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

Rebecca Williamson
Georgia State University, rawillia@gsu.edu

Andrew N. Meltzoff
University of Washington - Seattle Campus

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

Rebecca A. Williamson[a], Andrew N. Meltzoff[b]

[a] *Department of Psychology, Georgia State University, P.O. Box 5010, Atlanta, GA 30302 USA*
[b] *Institute of Learning and Brain Sciences, Portage Bay Building, University of Washington, Box 357988, Seattle, WA 98195 USA*

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ABSTRACT

Young children learn from others' examples, and do so selectively. Here we examine whether the efficacy of prior experience influences children's tendency to imitate. 36-month-olds received prior experience on a causal learning task. The children either performed the task themselves or watched an adult perform it. The nature of the experience was systematically manipulated such that the actor had either an easy or a difficult experience solving the task. Next, a second adult demonstrated an innovative technique for solving the task. Children who had a difficult first-person experience and those who had witnessed another person having a difficult time were significantly more likely to adopt and imitate the adult's innovation than those who had or witnessed an easy experience. Overall, children who observed another were even more likely to imitate than were those whose prior experience consisted of their own hands-on motor behavior, confirming that imitation is influenced by both own and others' prior experience.

Preschoolers are adept at imitative learning (e.g., 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 outcome produced by the acts, and the specific means used to attain those

outcomes (e.g., Carpenter & Call, 2002; Call & Carpenter, 2002; Want & Harris, 2002). The current research investigates factors that may regulate children's imitation of another's means. Two key factors are systematically manipulated. 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 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 the acts of others (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, often called "over-imitation" (e.g., 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; and in contrast, chimpanzees skipped the act when they could see that it was not causally necessary for obtaining 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, in press).

Even though children sometimes copy ineffective acts, a growing body of research indicates that their imitation is not rote, automatic, or compulsory but rather 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 are involved in producing outcomes than those that are not (Barr & Hayne, 1996; Bauer, 1992; Brugger, Lariviere, Mumme, & Bushnell, 2007; Hauf, Elsner, & Aschersleben, 2004) and children ages 12 months to 4 years are more likely to reproduce the outcomes (e.g., touching a particular spot), than the specific motor movements used to reach those outcomes (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 also imitate causal outcomes when these are brought about by a person versus seeing the same cause-effect relation occur "naturally" through object interplay with no human intervention (Bonawitz, et al., 2010). Although children have been shown to learn behaviors when no actor is shown, (e.g., Thompson & Russell, 2004; Tennie, Call, & Tomasello, 2006; Hopper, Lambeth,

Schapiro, & Whiten, 2008) the presence of an actor seems to be beneficial when children are learning and imitating complex acts (Hopper, Flynn, Wood, & Whiten, 2010; Meltzoff, 2007, experiment 3).

Young children will 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. For example, 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, the children 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 other's intended acts when an unseen goal must be inferred from a pattern of actions seems to emerge early in the second year of life (Bellagamba & Tomasello, 1999; Meltzoff, 2007, experiment 2; Nielsen, 2009). Children have also been shown to derive special benefit 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.

In order to more fully flesh out factors that regulate when and what children imitate, it is also important to consider the case in which two acts are *both effective* in reaching a goal but one is more efficient than another. Cues such as the *amount of effort* needed would indicate which is the more efficacious approach. Selectively choosing techniques that are shown to be relatively more effective is a powerful way to capitalize on social learning (Laland, 2004). There is some evidence that 2- to 3-year-olds will use such efficacy as a guide to choosing what and when to imitate (Harnick, 1978; Williamson, Meltzoff, & Markman, 2008). Williamson et al. (2008) gave 3-year-olds an initial experience completing a task, such as opening a drawer to retrieve a toy. For half of the children, the drawer was difficult to pull out and for the other half it was easy — though all children in both groups fully succeeded in accomplishing the task. Following this differential self-experience, all children then saw an adult demonstrate an innovate technique for solving the task. Results showed that those children with the difficult motor experience were significantly more likely to adopt the novel means shown by the adult.

The current study extends this finding by testing 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 (e.g., 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 infants' goal understanding, as measured by a

looking-time paradigm (Sommerville & Woodward, 2005). However, in addition to their own self-generated experiences, it is possible that young children may be able to use *others'* experiences with a task—information about efficacy picked up simply by observing others, not 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.

