Title
It’s all about the game: Infants’ action strategies during imitation are influenced by their prior expectations

Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 33(33)

ISSN
1069-7977

Authors
Yu, Yue
Kushnir, Tamar

Publication Date
2011

Peer reviewed

It's all about the game: Infants' action strategies during imitation are influenced by their prior expectations

Yue Yu (yy376@cornell.edu), Tamar Kushnir (tk397@cornell.edu)
Department of Human Development, Cornell University
Ithaca, NY 14850 USA

Abstract

Infants' imitation is influenced by causal and intentional cues. Here we examine whether imitation is influenced by prior social expectations. Infants (mean age = 27 months) first played one of three games either: 1) copying the experimenters' gestures, 2) establishing and working toward a shared goal or 3) a non-interactive control. They then participated in a separate imitation task involved both causally necessary and unnecessary actions and a goal. Infants who began by copying the experimenter were more likely to imitate causally unnecessary actions, infants who played a game with a shared goal were more likely to only perform causally necessary actions. Infants in the non-interactive control had no preferred response, and were least likely to achieve outcome as demonstrated. These results implicate the broader social context as an important factor guiding the actions infants choose to imitate, and have implications for the role of imitation in early learning.

Keywords: infant; faithful imitation; emulation; prior expectation; social context; social cognition.

Introduction

The tendency to imitate others plays an important role in the behavioral repertoire of infants and young children. Newborns imitate facial and manual gestures as part of their earliest affiliative interactions (Meltzoff & Moore, 1977, 1989). By 6 months, infants begin to imitate sequences of object-related actions as well. Increasingly over the first few years of life, imitation becomes more than a way to affiliate with others; it becomes an important mechanism for learning about the world (Meltzoff, 1995).

But infants do not always imitate faithfully. In fact, one important observation is that, in some cases, infants only copy the *goals* of another person's action, ignoring the exact means of producing those goals (termed "emulation", Tomasello, 1996). In other cases, infants reproduce whole action sequences faithfully (Lyons, Young, & Keil, 2007; McGuigan, Whiten, Flynn, & Horner, 2007; Nielsen & Tomaselli, 2009; Want & Harris, 2002). Studies show that which of the two behaviors – emulation or faithful imitation – infants engage in depends on several factors, including their understanding of physical causality, their ability to read intentional and pedagogical cues, and also on their assumptions that agents behave rationally in the pursuit of goals (Brugger, Lariviere, Mumme, & Bushnell, 2007; Carpenter, Call, & Tomasello, 2005; Gergely, Bekkering, & Király, 2002; McGuigan & Whiten, 2009; Meltzoff, 1995).

In this paper, we offer evidence of an additional factor that might drive imitative behavior, namely prior social expectations. We know from previous work that children can read and track others intentions during social interactions (Malle, Moses, Baldwin, & Bruner, 2003). These understandings could cause infants to form expectations which guide their action strategies broadly in the context of social interactions, and specifically, these expectations could result in different imitative behaviors even when controlling for other causal and intentional cues.

To investigate this, we assigned groups of 27-month-old infants to play one of three games prior to participating in an imitation task. The first game involved mimicking the hand gestures of the experimenter (playing "copy me"). The second game involved taking turns finding and putting pieces in a puzzle, and thus established a shared goal. The final game was non-interactive, and served as a control. Critically, none of these games involved the toys used in the imitation task, but rather were used to establish the tenor of the overall social interaction with the experimenter.

We selected a set of toys for use in the imitation test which in previous work (Brugger et al, 2007) were shown to be easy to operate and also causally transparent to infants of this age. A two action sequence was demonstrated towards toys, which led to an interesting effect. Of these two actions, the second (action B) was always necessary for producing the effect, but the first (action A) was only necessary for half of the toys. The other half of the time it was causally unnecessary. For example, in the "flowerbox", action A was to remove a Velcro latch, and action B was to open the lid. In the Necessary condition the Velcro latch was attached on the lid and held it close, whereas in the Unnecessary condition the Velcro latch was on the other side of box and did not hold the lid close. The critical imitation task, then, occurred when action A was demonstrated but was causally unnecessary, we could see whether infants' prior expectations would be more likely to lead to faithful imitation, emulation, or some other response.

