

Understanding young children's imitative behavior from an individual differences perspective

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Abstract

Research has shown that after observing a sequence of object-related actions, young children sometimes imitate the goal-directed aspects of the actions only, but other times faithfully imitate all aspects of the actions. In this study we explore whether this mixture of goal-directed and faithful imitation is based in part on individual differences between children. Forty-eight 2-year-old children (mean age = 26 months) completed a series of imitation tasks. Results revealed stable individual differences in children's imitation—measurements of their imitative behavior correlated both within and between different types of imitation tasks. We further used Principle Component Analyses to cluster these correlated measurements into two factors, and the two factors aligned well with the concepts of goal-directed and faithful imitation.

Keywords: goal-directed imitation; faithful imitation; individual differences; social cognition; Principle Component Analysis.

Introduction

Imitation is a powerful form of children's learning, and it is vital to the development of abilities ranging from language to social skills. Developmental research on children's imitative behavior has documented two seemingly contradictory phenomena. One line of research suggests that children selectively copy actions and aspects of actions that are goal-directed. Another line of research finds that children faithfully copy all actions and aspects of actions, even when they are apparently irrelevant to the goal of the model. In this study we ask whether these different types of imitative behavior may be based in part on individual differences.

Awareness of the goals of people's actions appear early in infancy (Woodward, 1998). Starting from the second year of life, infants and young children selectively copy actions that are performed intentionally over actions that are performed accidentally (Carpenter, Akhtar, & Tomasello, 1998), that fail to achieve the model's goal (Meltzoff, 1995), and that are forced by environmental constraints (Gergely, Bekkering, & Király, 2002). It should be noted that goals of actions can be hierarchically organized—in the absence of an obvious external goal, children are more likely to copy the manner of a model's action, thus perhaps inferring that to be the goal (Bekkering, Wohlschlagel, & Gattis, 2000; Carpenter, Call, & Tomasello, 2005).

On the other hand, research has documented a very different tendency in children's imitation—to be faithful to the model's actions even when there exists an obvious external goal. Across many studies in a variety of contexts, young children faithfully copy actions and aspect of actions

that are apparently useless or irrelevant to achieving an external goal, such as retrieving a reward (e.g., Horner & Whiten, 2005; Lyons, Young, & Keil, 2007; Nagell, Olguin, & Tomasello, 1993; Nielsen, 2006). Children at times copy goal-irrelevant actions even when they know doing so will reduce their chance of retrieving the reward (Lyons, Damrosch, Lin, Macris, & Keil, 2011). Importantly, children do not reproduce those actions merely because they mistaken them as being goal-relevant, because they verbally report those actions to be unnecessary for achieving the goal before or after copying them (Kenward, Karlsson, & Persson, 2011; Yu & Kushnir, 2014).

One explanation for the different imitative behavior across studies is that they occur in different contexts. Research has shown that even very slight modifications in the social context can significantly change how children imitate (Brugger, Lariviere, Mumme, & Bushnell, 2007; Nielsen, 2006; Yu & Kushnir, 2014). Different contexts may affect children's inferences about the objective of a social interaction: if children believe the objective is mainly instrumental, this may lead to more goal-directed imitation. Conversely, if they believe the objective is social or affiliative, this would lead to more faithful imitation (Over & Carpenter, 2012).

While this explanation has much empirical support suggesting that context is certainly important, there is another possible contributor to differences in imitative behavior that has received less research attention. This is the possibility that there are intrinsic factors that lead to individual differences in how children imitate. One such factor is age: Preschoolers have been shown to imitate more faithfully than toddlers (McGuigan & Whiten, 2009; McGuigan, Whiten, Flynn, & Horner, 2007; Yu & Kushnir, 2014). However, goal-directed and faithful imitation have often been observed in children of the same age and in the same context (McGuigan & Whiten, 2009; Nielsen, 2006; Yu & Kushnir, 2011), thus age by itself cannot account for all of the remaining variability.

A few recent studies have found connections between individual infant's understanding and replication of goal-directed and goal-irrelevant actions and other aspects of development. For example, infants' habituation rate towards goal-directed actions has been shown to predict their theory of mind ability in preschool years (Wellman, Lopez-Duran, LaBounty, & Hamilton, 2008). Also, infants who are rated high in extraversion imitate more faithfully than their peers who are rated low in extraversion (Hilbrink, Sakkalou, Ellis-Davies, Fowler, & Gattis, 2013). These studies suggest that individual differences in imitation may exist, may be stable, and may be related to children's

sociability or social cognition. They further lend support to the idea that individual differences should be preserved across various types of imitation tasks (i.e. across various instrumental and social contexts). We explore this idea in the following study.

