)	.37(.19)	2.92 ^{<i>**b</i>}
Vocabulary production	30.42(16.87)	21.21(11.81)	2.19 ^{<i>*b</i>}
Pronoun production	1.88(1.90)	1.13(1.30)	1.60 ^{<i>b</i>}

^{*a*} Gender is presented as number of females^{*b*} t-test^{*c*} chi-square^{*} $p < .05$ ^{**} $p < .01$

Table 2

Number of Imitators and Non-Imitators Passing Neither Task, Only Mirror Self-Recognition (MSR), Only Perspective-Taking (PT), or both.

	Imitators (N=24)	Non-imitators (N=24)
Neither	1	14
Only MSR	11	8
Only PT	3	1
Both	9	1

Table 3
Correlations Among Imitation, Perspective-Taking (PT), Mirror-Self-Recognition (MSR) and Vocabulary

	1	2	3	4
1. Imitation	-			
2. PT	-	.40**		
3. MSR	-	-	.47**	
4. Vocabulary	-	-	-	.31*

* $p < .05$

** $p < .01$