



Contents lists available at ScienceDirect

Cognitive Development



Own and others' prior experiences influence children's imitation of causal acts

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ARTICLE INFO

Keywords:

Imitation
Prior experience
Causal learning
Goals
Social cognition

ABSTRACT

Young children learn from others' examples, and they do so selectively. We examine whether the efficacy of prior experiences influences children's imitation. Thirty-six-month-olds had initial experience on a causal learning task either by performing the task themselves or by watching an adult perform it. The nature of the experience was manipulated such that the actor had either an easy or a difficult experience completing the task. Next, a second adult demonstrated an innovative technique for completing it. Children who had a difficult first-person experience, and those who had witnessed another person having difficulty, were significantly more likely to adopt and imitate the adult's innovation than those who had or witnessed an easy experience. Children who observed another were also more likely to imitate than were those who had the initial experience themselves. Imitation is influenced by prior experience, both when it is obtained through one's own hands-on motor manipulation and when it derives from observing the acts of others.

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Preschoolers are adept at imitative learning (Barr & Hayne, 2000; Carpenter, Call & Tomasello, 2002; Meltzoff, Kuhl, Movellan, & Sejnowski, 2009; Meltzoff & Williamson, 2010; Subiaul, Romansky, Klein, Holmes, & Terrence, 2007; Williamson, Jaswal, & Meltzoff, 2010). They can imitate many components of others' behaviors, including the model's goal or intention, the outcomes produced by those acts, and the specific means used to attain those outcomes (Call & Carpenter, 2002; Carpenter & Call, 2002; Want & Harris, 2002). This study systematically manipulates two key factors that may regulate children's

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imitation. First, we examine whether 36-month-olds vary their imitation of means depending on the *efficacy* of those means. Second, we examine whether children's prior experience influences imitation; specifically, we ask whether children take into account both their own prior hands-on motor experience (doing the act), as well as the experience of observing the efficacy of others' acts (watching the act being done).

Imitation exerts a powerful pull on preschoolers. Under certain conditions, they imitate acts that are not causally necessary for completing a task, a tendency often called "over-imitation" (Horner & Whiten, 2005; Lyons, Young, & Keil, 2007; McGuigan, Whiten, Flynn, & Horner, 2007; Nielsen & Tomaselli, 2010). Horner and Whiten found that after seeing an adult perform a non-functional act as a means to obtain a reward, 3- and 4-year-olds usually produced this unnecessary act; in contrast, chimpanzees skipped the act when they could see it was not causally necessary to obtain the reward. The tendency to imitate unnecessary acts in certain situations persists in school-aged children (McGuigan et al., 2007) and adults (McGuigan, Makinson, & Whiten, 2011).

Although children sometimes copy ineffective acts, a growing body of research indicates their imitative behavior is not rote, automatic, or compulsory, but is flexibly regulated depending on context and usefulness of the example. Children can selectively choose what, when, and whom to imitate (Meltzoff et al., 2009). For example, infants and toddlers are more likely to imitate acts that contribute to outcomes than those that do not (Barr & Hayne, 1996; Bauer, 1992; Brugger, Lariviere, Mumme, & Bushnell, 2007; Hauf, Elsner, & Aschersleben, 2004), and children aged 1–4 years are more likely to reproduce outcomes (e.g., touching a particular spot), than the specific motor movements used to reach them (e.g., the particular type of reach used to touch the spot; Bekkering, Wohlschläger, & Gattis, 2000; Carpenter, Call, & Tomasello, 2005; Gleissner, Meltzoff, & Bekkering, 2000; Wagner, Yocom, & Greene-Havas, 2008; Williamson & Markman, 2006).

Imitation is also regulated by social context. Toddlers are more likely to imitate socially available adults (Brugger et al., 2007; Nielsen, 2006; Nielsen, Simcock, & Jenkins, 2008) and to duplicate intentional rather than accidental acts that produce an outcome (Carpenter, Akhtar, & Tomasello, 1998). Two-year-olds preferentially imitate outcomes caused by a person versus ones that occur "naturally" through object interplay with the same cause-effect relation but no human intervention (Bonawitz et al., 2010). Although children have been shown to learn behaviors when no actor is shown (Hopper, Lambeth, Schapiro, & Whiten, 2008; Tennie, Call, & Tomasello, 2006; Thompson & Russell, 2004), the presence of an actor appears to be beneficial when children are learning and imitating complex acts (Hopper, Flynn, Wood, & Whiten, 2010; Meltzoff, 2007, experiment 3).