In this study we systematically investigated individual differences in imitative behavior by administering a series of imitation tasks to a group of 2-year-old children. We chose 2-year-olds because previous studies suggest a mixture of goal-directed and faithful imitation on average at this age, as well as a large amount of behavioral variation across even the same types of imitation tasks (e.g., McGuigan & Whiten, 2009; Yu & Kushnir, 2014). The imitation tasks we employed included both those emphasizing an instrumental goal and those emphasizing a social goal.

We employed the puzzle box tasks from five previous imitation studies (Brugger, et al., 2007; Horner & Whiten, 2005; Lyons, et al., 2011; Nielsen, Moore, & Mohamedally, 2012; Yu & Kushnir, 2014). In these tasks children see an action sequence leading to the retrieval of a reward from a puzzle box. The action sequence comprises one or two actions that are irrelevant for retrieving the reward, followed by one or two actions that are relevant, and finally the retrieval of the reward. We measured children's goal-directed imitation by calculating the percentage of goal-relevant actions they imitated, and we measured their faithful imitation by calculating the percentage of goal-irrelevant actions they imitated. We predicted individual children's imitative response to be correlated among these different puzzle box tasks.

We also employed the puppet show task (Carpenter, et al., 2005), in which an experimenter moves a puppet to either a cardboard house (House condition) or a same location without a house (No House condition), and she does the action in a particular manner (a certain style accompanied by a sound). The presence or absence of the house leads to condition differences in imitation; infants will usually match the final location when a house is present, and match the manner of the action when the house is absent. In our study we measured children's goal-directed imitation by calculating the number of goals they matched (final location in House condition and manner in No House condition). We also measured their faithful imitation by the amount of action manner children matched regardless of condition. Though we expected to replicate the usual condition differences on the group level, we also predicted that individual children's imitation would be correlated between conditions.

The context established in these two types of tasks is similar in some ways (all involve imitation), but also importantly different. In the puzzle box tasks, the relevance of actions to the goal is established by physical cause and effect (the goal-relevant actions are physically necessary to retrieve the reward, and the goal-irrelevant actions are unnecessary). In the puppet show tasks, the relevance of aspects of actions to the goal is established by the model's

intentions (the location is the goal in the House condition because the model intended to put the puppet in the house; in the absence of the location, the model's intentions must be inferred to be otherwise). Thus, in our final analysis, we looked to see if individual differences could account for some of the differences in imitative behavior that might transcend immediate contextual influences. To the extent that individual factors contribute to differences in imitative behavior, we expected to see correlations in children's imitative behavior across these two types of tasks.

Method

Participants

Participants were 48 2-year-olds (21 boys, mean age = 26 mo, range = 23-32 mo) recruited from a small town in upstate NY. One additional child was tested but excluded from analysis because she did not understand English. According to parental report, 79% of the included children are Caucasian, 98% of their primary caregivers have college diploma or higher, and 85% of their families have an annual household income > \$50,000. Children received stickers for their participation, and their parents received \$10.

Procedure

The same male experimenter (E) and one of eight assistants conducted the experiment. Children first warmed up with E and assistant in a laboratory corridor filled with toys. After children felt comfortable, they were introduced into a playroom where all testing take place. E sat facing children across a table for all tasks except for the third set of puzzle box tasks, in which both E and children played on the floor away from the table. The accompanying parents sat next to children in a separate chair, and were instructed to remain neutral. All sessions were videotaped.

During testing children completed the puzzle box tasks and puppet show task as part of a longer testing session. Because our major interest in this study was individual differences, all tasks were presented in a fixed order (first set of puzzle boxes, second set of puzzle boxes, puppet show task, third set of puzzle boxes). These imitation tasks were interspersed throughout the longer testing session.

Puzzle box tasks. We built three sets of puzzle boxes, with three boxes in each set. The first set (the Flower Box, the Ramp, and the Rake) mimicked those originally used in Brugger and colleague's study (2007), and was recently used in Yu & Kushnir (2014). The second set (the Blue Box, the Switch Box and the Artificial Fruit) mimicked those used in Nielson and colleague's study (2012). The third set comprised a replicate of the Clear Box (Horner & Whiten, 2005), as well as replicates of the Monkey Box and the Prize Box (Lyons, et al., 2011). Each of these puzzle boxes contained a reward in them, and was associated with an action sequence to retrieve the reward. Each of these action sequences comprised one or two actions that are irrelevant for retrieving the reward, followed by one or two actions

that are relevant, and finally the retrieval of the reward. Notably, the boxes in the third set were mostly used for preschoolers in previous studies, and one study which used them with 2-year-olds showed only 17% of children imitated the goal-irrelevant actions (McGuigan & Whiten, 2009). We expect the same to happen in our study.

