Infants make more attempts to achieve a goal when they see adults persist

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Title: Infants make more attempts to achieve a goal when they see adults persist.

Authors: Julia A. Leonard[1*], Yuna Lee[1], Laura E. Schulz[1]

Affiliations:
[1] Department of Brain and Cognitive Sciences. Massachusetts Institute of Technology. 77 Massachusetts Avenue, Cambridge, MA 02139, USA

*Correspondence to: jlnrd@mit.edu

Abstract:

Persistence, above and beyond IQ, predicts long-term academic outcomes. To look at the effect of adult models on infants' persistence, 15-month-olds were assigned to an Effort condition in which they saw an adult try repeatedly, using various methods, to achieve each of two different goals; a No Effort condition in which the adult achieved the goals effortlessly, or a Baseline condition. Infants were then given a difficult, novel task. Across an initial study and two pre-registered experiments (N = 262), infants in the Effort condition made more attempts to achieve the goal than infants in the other conditions. Pedagogical cues modulated the effect. The results suggest that adult models causally affect infants' persistence and that infants can generalize the value of persistence to novel tasks.

One Sentence Summary: Infants who see adults work hard to succeed persist longer at their own tasks than they do at baseline or after seeing adults succeed effortlessly.

Main Text:

Many cultures emphasize the value of effort and perseverance. This emphasis is substantiated by scientific research; individual differences in conscientiousness, self-control, and grit correlate with academic outcomes independent of IQ (*1-3*). Even the way children think about the relationship between hard work and achievement affects school outcomes: experimental interventions suggest that children who believe effort determines achievement out-perform those who believe ability is a fixed trait (*4*). Although most research on persistence has focused on school-age children (e.g., *5, 6*), studies suggest that persistence in infancy and early childhood statistically predicts longer-term cognitive outcomes (*7-9*), arguably mediated by a suite of temperamental and cognitive factors involved in executive function and "effortful control" (see *10, 11* for reviews). In addition to such intrinsic factors, observational studies suggest that early task persistence may be affected by adult behaviors including developmentally appropriate support for children's autonomy, caregiver responsiveness, and praise for children's effort rather than ability (*12-14*).

However, previous studies leave open the question of whether there is a causal relationship between adult behavior and infants' persistence. Additionally, they leave open the question of whether infants' persistence might be affected not just by adults' responses to *infants*, but by adults' responses to *challenges*. Here we ask whether infants might be sensitive to evidence that hard work pays off. Does seeing an adult exert effort to succeed encourage infants to persist longer at their own challenging tasks?

Both empirical and theoretical work suggests that young human learners can draw rich, abstract generalizations from sparse data (see *15* for discussion). A few examples suffice for infants to infer novel words (*16*), causal relationships (*17-19*), and social roles (*20, 21*). Especially in pedagogical contexts, where adults make eye contact, say the child's name, use child-directed speech, and perform intentional actions, infants draw broad, generalizable inferences from adult models (*22, 23*). However, in such studies, infant behavior is simply a dependent measure used to assess infants' learning of novel concepts, and there are few behavioral costs associated with learning new information. Here by contrast, we ask whether infants can draw an abstract inference about how to behave, and in particular, whether they can learn the value of engaging in costly, effortful actions.

We tested the hypothesis that infants who saw even a couple examples of an adult working hard to achieve her goals would persist longer on a novel task than those who saw an adult succeed effortlessly. For the adult model, we chose goals that might be comprehensible to infants: opening a container and detaching a clasp from a key chain. Intuitively, "working hard" at these tasks may involve a number of different behaviors (e.g., repeating actions, trying different actions, speculating on the appropriate actions, etc.; see movie S1). This limited our ability to specify which aspects of the modeled behavior might be important to the infants but allowed us to assess infants' response to behaviors roughly comparable to those they might see outside the laboratory. By contrast, the infant task – activating a toy -- was chosen for ease and reliability of coding; here task persistence was operationalized simply as the number of button presses. The design thus provided a strong test of infants' ability to infer the value of effort: infants had to generalize from the diversity of observed adult behaviors to the effort appropriate for their own goal. In line with other work on infants and adult models of rational action (e.g., *24*), we tested 13-18-month-olds (mean: 15.37 months). Infants were randomly assigned to an Effort, No Effort, or Baseline condition (n=34/condition). To ensure the robustness of the results, we subsequently ran a pre-registered replication of the Effort/No Effort contrast (available on the Open Science Framework at osf.io/g3aws post-publication, n=40/condition). See SM for the pre-registered replication and details of the methods and analyses throughout.