Young children also learn from unsuccessful efforts to reach a goal. Meltzoff (1995) found that 18-month-olds could infer and reproduce an adult's intentions from an unsuccessful demonstration. After watching an adult try to separate a barbell-shaped object unsuccessfully (his hands slipped off the ends), children did not reproduce the exact movements by slipping their fingers from the side of the object. Instead, they reproduced what they perceived to be the model's goal or intention by wrapping their fingers firmly around the sides and yanking the object apart. This ability to enact others' intended acts when an unseen goal must be inferred from a pattern of actions appears to emerge early in the second year (Bellagamba & Tomasello, 1999; Meltzoff, 2007, experiment 2; Nielsen, 2009). Children have also been shown to benefit especially from demonstrations that directly contrast effective and ineffective techniques (Want & Harris, 2001; Nielsen, 2006). For example, Nielsen found that 12-month-olds were more likely to imitate the use of a tool after seeing an ineffective demonstration that did not use one.

To better understand the factors that regulate when and what children imitate, it is important to consider the case in which two acts are *both effective* in reaching a goal but one is more efficient. Cues like amount of effort needed would indicate which is the more efficacious approach. Selectively choosing techniques shown to be relatively more effective is a powerful way to capitalize on social learning (Laland, 2004). There is evidence that 2 to 3-year-olds use efficacy as a guide in choosing what and when to imitate (Harnick, 1978; Williamson, Meltzoff, & Markman, 2008). Williamson et al. (2008) gave 3-year-olds an initial task such as opening a drawer to retrieve a toy. Although all children successfully completed the task, for half the children, the drawer was intentionally made difficult to pull out, and for the other half it was made easy. Following this differential self-experience, all children then saw an adult demonstrate an innovative technique for completing the task. Children with the

difficult motor experience were significantly more likely to adopt and imitate the novel means shown by the adult.

The present study extends this finding by examining whether first-person motor experience is necessary for this effect. Several researchers have suggested that self-experiences play an important role in shaping children's social and causal understanding (Meltzoff & Brooks, 2008; Tomasello, 1999; Woodward, Sommerville, Gerson, Henderson, & Buresch, 2009). For example, giving 10-month-olds hands-on experiences with means-ends sequences changed their goal understanding, as measured by a looking-time paradigm (Sommerville & Woodward, 2005). However, it is possible that young children may also be able to use *others'* experiences with a task – that is, they may glean information about efficacy simply by observing others, without acting themselves (see Marshall & Meltzoff, 2011, for relevant developmental neuroscience work). This capacity would improve the selectivity, usefulness, and power of social learning and imitation.

This study explores how children use efficacy information provided by their own and others' acts. Specifically, we investigate whether witnessing another person having an easy or difficult experience – prior to and without engaging in the task oneself – influences imitation of the other's innovative technique.

1. Method

Two factors were systematically manipulated – person performing the act (self versus other) and nature of prior experience (ease versus difficulty achieving the goal). We hypothesized that children would be more likely to imitate a distinctive act demonstrated by an adult if prior experience indicated that the goal was difficult to achieve, whether that prior experience was gained through the child's own acts or through observation of the adult's acts.

1.1. Participants

Participants were 80 children (38 girls; mean age 35.9 months, range 35–36 months), recruited by telephone through a university's child participant list. According to parental reports, the sample's racial and ethnic composition was 76.25% white, 3.75% Hispanic, 2.5% Asian, 1.25% Hawaiian/Pacific Islander, 7.5% mixed race, and 8.75% other/unknown. Direct measures of socioeconomic status were not obtained, but the sample was generally middle- to upper-middle class. Two additional children's data were excluded due to experimenter error.

1.2. Materials

Two sets of stimuli were used – each on one of two trials. Both sets consisted of three containers, each with a small toy inside (Fig. 1). The two sets were visually distinct and differed from each other in size, shape, and color. All containers within each set were identical. One set consisted of three blue plastic boxes (20 × 6 × 17 cm), each of which had a small, black, sliding switch (nonfunctional) in the upper corner of the top surface. The second set consisted of three red, stacked drawers (21 × 16 × 17 cm), each of which had a toggle lever (nonfunctional) on the right side of each drawer. The first container in each set had a hidden mechanism that, when engaged, increased resistance and made it difficult (but not impossible) to open.

1.3. Design and procedure

In all groups, two experimenters (E1 and E2) sat with the child at a small table in a quiet room in a university laboratory. Sessions were video-recorded for subsequent coding. Each child participated in two trials, one for each stimulus set. Stimuli (boxes or drawers) were placed in front of the child on the table. Which stimuli were presented first was counterbalanced across children.