The current study explores how children make use of efficacy information provided by the acts of self and other. Specifically, we investigate whether witnessing another person having an easy or difficult experience – prior to and without engaging in the task oneself – influences the 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 in achieving the goal). The hypothesis is that children will subsequently be more likely to imitate the distinctive act demonstrated by an adult if prior experience indicates that the goal is difficult to achieve—whether that experience is gained through first-person (one's own acts) or third-person (observation of others' acts) channels.

1.1 Participants

The participants were 80 children (35-36 months old, M =35.9; 42 males), recruited by telephone through a University's child participant list. According to parental report, the racial composition of the sample 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, one on each of two trials. Both sets consisted of three containers, each with a small toy inside (see Figure 1). The two sets of were visually distinct and differed in size, shape, and color from each other. All of the containers within each set were identical. One set of stimuli consisted of three, blue plastic boxes (20 x 6 x 17 cm), each of which had a small black sliding switch (nonfunctional) in the upper corner of the top surface. The second set of stimuli consisted of three red, stacked drawers (21 x 16 x 17 cm), each of which had a (nonfunctional) toggle lever on the right side of each drawer. The first container in each stimulus 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 at a small table with the child in a quiet laboratory room in a university setting. The three boxes or drawers were placed in

front of the child on the table. The sessions were video-recorded for subsequent blind scoring. Each child received two trials, one with each stimulus set. Which stimuli were presented first (drawers or boxes) was counterbalanced between children.

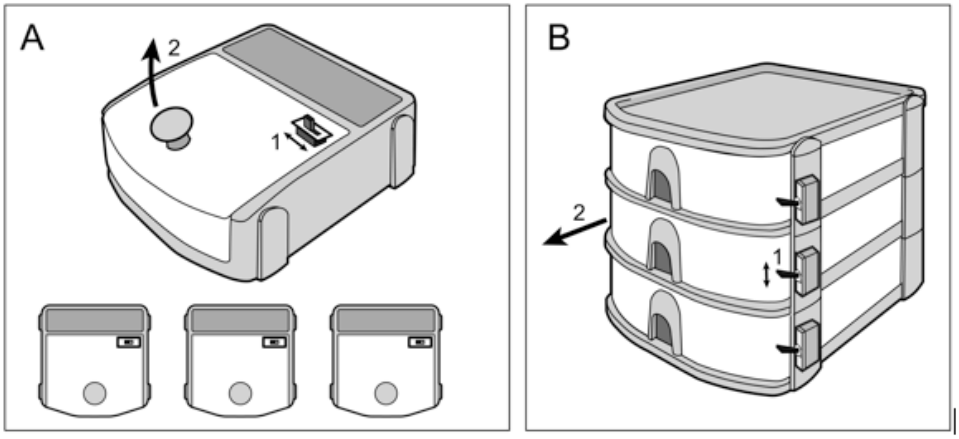

Figure 1. The box stimuli (A) and the drawer stimuli (B). For the box stimuli an aerial view is provided to show the three containers; for the drawer stimuli the three containers were vertically stacked, as shown. For the box stimuli, the act demonstrated by *E*1 was sliding the switch on the second box (shown in A) and opening the box easily. For the drawer stimuli, *E*1 flipped the second toggle (shown in B) and opened the corresponding drawer easily. For the boxes, the far left box was used for the initial experience (Phase 1), the middle box for the demonstration (Phase 2), and the box on the right for test 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.

We crossed two independent factors – person (self / other) and experience (easy / difficult). Participants were randomly assigned to one of four independent groups. These groups varied in their experience on the first container before they saw the adult's innovative solution: Self-easy, self-difficult, other-easy, and other-difficult.

1.3.1 Initial experience: Phase 1. 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 were had added resistance so that they were difficult to open, while in the easy groups the box lid (or drawer) moved freely and was therefore easy to open.

In the self-experience groups, *E*1 directed the children to open the first container. In the other-experience groups, *E*1 told the children that *E*2 would open the first drawer or box, and *E2* did not act until the children were watching. *E*2's behavior was carefully scripted to illustrate either an easy or difficult experience. When having an easy experience, *E*2 simply opened the box or drawer and gave the toy that was inside to the child to play with. When having a difficult experience, *E*2 pulled at the container, paused when it met with resistance and would not open, commented on the difficulty and then yanked harder so as to pull the container open. In all cases in all groups, when the first container was successfully opened to reveal the toy, *E*2 labeled 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 moving on to the next phase. Phase 1 provided the initial experience, or back drop, for the novel act demonstration, which came in Phase 2.