In our study, each child played with three puzzle boxes, one from each set. For each task, E presented the puzzle box, said “Watch me”, and demonstrated the action sequence in a slow, deliberate fashion. At the end he took out the reward and showed it to children. He then removed the box and the reward from children’s view, and placed the reward back inside. He returned the box, saying “Now your turn”. Children played with the box until they retrieved the reward, or until they lost interest in the box. The videos were coded along three independent dimensions: how many goal-relevant children imitated, how many goal-irrelevant actions they imitated, and whether they retrieved the reward. Videos from 10 children (21% of all children) were coded by a second coder, and inter-rater reliability was high (Cohen’s Kappa = 1 for reward retrieval, 0.90 for imitation of goal-relevant actions, and 1 for imitation of goal-irrelevant actions).

Puppet show task. The puppet show task was administrated and coded in an identical way as in the original research (Carpenter, et al., 2005), the only difference being we reduced the number of trials from eight to four. In each trial children were presented with one of two mats on the table: an empty mat (No House condition) or a mat with two cardboard houses on the centers of the mat’s left half and right half (House condition). In both conditions, E moved a puppet (e.g., a mouse) towards the center of the mat’s left half or right half. In the House condition the final location was inside one of the houses. In the No House condition the final location was the same spot on the mat, but not in a house. The final location was to the left side of the mat for half the trials in each condition, and was to the right side for the other half. E used one of two action styles when moving the puppet: he either made the puppet jump on the mat several times (“hopping”), or slid the puppet without breaking contact with the mat (“sliding”). E always made a repeated short sound (e.g., “bebebe...”) to accompany the hopping style, and he made a long sound (e.g., “beeeee...”) to accompany the sliding style. The puppet was made to hop in half of the trials in each condition, and to slide in the other half. The order of condition (House vs. No House), style (hopping vs. sliding) and final location (left vs. right) were counterbalanced between children.

In each of the four trials, E first elicited children’s attention by calling their names. He said “Watch me”, and moved the puppet to one of the final locations. E then picked up the puppet and placed it in front of children. E told children, “Your turn”, and waited children’s response till he or she stopped handling the puppet. The videos were coded for whether children matched E on style, sound effect and final location. Videos from 10 children (21% of all

children) were coded by a second coder, and inter-rater reliability was high (Cohen’s Kappa = 0.84 for style, 1 for sound, and 0.85 for location).

Results

The results section is organized as follows: We first report children’s responses *within* each set of imitation tasks, then report correlations of children’s responses *between* tasks.

Puzzle box tasks

All three puzzle boxes tasks were administrated to all children. One child (2%) provided no relevant response throughout all three tasks. This child was included in data analysis, though excluding her would not qualitatively change any of the results.

Overall children retrieved the reward for 76% of the puzzle boxes ($SD = 31\%$). They imitated the goal-relevant action for 79% of the puzzle boxes ($SD = 27\%$), and they imitated the goal-irrelevant action for 43% of the puzzle boxes ($SD = 27\%$), the difference between goal-relevant and goal-irrelevant actions was significant, $t(47) = 4.42$, $p < .001$, $d = 0.64$. Therefore, we observed evidence for both goal-directed imitation (as children copied more goal-relevant actions than goal-irrelevant actions) and faithful imitation (as children still copied 43% of the goal-irrelevant actions).

Next we investigated individual differences by analyzing intercorrelations between the outcome measurements. Not surprisingly, the retrieval of reward was predicted by the imitation of goal-relevant actions for each puzzle box ($r_s > .43$, $p_s < .002$), but not predicted by the imitation of goal-irrelevant actions ($r_s < .16$, $p_s > .2$). Moreover, the outcome measurements were correlated across the three sets of puzzle boxes. For retrieval of rewards, we observed correlations for all three pairs of sets ($r_s > .26$, $p_s < .07$). For imitation of goal-relevant actions, the correlation was significant between the first and second sets ($r = .41$, $p = .004$), and was marginally significant between the first and third set ($r = .24$, $p = .10$). For imitation of goal-irrelevant actions, the correlation was significant between the first and second sets ($r = .41$, $p = .004$). The percentage of goal-irrelevant actions children imitated in the third set was low ($M = 16\%$, $SD = 31\%$), and was not significantly correlated with that of the first two sets, possibly due to a floor effect. These correlations confirmed our hypothesis about consistency in individual children’s imitative behavior. We computed composite scores of “faithful imitation” and “goal-directed imitation” by summing up the percentages of goal-irrelevant and goal-relevant actions children imitated in each set.