We crossed two independent factors: person (self/other) and experience (easy/difficult). Participants were randomly assigned to one of four independent groups that varied with respect to their

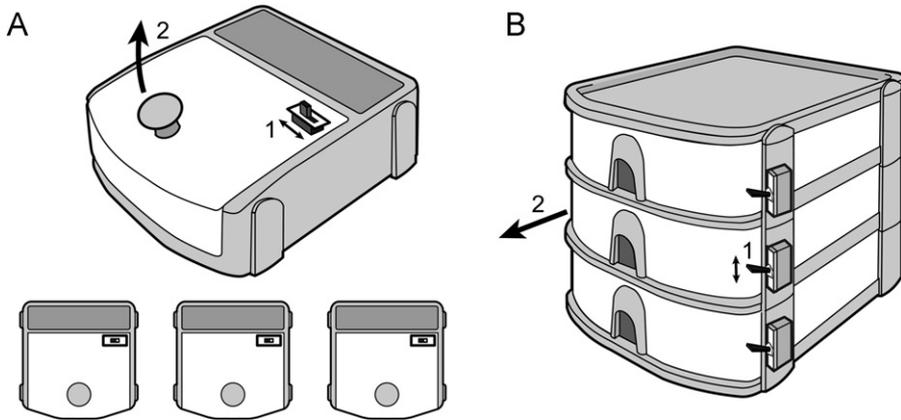


Fig. 1. Box stimuli (A) and drawer stimuli (B). For the box stimuli, an aerial view shows the three containers; for the drawer stimuli the three containers were vertically stacked as shown. For the box stimuli, *E1* slid the switch on the second box (shown in A) to open the box easily. For the drawer stimuli, *E1* flipped the second toggle (shown in B) and easily opened the corresponding drawer. For the boxes, the far left box was used for the initial experience (Phase 1), the middle box was used for the demonstration (Phase 2), and the box on the right was used to assess the children's imitation (Phase 3). For the drawers, the top drawer was used for the initial experience, the middle drawer for the demonstration, and the bottom drawer for the test.

experience with the first container (before seeing the adult's innovative solution): Self-easy, self-difficult, other-easy, and other-difficult.

1.3.1. Phase 1: Initial experience

The initial experience varied as a function of group and constituted the experimental manipulation. In the "difficult" groups, the first box (or drawer) in each set was difficult to open due to added resistance; in the "easy" groups the box lid (or drawer) moved freely and was easy to open.

In the self-experience groups, *E1* directed the child to open the first container. In the other-experience groups, *E1* told the child that *E2* would open the first drawer or box, and *E2* did not act until the child was watching. *E2*'s behavior was carefully scripted to illustrate either an easy or a difficult experience. For the easy experience, *E2* simply opened the box or drawer and gave the toy inside to the child. For the difficult experience, *E2* pulled at the container, paused when it met with resistance and would not open, commented on the difficulty, and then yanked harder to pull the container open. In all cases in all groups, when the first container successfully opened to reveal the toy, *E2* named the object (e.g., "Look, it's the pig"). When the child was finished playing with the toy it was returned and the drawer or box closed before the experimenters moved to the next phase. Phase 1 provided the initial experience or backdrop for the novel act demonstration, which came in Phase 2.

1.3.2. Phase 2: Demonstration

The demonstration was identical across groups. Following the Phase 1 experience, all children observed the same demonstration. *E1* drew the child's attention ("It's my turn now, watch") and acted only when the child was watching. *E1* produced a distinctive means (the target act) before easily opening the second container in the set of three. Specifically, for the box, she slid a switch on the top surface of the box and then easily opened it; for the drawer, she flipped a toggle lever located on the side of the drawer and then easily pulled it open.

1.3.3. Phase 3: Test

The test phase was the same for all groups. *E1* told the child it was "your turn now" and asked the child to open the third container. We wanted to learn whether children would imitate the specific novel act shown to them in the demonstration period (slide the switch or toggle the lever). The response period started when the adult closed the second drawer or box and ended when the child opened the third. There was no time limit, and all children opened the third drawer. After children completed the

three phases with the first set of containers, the second set was introduced (“I have some more toys to play with”), and the procedure was repeated with the second set of stimuli. In most cases, the child returned the toy to the container at the end of each phase. In rare cases in which the child was bored or unresponsive, E1 returned the toy.

1.4. Scoring and dependent measures

Research assistants blind to experimental group scored children’s production of the distinctive means demonstrated by E1 – either sliding the switch or flipping the toggle. Whether the child produced the target act during the response period for each trial was scored from video using a dichotomous yes/no measure. A “yes” was scored if the child was judged to have intentionally manipulated the switch or toggle in the way the adult did before attempting to open the container. Each child received a target act score of 0, 1, or 2, depending on the number of trials on which they produced the target act. For children in the self-experience groups, it was also possible to tally the target act measure during their initial prior experience phase (Phase 1), because these children were given hands-on experience prior to seeing the adult demonstration. A second scorer, also blind to the experimental group, coded a randomly chosen 25% of the participants’ trials. Agreement was 100%, yielding a kappa of 1.0.