1.3.2 Demonstration: Phase 2. The demonstration was held constant across all groups. After children were given the prior experience (see four groups described above), all children observed the same demonstration. For the demonstration period, *E*1 drew the children's attention ("It's my turn now, watch") and acted only when the child was watching. *E*1 produced a distinctive means (the target act) before easily opening the second container in the set of three. More specifically, for the box stimuli, she slid a switch on the top surface of the box and then easily opened it; and for the drawer, she flipped a toggle lever that was located on the side of the drawer and then easily pulled open the drawer.

1.3.3 Test: Phase 3. The test phase was the same for all groups. *E*1 told the child it was "your turn now" and asked the children to open the third container. The experimental question was whether children imitated the specific novel act that had been shown to them in the demonstration period (slid the switch or toggled the lever). The response period was defined as from the time the adult closed the second drawer or box until the child opened the third. No specific time limit was used, and all children achieved this end of opening the third drawer. After the 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 when the child was bored or unresponsive, *E*1 returned the toy.)

1.4 Scoring and Dependent Measures

Research assistants, blind to experimental group, scored the children's production of the distinctive means demonstrated by *E*1— 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. Children were credited with a "yes" if they were 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 those 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 the children were given hands-on experience in this group prior to seeing the adult demonstration. A second scorer, also kept blind to the children's 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 collapsed across these factors for subsequent analyses.

2.1 Manipulation Check: Initial Self-Experience

We first analyzed the behavior of the children in the self-experience group during their initial, Phase-1 experience. As expected, the children in the difficult group were more likely to struggle to complete the opening, confirming that our experimental manipulation was working: Even though *all* children achieved the outcome of retrieving the toy from the first box (or drawer), children in the difficult group took *longer* on average to complete the openings, as expected, because the container was jammed (difficult M = 10.51s, SD = 4.97, easy M = 1.50s, SD = 1.00) $t(38) = 7.95$, $p < .0001$, $d = 2.58$.

During this baseline initial 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 as a function of experimental group. As predicted, children who were randomly assigned to the difficult groups (whether self or other) produced significantly more target acts during test (M = 1.28, mean rank = 48.13) than were children who were randomly assigned to the easy experience group (M = .68, mean rank = 32.88), Mann-Whitney U = 495.0, p = .002, r = .35). These results indicate that the children's ultimate imitation of the adult's demonstration was influenced by the type of experience they or another person initially had with the task.

A more detailed examination of these overall results (see Figure 2) shows that children in the self-difficult group (M = 1.10, mean rank = 25.05) were significantly more likely to produce the target acts than were children in the self-easy group (M = .40, mean rank = 15.95), U = 109.0, p = .01, r = .42. Consistent with this, children in the other-difficult group (M = 1.45, mean rank = 23.83) were more likely to produce the target acts than were children in the other-easy group, though this difference was not statistically significant (M = .95, mean rank = 17.18), U = 133.5, p = .07, r = .31 (this and other tests are reported as 2-tailed values).

Overall, there was also a difference in target act production during the test phase depending on the person who produced the motor experience (self or other) in the initial phase of the experiment. Regardless of ease or difficulty, those 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) than were children who had the initial experience with the task themselves (M = .75, mean rank = 34.78); U = 571.0, p = .02, r = .26.

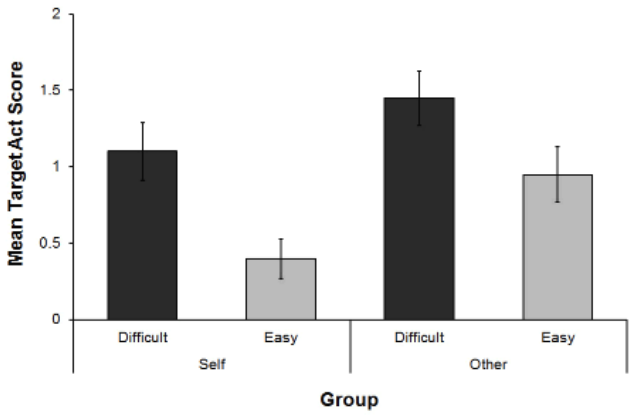

Figure 2. Mean number of target acts produced (plus and minus standard error) when the children either had a difficult or easy experience themselves or witnessed another person have a difficult or easy experience.