Using a similar method, Brugger et al (2007) showed that 15-month-old infants were not likely to perform the first action (action A) when it was unnecessary, despite it was part of the demonstration. Thus we could expect that, minimally (in the absence of social cues which would elicit faithful imitation), infants in our study would also likely perform only the actions necessary to produce the desired outcome. Critically, then, the ability to understand the causal properties of the toys was readily available to infants and held constant across conditions.

Also held constant across conditions were the social cues *during* the imitation task. This was important because in previous work such cues (e.g. pedagogical intent) have been shown to influence children's tendency to faithfully imitate (Brugger, et al, 2007; Király, 2009; Lyons et al, 2007; Nielsen, 2006). In our imitation task, all demonstrated

actions were performed with pedagogical intent. Consequently any differences in imitation could be attributed to participating in one of the three initial games, and not to the social cues during the imitation task itself. Our hypothesis was that the prior expectation (as established in the initial game) would influence the infant's *action strategy* during imitation. That is, playing a game that emphasized mimicking hand gestures would lead to more faithful imitation, whereas playing a game that emphasized a shared goal would lead to more emulation. More critically, our goal was to demonstrate that different actions across the two contexts are due to infants' different social inferences about the game being played (i.e. copying actions vs. sharing goals), rather than to different levels of social engagement. Thus, we included controls for level of engagement both within conditions and at baseline. Comparisons between Necessary and Unnecessary conditions allowed us to check for the possibility that prior game context could simply cause different levels of engagement or attention. If prior game context leads to different social inferences, then we expect it to influence the imitation of causally unnecessary actions but not to affect the execution of causally necessary ones. Furthermore, a separate group of infants began with a non-interactive prior game to measure imitation at baseline (i.e. with only the social cues available during the imitation task).

Method

Participants

Participants were 36 healthy infants (19 males, mean age = 27 mo, range = 23-33 mo) recruited from an infant database in a small town in upstate NY. Five additional infants were recruited but were not able to complete the test. According to parental report, 69% of the included infants are Caucasian, 50% have siblings, 50% had attended day care (median length = 18 mo), 97% of their mothers have college degree or higher. Equal group of infants (n = 12) were randomly assigned to one of three prior games. The average age for the copy-me, find-the-piece and drawing games are 27.1, 27.5 and 26.6 months respectively. All infants received a gift for their participation.

Material

Five toys were used in the imitation game: the box, the ramp, the rake (these three were adapted from Brugger, et al., 2007) and two versions of the birdhouse (see Fig. 1). For the first three toys, each could be set up so that the first action (action A) was either necessary for retrieving the piece or unnecessary. Detailed descriptions of these three toys can be found in the original study (Brugger, et al., 2007). We constructed two versions of the birdhouse (one used in Necessary condition and one used in Unnecessary condition) following the same logic. Importantly, like the toys taken from Brugger et al (2007), the causal properties of the birdhouses were designed to be transparent to infants of this age.