2. Results

Preliminary analyses showed no significant effects of stimuli (boxes versus drawers), trial (1st or 2nd), or gender on the target act score; we thus collapsed across these factors for subsequent analyses.

2.1. Manipulation check: Initial self-experience

We first analyzed the behavior of children in the self-experience group during Phase 1. As expected, children in the difficult group were more likely to struggle to complete the opening, which confirmed that our experimental manipulation worked. Even though all children successfully retrieved the toy from the first box or drawer, children in the difficult group took longer on average to do so, because the container was jammed (difficult group $M = 10.51$ s, $SD = 4.97$; easy group $M = 1.50$ s, $SD = 1.00$), $t(38) = 7.95$, $p < .0001$, $d = 2.58$.

During this baseline experience, children’s rates of target act production (manipulating the switch or toggle) were low ($M = .40$, $SD = .67$), as expected, and there was no significant difference between the easy and difficult groups, $p > .05$ (Mann–Whitney U -test).

2.2. Test trials: Assessment of imitation

2.2.1. Effects by experimental group

As predicted, children assigned to the difficult groups (whether self or other) produced significantly more target acts during the test ($M = 1.28$, mean rank = 48.13) than did children assigned to the easy experience group ($M = .68$, mean rank = 32.88), Mann–Whitney $U = 495.0$, $p = .002$, $r = .35$). Thus, children’s imitation of the adult’s demonstration was influenced by the type of experience they or another person initially had with the task.

As shown in Fig. 2, children in the self-difficult group ($M = 1.10$, mean rank = 25.05) were significantly more likely to produce the target acts than children in the self-easy group ($M = .40$, mean rank = 15.95), $U = 109.0$, $p = .01$, $r = .42$. Consistent with this finding, children in the other-difficult group ($M = 1.45$, mean rank = 23.83) showed greater production of the target acts compared to children in the other-easy group, although this difference was not statistically significant ($M = .95$, mean rank = 17.18), $U = 133.5$, $p = .07$, $r = .31$ (this and other results reported as 2-tailed values).

Overall, there was also a difference in target act production during the test phase depending on who produced the motor experience (self or other) in the initial phase of the experiment. Regardless of ease or difficulty, children who saw E2 act on the box (or drawer) during the initial phase (and thus saw both E1 and E2 act) were more likely to produce the target acts ($M = 1.20$, mean rank = 46.23)

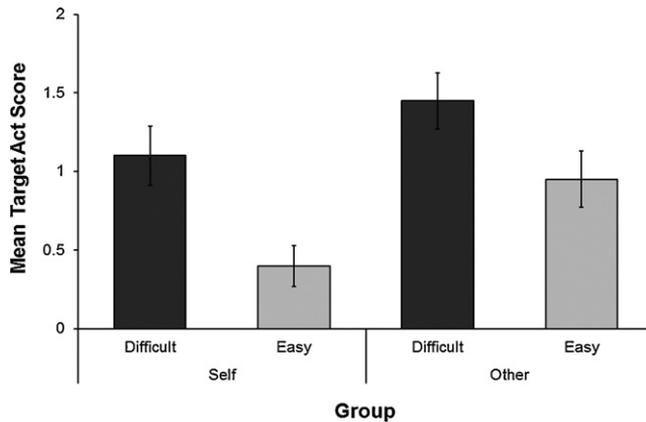


Fig. 2. Mean number of target acts produced (plus and minus standard error) when children had either a difficult or easy experience themselves or witnessed another person having a difficult or easy experience.

than children who themselves acted in the initial phase ($M = .75$, mean rank = 34.78); $U = 571.0$, $p = .02$, $r = .26$.

2.2.2. Effects by trial phase

Next, we consider the within-subject change in children's target act production during the test phase (Phase 3), compared to during the initial experience phase (Phase 1), when they had not yet seen the target demonstration. In the self-experience group, each participant acted as his or her own control, since children were able to manipulate the objects themselves before the test. A Wilcoxon signed-ranks test shows that children produced significantly more target acts in the test phase than in Phase 1, $z = 2.52$, $p = .01$, $r = .40$. If we further sub-divide the self-experience group (resulting in a smaller n for each subdivision), we find this difference also approached significance in each of the subgroups considered alone (easy, $z = 1.89$, $p = .06$, $r = .42$; difficult, $z = 1.83$, $p = .07$, $r = .41$).