Puppet show task

Three children (6%) were not included in the analysis for the puppet show task because they were too distracted or fuzzy to complete the task. Data from the remaining 45 children were used, including one child (2%) who provided no relevant response throughout all four trials. Excluding

Table 1: Intercorrelations among six outcome measurements in the puppet show task ($N = 45$).

		Style		Sound		Location	
		House	No House	House	No House	House	No House
Style	House	—	.274[†]	.446^{**}	.270[†]	.153	.098
	No House		—	.310[*]	.616^{**}	.337[*]	.222
Sound	House			—	.621^{**}	.197	.020
	No House				—	.264[†]	.266[†]
Location	House					—	.147
	No House						—

Note. [†] $p < .10$; ^{*} $p < .05$; ^{**} $p < .01$

this child would not qualitatively change any of the results.

We replicated the results of the original study (Carpenter, et al., 2005) in showing different imitative behavior between conditions. In the House condition children were more likely to match location than to match style and sound, location vs. style: $t(44) = 2.94, p = .005, d = 0.44$, location vs. sound: $t(44) = 4.08, p < .001, d = 0.61$, style vs. sound: $t(44) = 0.65, ns$. In the No House condition they were more likely to match style and sound than to match location, and also more likely to match style than to match sound, location vs. style: $t(44) = -6.57, p < .001, d = -0.98$, location vs. sound: $t(44) = -2.46, p = .02, d = -0.37$, style vs. sound: $t(44) = 4.74, p < .001, d = 0.71$.

To rule out possible order effect, we first compared the dependent measurements based on the order E administered the four trials, and results showed no difference for any of the dependent measurements ($ps > .3$). We also analyzed children’s responses in the first trial, and results showed the same pattern as when all four trials were considered: For those tested in the House condition first (24 children total), 11 children matched location but did not match style or sound, and 5 children matched style or sound but did not match location. For those tested in the No House condition first (21 children), no child matched location but did not match style or sound, and 9 children matched style or sound and did not match location. The patterns across the two conditions were significantly different, Fisher’s exact $p = .001$.

We then examined intercorrelations among different measurements (Table 1). As predicted, we observed correlations of matching style and sound across conditions, $rs > .27, ps < .07$, which showed stability in children’s faithful imitation. Also as predicted, the matching of final location in the House condition was correlated with the matching of style and sound in the No House condition, $rs > .26, ps < .08$, which showed stability in children’s goal-directed imitation.

We further performed a Principle Component Analysis (PCA) to cluster these correlated measurements into lucid factors. When applied to behavioral studies, PCAs are typically used for evaluating the validity of tasks and measurements (e.g., Carlson, Mandell, & Williams, 2004). However, at its essence a PCA extract factors from analyzing the variance across individuals, therefore it is also an ideal tool for understanding the underlying structure of

individual differences. Here we used IBM SPSS 20 to perform the PCA. We submitted all six measurements (matching of style, sound and location in the two conditions) to the PCA, and used oblique rotation (oblimin) to allow factors to correlate. Presumption check showed that sample size was adequate for the analysis (overall KMO statistic = 0.60, KMO for all variables > 0.5), and the variables were sufficiently correlated (Bartlett’s test $p < .001$, communalities for all variables > .3). Results revealed two factors with eigenvalue > 1 (Table 2). The first component had high loadings on all four measurements we hypothesized to represent faithful imitation (matching style and sound in both conditions). The second component had high loadings on all three measurements we hypothesized to represent goal-directed imitation (matching final location in the House condition, and matching style and sound in the No House condition). In addition, it also had high loadings on matching final location in the No House condition. One possible explanation is that when the house was absent the goal of the action was unclear; and since the final location was still a salient element of the action, children still treated it as a part of the goal. Two variables (matching style and sound in No House condition) showed high loadings on both factors, but this was expected based on our hypothesis. The first factor explained 42% of the total variance, and the second factor explained an additional 18%. We computed composite scores by summing up variables that has a loading > 0.4 on the factor, and named them “faithful imitation” and “goal-directed imitation”.

Table 2: Factor loadings based on a PCA for six outcome measurements in the puppet show task ($N = 45$).