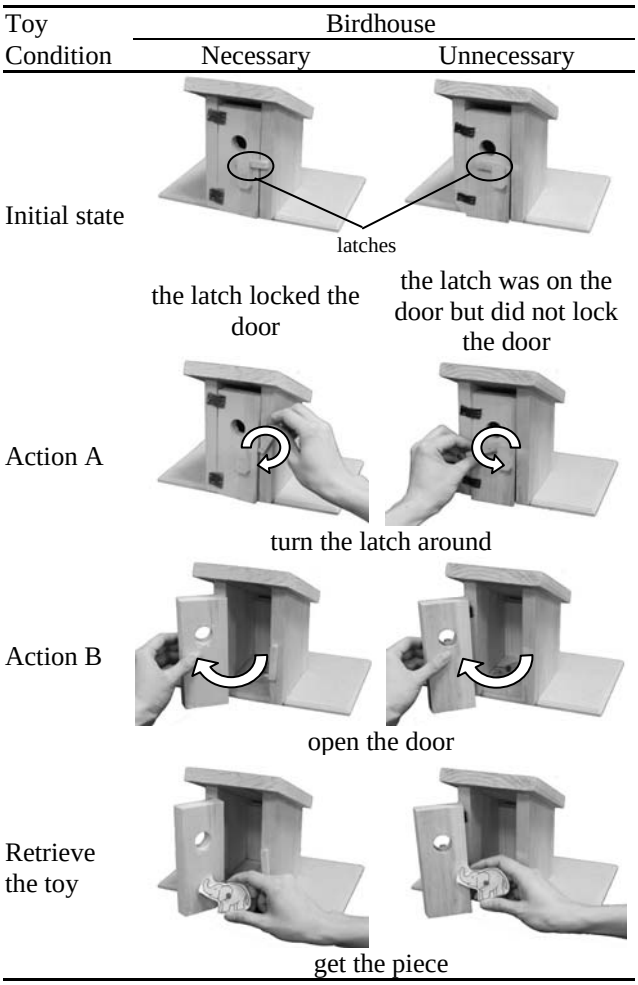

Figure 1: The birdhouses used in the imitation game. Two versions of birdhouses were built: one version (Necessary condition) required two causal actions (i.e., unhook the latch, open the door) to open and retrieve a puzzle piece, whereas the other toy (Unnecessary condition) was perceptually identical except that only the second of these two actions was necessary (i.e., the latch did not lock the door, so turning the latch was not necessary for retrieve puzzle piece).

The objects to be retrieved from the toys (8 in total) were all puzzle pieces in the shape of baby animals, roughly 2 inches in diameter.

Procedure

The study used 3 (prime game: copy-me, find-the-piece, drawing; between-subjects) × 2 (condition: Necessary, Unnecessary; within-subjects) design. Infants were tested in a quiet room with one table and three chairs. They sat next to their parents at the table. If they felt uncomfortable, they could sit on their parents' lap. The experimenter sat across the table, facing the infants. The entire session was videotaped. Infants participated in a familiarization session first, followed by one of three prior games, and then they played the imitation game.

Familiarization The familiarization session was designed to make sure that infants were familiar with the causal properties of all toys used in the imitation game. A male experimenter sequentially showed infants the four empty toys (the box, the ramp, the rake, and Necessary version of the birdhouse). The order of the toys was counterbalanced across participants. For each toy the experimenter said "Look! Have you seen this toy before? You can play with it", and pushed the toy to them. Infants played with each toy for up to 1 minute. If they did not explore all causal actions related to the toy (action A and B) before shifting attention away, the experimenter would point out the related parts on the toy and let infants try these actions.

Prior Games Following familiarization, the infants were randomly assigned to one of three games. The *copy-me game* involved mimicking the hand gestures of the experimenter. The experimenter started by saying "(Infant's name), let's play a game called 'copy-me'. I will do some actions, and you will follow me and do the same." He then demonstrated the first "clap-slap" action, and prompted the infants to do the same thing. After the infants followed correctly for about 5 seconds, the experimenter moved on to demonstrate the second action. The infants copied a total of four actions, including "clap-slap" (alternately clapping hands and slapping hands on the table), "open shut" (alternately opening and shutting two hands), "rub hands" (rubbing hands slowly) and "flying" (crossing the thumbs of two hands and flapping the other fingers as a bird flapping wings).

The *find-the-piece* game involved establishing a shared goal. The experimenter first presented a puzzle board with eight sockets on it (four mom animals, four baby animals). These sockets could be fitted by different pieces with animal drawings. Four of the pieces (mom animals) were placed beside the board, and the other four (baby animals) were hidden in the toy boxes and served as the pieces to be retrieved during imitation game. The experimenter started by saying "(Infant's name), look at this! What are these animals?" After infants identified the animals, the experimenter drew their attention to the pieces beside the board and said "Look, the mom elephant is outside! Let's help the mom elephant go back home!" He then picked up the mom elephant piece, and put it back to the right spot with little hops indicating walking. Then he turned to the infants and said "Now let's see, who else is outside? Could you help the mom giraffe to get back to her home?" He encouraged infants to pick up and fit in the other three pieces of mom animals. After they did so, the experimenter said "Good job! But look, the baby animals are still missing. Let's find the baby animals."

The *drawing* game served as a non interactive control. The experimenter took out a crayon and a piece of paper, and said "Let's play a drawing game. You can draw whatever you want". He then gave infants the crayon and paper to draw, and did not interact with them during drawing.