2.2.2 ***Effects as a function of trial phase.*** Next, we consider the within-subject change in children's target act production during the test phase (Phase 3; see Methods) as compared to during their initial experience phase (Phase 1) before children had seen the target demonstration. In the self-experience group, each child can be used as his or her own control, since children at first had a chance 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 before they had seen the target-act demonstration, z = 2.52, p = .01, r = .40. If we further sub-divide this self-experience group (resulting in a smaller n for each subdivision), we find that this difference also approached significance in both of the subgroups taken alone (easy: z = 1.89, p = .06, r = .42 and difficult: z = 1.83, p = .07, r = .41).

Using a between-subjects(independent group) comparison, there is also converging evidence of the same point. Children in the other-experience group also showed significantly more target acts in the test phase (M = 1.20, mean rank = 50.4) than did the independent group of children in the self-experience group during Phase 1 who had not seen the target act demonstrated (M = .40, mean rank = 30.6), Mann-Whitney U = 404.0, p < .001, r = .46. If we further sub-divide this more finely, 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. General Discussion

We tested whether prior experience obtained via both first-person and third-person channels 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. Following this, the children always saw a different adult use a distinctive means (sliding a switch or flipping a toggle) before easily achieving the goal. In those cases where the initial experience was *difficult*, the 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 observation of the acts of others) as the critical factor: Children in all groups saw the *same* demonstration during the second phase of the experiment – an adult drew the children's attention, produced the target act with a purposeful manner, and achieved the goal. Only the experience in the first phase of the experiment varied. The results showed that children were more likely to adopt and imitate the adult's means if they either *had themselves*, or *witnessed* another having, a difficult time reaching the goal compared to if the initial experience was easy. Although hands-on experience may promote learning in some cases (e.g., Williamson et al., 2008), the current results show that by 36 months of age children are not limited to evaluating efficacy from their own experiences. They are also able to use *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 were children in the other-experience groups (combining easy and difficult). The children's own motor experience with *successfully* completing the task, whether easily or with difficulty, may have led to reduced imitation of the model's behaviors, relative to the children who only observed another complete the task. Alternatively, the high levels of imitation in the other-experience groups might be due to children interpreting the second actor's switch in means from what the first actor did as a *correction*. The change might indicate that the initial strategy is not efficient or socially/culturally desirable. An interesting follow-up to this research would be to investigate whether children would be likely to imitate the second adult after seeing contrasting demonstrations even if information about efficacy was not shown.

Young children's consideration of prior efficacy has the potential to improve their social learning (Boyd & Richerson, 1985; Laland, 2004; Williamson et al., 2008). Other studies using different paradigms have produced results that are broadly compatible with

the current ones. Research shows that preschoolers take others' accuracy or trustworthiness into account when acquiring new words (e.g., Birch, Vauthier, & Bloom, 2008; Koenig, Clément, & Harris, 2004; Jaswal & Neely, 2006). Young children also modify their approach to a problem depending on whether the model they see succeeds or fails in achieving the outcome (Want & Harris, 2001; see also, Nielsen, 2006). The current experiments extend this 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 – i.e., whether they had a difficult or easy time achieving a goal using a particular technique. This relative efficacy of the act influences their tendency to adopt and imitate the adult's act. When the first adult was seen to have a difficult experience reaching an outcome, children had an increased tendency to imitate a second actor's more efficacious technique relative to when the first actor completed the task easily. Neither actors' behaviors were unsuccessful; others' relative efficacy alone was sufficient to influence children's imitation.

The current findings fit with 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 efficacious to do so: When they themselves, or another person, had difficulty using a straightforward option, children rapidly picked up the novel technique and imitated it. In contrast, when the task was easy to complete without the adult's novel means, children were less likely to adopt them. Information about a task gained through prior experiences —whether hands-on or simply observational experience—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 experiment treated prior "experience" rather abstractly and weighed both their own and others' experiences when choosing to imitate.

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