	Factors	
	1 (Faithful imitation)	2 (Goal-directed imitation)
House, style	.706	.080
No House, style	.545	.682
House, sound	.872	.164
No House, sound	.735	.597
House, location	.213	.625
No House, location	-.036	.730

Table 3: Correlations between children’s imitative behavior in the puppet show task and in the puzzle box tasks.

		Puzzle box tasks	
		Goal-directed	Faithful
Puppet show task	Goal-directed	.331*	.193
	Faithful	.089	.318*

Note. * $p < .05$

Correlation between tasks

As hypothesized, we observed individual differences in how children imitated within the puppet show task and the puzzle box tasks. Next we explored children’s imitative behavior *across* these two different types of tasks (Table 3). As predicted, goal-directed imitation in the two types of tasks was positively correlated ($r = .33, p = .03$), and faithful imitation in these two types of tasks was also positively correlated ($r = .32, p = .03$). Therefore children reliably vary along how goal-directed and how faithful they imitate across tasks.

To confirm these results we further performed a PCA with all six measurements from the puppet show task and all three measurements from the puzzle box tasks. The presumptions for the analysis were all met (overall KMO statistic = 0.63, KMO for all variables > 0.5, Bartlett’s test $p < .001$), and again we used oblique rotation (oblimin). Results again revealed two factors with eigenvalue > 1 (Table 4). The first factor had high loadings on all measurements representing faithful imitation. The second factor had high loadings on all measurements representing goal-directed imitation (the loading on matching sound in the No House condition was lower than .4 but still above .3), as well as matching location in the No House condition. The first factor explained 32% of the total variance, and the second factor explained an additional 19%. Composite scores were computed by summing up variables that has a loading > 0.4. Composite scores for the two factors were positively correlated with each other ($r = .32, p = .03$).

Table 4: Factor loadings based on a PCA for six outcome measurements in the puppet show task and three outcome measurements in the puzzle box tasks ($N = 45$).

		Factors	
		1 (Faithful imitation)	2 (Goal-directed imitation)
Puppet show task	House, style	.599	.138
	No House, style	.581	.567
	House, sound	.862	.033
	No House, sound	.816	.337
	House, location	.307	.559
	No House, location	.120	.583
Puzzle box tasks	Retrieval	.082	.704
	Goal-relevant	-.018	.858
	Goal-irrelevant	.532	.026

Discussion

In this study we looked at 2-year-old children’s imitation of a model’s actions on objects. With a same group of children who are similar in age, we administrated both imitation tasks with an instrumental goal and imitation tasks with a social goal. We found that 1) on a group level, 2-year-olds showed tendencies for both goal-directed and faithful imitation that are similar to those found in prior work emphasizing contextual influences on children’s imitative behavior; 2) beyond this, there were stable individual differences in imitative behavior both within and across tasks; and 3) two major factors that characterize these individual differences align well with the concepts of goal-directedness and faithfulness in the imitation literature, and when combined these two factors explained more than half of the variance observed in children’s imitative behavior.

We started exploring individual differences in imitative behavior by examining intercorrelations within each type of imitation tasks. Results showed stable individual differences in imitative behavior across different stimuli in the puzzle box tasks, and between different conditions in the puppet show task.

Furthermore, the individual differences in imitative behavior was stable across tasks—goal-directed imitation in the two tasks was positively correlated, and faithful imitation in the two tasks was positively correlated. Given that puzzle box tasks featured instrumental goals the and the puppet show tasks featured social goals, these correlations show that the observed individual differences transcend contextual influences such as inferences about the goals of a particular task.

We further employed PCAs to confirm and clarify the intercorrelations. When we submit all measurements of all tasks to a PCA, it extracted two factors that collectively explained 51% of the total variance. One factor has high loadings on measurements representing goal-directed imitation, and the other factor has high loadings on measurements representing faithful imitation.

Critically, the final composite scores representing goal-directed and faithful imitation correlated positively with each other. This final result suggests that these two may together represent a broader construct which captures how likely individual children are to imitate in any given social interaction; children can vary from not imitating at all (thus low on both factors) to imitating all components of the model (thus high on both factors).

This study provides a first demonstration of how analyzing individual differences can contribute to our understanding of children’s imitative behavior. It leads to a new set of questions: For example, if some children at age 2 are more “imitative” than others, how stable are these differences with age? Are these differences concurrently or predictively related to other aspects of cognitive and social development? Do these differences have any direct influence on what individual children are likely to learn from social interactions? To address these questions, future

research needs to examine individual differences in a wider range of tasks, and to longitudinally assess the stability of these individual differences across ages. These researches will provide valuable insights on how social learning varies in young children, and may help to create effective social environments to support individual children's learning.

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