Imitation Game Immediately after they had played the prior game, infants participated in the imitation game. The imitation game was comprised of 8 trials, 4 in Necessary condition and 4 in Unnecessary condition. The order of toys and conditions were staggered within participants and counterbalanced between participants. For each trial, the experimenter took out the toy box and placed it out of the infants' reach. He said "Watch me", and performed the three actions (action A, action B, and retrieving the puzzle piece) in a slow, deliberate fashion. At the end he took out the puzzle piece and showed it to the infants. He then removed the toy from the infants' view and placed the piece back inside. He again presented the toy to the infants, saying "Now your turn!" The infants were allowed to play with the toy until they had retrieved the piece or until 1 minute had passed.

Coding

All videos from the imitation games were coded by two research assistants blind to the purpose of the study. Prior to coding, all information related to the prior game was clipped out from the video, to ensure that the coders were condition-blind as well. For each trial, the coders first recorded whether the infants retrieved the puzzle piece. For those trials in which the piece was retrieved, infants' retrieval time (time period from first touching the toy to getting the piece out) and action strategy were also coded. For action strategy, the coders first coded infants' individual actions along the timeline. Individual actions were coded as one of the following: action A, action B, the action of retrieving the piece, other actions aiming at getting the piece out, other actions with the toy (not aiming at getting the piece out), actions directed at the demonstrator, and actions directed at parent. Then, the sequence of actions was converted to one of three retrieval strategies: "A+B" described an action sequence of action A, then action B, followed by retrieving the piece, with no other actions inserted among them. This represented faithful imitation of the demonstrator's action sequence. "B only" described a sequence of action B, followed by retrieving the piece, without action A or any other actions. This represented emulation of the demonstrator's goal to get the piece (note that this sequence was only possible in the Unnecessary condition, since in the Necessary condition it was not possible to retrieve the piece without completing both A and B). Finally, "other" included all performances that couldn't be characterized as "A+B" or "B only". This could have involved either reversing the order of A and B, adding additional actions into the sequence, or retrieving the toy in a way different from the demonstration. All of these "other" responses occurred roughly an equal proportion of the time (9.0%, 7.6%, 10.4% of total responses, respectively). Inter-rater reliability was high for all measurements (for whether the piece was retrieved, percentage of agreement = 99.0%; for retrieval time, inter-rater correlation = 94.8%, for action strategy, Cohen's Kappa = 80.4%).

Results

The results showed that infants' action strategy (action A+B, action B only, other action) in the Unnecessary condition differed by the prior game they played (Fig. 2). We analyzed the number of responses in a 3 (prior game) × 3 (action strategy) ANOVA. Results showed a main effect for action strategy (F (2, 32) = 14.41, p < .001, η^2_p = .47), and an interaction effect between prior game and action strategy (F (4, 66) = 4.56, p = .003, η^2_p = .22). The main effect was largely due to the small number of "other" responses across conditions. Critically, the interaction effects demonstrated that infants' action strategy differed significantly depending on the expectations from the prior game. Infants who played copy-me game performed more "A+B" responses than "B only" and "other" (ps < .02, ds > 0.82). This group also performed significantly more "A+B" responses than infants who played find-the-piece and drawing games (ps < .01, ds > 1.15). Infants who played find-the-piece game performed "B only" marginally more than "A+B" (p = .064, d = 0.59), and significantly more than "other" action (p = .002, d = 1.14). They also performed more "B only" then those in copy-me game (p = .018, d = 1.05). Infants who played drawing game did not show a preference for any particular strategy (ps > .5, ds < 0.2), but they performed more "other" types of responses then those in copy-me and find-the-piece games (ps < .03, ds > 0.95). In sum, infants who played copy-me game tended to faithfully imitate the causally unnecessary actions, whereas infants who played find-the-piece game tended to perform only the actions necessary to achieve the desired outcome.