We obtained similar findings using a between-subjects (independent group) comparison. Children in the other-experience group performed significantly more target acts in the test phase ($M = 1.20$, mean rank = 50.4) than did children in the self-experience group, who had not seen the target act demonstrated during Phase 1 ($M = .40$, mean rank = 30.6), Mann-Whitney $U = 404.0$, $p < .001$, $r = .46$. If we further sub-divide groups, the effects remain unchanged: This difference was significant for independent group comparisons of the other-easy group at test (versus self-easy Phase 1), $U = 91.0$, $p = .003$, $r = .53$; and the other-difficult group at test (versus self-difficult Phase 1), $U = 103.5$, $p = .008$, $r = .44$.

3. Discussion

We examined whether efficacy information obtained via first-person or third-person experience influences 36-month-olds' imitation of a new adult. We systematically varied whether the children themselves, or an adult they observed, had a difficult or easy experience completing the task. After the initial experience, children always observed a different adult use a distinctive means (sliding a switch or flipping a toggle) before easily achieving the goal. In cases in which the initial experience was difficult, children were significantly more likely to imitate the distinctive means used by the adult than when the experience was easy.

The experimental procedure isolates children's prior experience (whether first-hand or through observing the acts of others) as the critical factor. All groups saw the *same* demonstration during the second phase of the experiment: an adult drew the child's attention, produced the target act with a purposeful manner, and achieved the goal. We varied nothing but children's experience in the first phase of the experiment. Results showed that children were more likely to adopt and imitate

the distinctive means if they had, or if they witnessed another person having, difficulty reaching the goal, compared to when the initial experience was easy. Although hands-on experience may promote learning in some cases (Williamson et al., 2008), our results show that by 36 months, children are not limited to evaluating efficacy from their own experiences. They can also use observations of others' efficacy to guide their imitation of goal-directed causal acts.

There may, however, be some privilege to children's own hands-on experiences. Children in the self-experience groups overall (combining easy and difficult) were less likely to imitate the target acts than children in the other-experience groups (combining easy and difficult). The children's own motor experience with *successfully* completing the task, whether with ease or difficulty, may have led to reduced imitation of the model's behaviors, relative to the children who only observed another complete the task. Alternatively, high levels of imitation in the other-experience groups might be due to children interpreting the second actor's change in means from what the first actor did as a *correction*. The change might have indicated to them that the initial strategy was not efficient or socially/culturally desirable. An interesting follow-up would be to investigate whether children would be likely to imitate the second adult after seeing contrasting demonstrations, even if information about efficacy is not shown.

Consideration of others' prior efficacy can potentially improve young children's social learning (Boyd & Richerson, 1985; Laland, 2004; Williamson et al., 2008). Studies using different paradigms have produced results broadly compatible with our own. Preschoolers take others' accuracy or trustworthiness into account when acquiring new words (e.g., Birch, Vauthier, & Bloom, 2008; Jaswal & Neely, 2006; Koenig, Clément, & Harris, 2004). Young children modify their approach to a problem depending on whether the model they observe succeeds or fails (Nielsen, 2006; Want & Harris, 2001). Our research extends this work by suggesting that young children also track the *relative efficacy of another person's specific means*, even when two different means are shown to be successful – that is, they consider whether the actor had a difficult or easy time achieving a goal using a particular technique. Relative efficacy of the act influences children's tendency to adopt and imitate the adult's act. When the first adult was observed to have difficulty reaching an outcome, children showed an increased tendency to imitate a second actor's more effective technique, compared to when the first actor completed the task easily. Neither actors' behaviors were unsuccessful; relative efficacy alone was sufficient to influence children's imitation.

Our findings support the idea that young children's imitative learning can be regulated and selective and is not limited to blind, automatic, or compulsory copying. The children in this experiment chose to imitate when it was effective to do so. When they or another person had difficulty reaching a goal by straightforward means, children rapidly adopted a novel technique through imitation. In contrast, when the task was easy to complete without the adult's novel technique, children were less likely to adopt it. Information about a task gained through prior experience, whether hands-on or observational, may be one factor that helps children regulate their behavior (including over-imitation) as they choose who, what, and when to imitate. The children in this study weighed both their own and others' experiences when choosing to imitate.

Acknowledgements

We thank the participating families. We gratefully acknowledge funding from the National Institutes for Health (HD-22514) and the National Science Foundation (LIFE Center grant SBE-0354453) to ANM. The views expressed here are those of the authors and do not necessarily represent those of NIH or NSF.

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