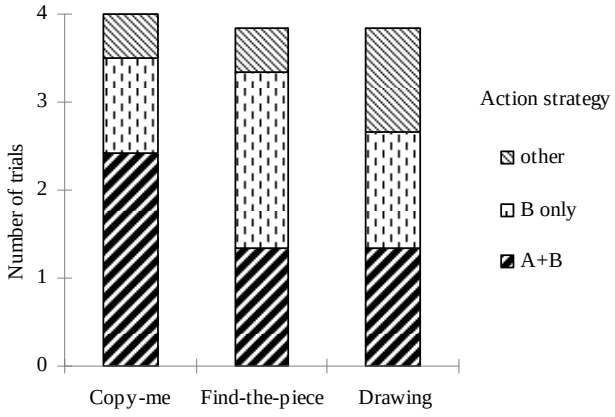

Figure 2: Infants' action strategy in Unnecessary condition. Infants who played copy-me game were more likely to reproduce the whole action sequence ("A+B") than the other two groups (ps < .01); Infants who played find-the-piece game were more likely to use the most direct way to get the puzzle piece ("B only") than those played copy-me game (p = .018); Infants who played drawing game were more likely to use a way different from the demonstration ("other") than the other two groups (ps < .03).

We also analyzed infants' action strategy in the Necessary condition (Fig. 3) to make sure that the prior games did not simply influence overall level of social engagement. The results in the Necessary condition showed no significant differences in action strategy across the three game contexts (F (2, 33) = 1.88, p = .17). Additionally, for both Necessary condition and Unnecessary condition, infants playing three prior games did not differ in total number of retrievals or average retrieval time (ps > .2), indicating equal levels of engagement in the task.[1]

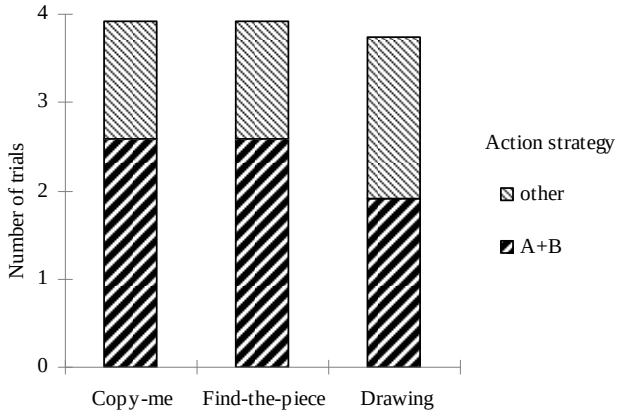

Figure 3: Infants' action strategy in Necessary condition. Action strategy did not differ significantly by prior games. When both actions were causally necessary, infants tended to imitate faithfully the experimenters' actions.

Discussion

In this study, 27-month-old infants played an imitation game after they played one of three prior games. In the imitation game itself, actions were demonstrated with clear pedagogical intent. Nonetheless, the different emphasis placed on copying actions vs. sharing goals in the prior games significantly influenced infants' action strategies during imitation. Infants who played "copy-me" were more likely to faithfully imitate the experimenter's causally unnecessary actions. In contrast, infants who played "find-the-piece" were more likely to avoid unnecessary actions and instead only copy necessary ones. Infants who played a non-interactive control game, but again saw the same pedagogical demonstration during the imitation task, were equally likely to faithfully imitate, emulate, or explore their own way of achieving the goal.

Importantly, we also found that different action strategies across the two contexts could not be explained by different levels of attention or social engagement. Instead, our results suggest that different action strategies were due to infants' different social inferences about the game being played (i.e. copying actions vs. sharing goals). Previous studies show

[1] Infants' "A+B" and "B only" responses did not differ between the first time and second time they played with one toy (ps > .2). This is true for both Necessary and Unnecessary condition (ps > .2), and for the three prior games (ps > .05). However, infants performed more "other" responses in the first time then in the second time (p = .014), and they were more likely to get out the piece in the first time (p < .001).

that infants can learn differential action strategies from different intentional cues before and during imitation (Brugger, et al., 2007; Carpenter, Call, & Tomasello, 2002; Carpenter, et al., 2005; Gergely, et al., 2002). Similarly, we suggest the initial games caused infants to form expectations about the entire social interaction. Thus, we provide evidence that infants' inferences about global social context influence local social behavior.

However, the nature of infants' inference is still an open question. For example, it may be that infants understood the prior game as the demonstrators' preference to play in a particular way. On the other hand, infants might have understood the prior game as setting up rules to be followed (Rakoczy, 2008). One possible way to examine whether infants' inferences were about a particular individual or about the game context is to test their imitative response in the demonstrator's absence, or in the presence of a new person. It is also possible that the expectation could be interpreted differently across development, in particular as children form more advance social cognitive theories about the causes of others' behaviors. Such questions need to be addressed in future research.

The current results also have implications for early learning. Of particular interest is the fact that infants in the non-interactive control were less likely than infants in either interactive group to perform either of the demonstrated action. Thus, it seems that when social expectations of any sort are absent, infants are less likely to learn from others' actions. It is important to note that the children in the non-interactive control group were not less engaged or attentive, but rather were more likely to explore their own way of acting on the objects. This is consistent with evidence from preschool children demonstrating trade-offs between exploratory play and imitative learning (e.g., Bonawitz et al., in press).

In sum, our results demonstrate that, beyond causal and intentional understandings, prior social expectations can also guide infants' social inferences, and thus their choice of action when learning from others. Our findings implicate the broader social context as an important factor in imitative learning.

Acknowledgments

We gratefully thank Katy Braun, Shelby Distenfeld, Niki Klein, Alexis Ritter, Chris Vredenburgh, and Katie Weidlein, for assistance with recruitment, testing and coding.

References

Bonawitz, E., Shafto, P., Gweon, H., Goodman, N. D., Spelke, E., & Schulz, L. (in press). The double-edged sword of pedagogy: Instruction limits spontaneous exploration and discovery. *Cognition*.

Brugger, A., Lariviere, L. A., Mumme, D. L., & Bushnell, E. W. (2007). Doing the right thing: infants' selection of actions to imitate from observed event sequences. *Child Development, 78*(3), 806-824.

Carpenter, M., Call, J., & Tomasello, M. (2002). Understanding "prior intentions" enables two–year–olds to imitatively learn a complex task. *Child Development, 73*(5), 1431-1441.

Carpenter, M., Call, J., & Tomasello, M. (2005). Twelve- and 18-month-olds copy actions in terms of goals. *Developmental Science, 8*(1), F13-F20.

Gergely, G., Bekkering, H., & Király, I. (2002). Rational imitation in preverbal infants. *Nature, 415*(6873), 755.

Király, I. (2009). The effect of the model's presence and of negative evidence on infants' selective imitation. *Journal of Experimental Child Psychology, 102*(1), 14-25.

Lyons, D., Young, A., & Keil, F. (2007). The hidden structure of overimitation. *Proceedings of the National Academy of Sciences of the United States of America, 104*(50), 19751-19756.

Malle, B. F., Moses, L. J., Baldwin, D. A., & Bruner, J. S. (2003). *Intentions and Intentionality: Foundations of Social Cognition*. Cambridge, MA: The MIT Press.

McGuigan, N., & Whiten, A. (2009). Emulation and "overemulation" in the social learning of causally opaque versus causally transparent tool use by 23- and 30-month-olds. *Journal of Experimental Child Psychology, 104*(4), 367-381.

McGuigan, N., Whiten, A., Flynn, E., & Horner, V. (2007). Imitation of causally opaque versus causally transparent tool use by 3- and 5-year-old children. *Cognitive Development, 22*(3), 353-364.

Meltzoff, A. N. (1995). Understanding the intentions of others: Re-enactment of intended acts by 18-month-old children. *Developmental Psychology, 31*(5), 838-850.

Meltzoff, A. N., & Moore, M. K. (1977). Imitation of facial and manual gestures by human neonates. *Science, 198*(4312), 74-78.

Meltzoff, A. N., & Moore, M. K. (1989). Imitation in newborn infants: Exploring the range of gestures imitated and the underlying mechanisms. *Developmental Psychology, 25*(6), 954-962.

Nielsen, M. (2006). Copying actions and copying outcomes: social learning through the second year. *Developmental Psychology, 42*(3), 555-565.

Nielsen, M., & Tomaselli, K. (2009). Over-imitation in the kalahari desert and the origins of human cultural cognition. *Nature Precedings,* 713.

Rakoczy, H. (2008). Taking fiction seriously: Young children understand the normative structure of joint pretence games. *Developmental Psychology, 44*(4), 1195-1201.

Tomasello, M. (1996). Do apes ape? In C.M. Heyes & B.G.Jr. Galef (Eds.), *The roots of culture: Social learning in animals* (pp. 319-346). New York: Academic Press.

Want, S. C., & Harris, P. L. (2002). How do children ape? Applying concepts from the study of non-human primates to the developmental study of 'imitation' in children. *Developmental Science, 5*(1), 1-14.