In Experiment 1, the experimenter made eye contact with the infant, greeted the infant by name, and used child-directed speech throughout. In the Effort condition the experimenter picked up a container with a toy inside, announced her intention ("Look, there's something inside of there! I want to get it out!"), then worked to open the container, narrating her attempts as she proceeded ("Hmm … I wonder how I can get my toy out of here? Does this work? No, how about this …"). She successfully opened the container only at the end of a 30-second interval. The experimenter then put aside the container and demonstrated a carabiner with a toy keychain attached. She announced her intention ("How do I get this off?") and again worked at the task, narrating her efforts and only succeeding at the end of the 30-second interval. The No Effort condition was identical except that the experimenter successfully accomplished each goal within 10 seconds and repeated the task twice more, for a total of three demonstrations over each 30-second interval. In the Baseline condition, the adult did not model any behavior and the infant proceeded directly to the test trial. (See Figure 1.)

In the test trial, the experimenter introduced the infant to a music box with a button. The button was easy for infants to press, but inert. The experimenter said, "Now it's your turn to play with a toy. See this toy! This toy makes music!" The experimenter placed the toy out of the infant's sight and activated the music toy using a hidden button designed to be difficult for infants to find or activate. The experimenter then handed the toy to the infant and left the room. The test trial was terminated after two minutes or after the baby handed the toy to her parent and/or threw the toy down a total of three times (called a "handoff" throughout). All trials were videotaped.

We looked both at how many times infants pressed the button overall before the termination of the experiment and, as a potentially more nuanced measure, the number of times the infants pressed the button before the first handoff. (See Figure 2 and Tables 1 and 2 for results and analyses.) Both the total number of times infants pressed the button and the number of times they pressed the button before first handoff differed by condition (Total button presses: $F(2, 99) = 5.10$, $p = .008$, $\eta^2 = .10$; Presses before first handoff: $F(2, 99) = 4.88$, $p = .01$, $\eta^2 = .09$). Planned follow-up analyses revealed that, as predicted, children in the Effort condition pressed the button more times than children in the No Effort condition and children at Baseline; there was no significant difference in total button presses between the No Effort condition and the Baseline condition. The same pattern of results held looking only at the number of button presses before the first hand-off. All results were obtained through linear models but remained the same when tested with non-parametric Wilcoxon rank-sum test (Total button presses: Effort vs. Baseline, $W = 793$, $p = .008$; r = -.32; Effort vs. No Effort, $W = 763$, $p = .02$; r = -.27; No Effort vs. Baseline, $W = 593$, $p = .86$; r = -.02. Presses before first handoff: Effort vs. Baseline, $W = 367.5$, $p = .01$; r = -.31; Effort vs. No Effort, $W = 390.5$, $p = .02$; r = -.28; No Effort vs. Baseline, $W = 582.5$, $p = .96$; r = -.01). Post-hoc analyses suggest that these results were specific to infants' persistence in trying to activate the toy; there were no differences in overall playtime between conditions ($F(2,99) = 2.47$, $p = .09$, $\eta^2 = .05$) or tendency to hand-off or discard the toy between conditions ($X^2(6, N=102) = 4.55$, $p = .60$).

In the pre-registered replication of the contrast between the Effort and No Effort conditions, again, infants in the Effort condition pushed the button both more times overall and more times before the first hand-off than infants in the No Effort condition. (Total button presses: $W = 1043.5$, $p = .02$, $r = -.26$; Button presses before first handoff: $W = 1026.5$, $p = .03$, $r = -.24$). Analyses again revealed that the results were specific to infant persistence in activating the toy; there were no differences in overall playtime by condition ($t(78) = 1.66$, $p = .10$, $d = .37$) or in tendency to discard or hand off the toy between conditions ($X^2(3, N=80) = 3.96$, $p = .27$). Removing outliers (values 1.5 interquartile range above the 3rd quartile) had no effect on the results in either Experiment 1 or the replication. (See SM.) These results suggest that two examples suffice for infants to generalize the value of effort to a new task.

As noted, infants are especially likely to draw rich, abstract inferences in pedagogical contexts (*22-23).* However, times when adults are struggling to achieve their goals may be times when they are especially *unlikely* to engage infants pedagogically. To look at whether pedagogical cues are critical to infants' inferences or whether infants can infer the value of effort merely from observing an adult struggling to achieve goals, we eliminated ostensive cues in Experiment 2 (pre-registered here: https://osf.io/xjz8e/registrations/): the experimenter did not make eye contact, use infant-directed speech, or use the infant's name during the Effort and No Effort demonstrations. Consistent with previous research (*25, 26*), the results suggest that pedagogical cues modulate learning. The primary result replicated: infants in the Effort condition pressed the button more times overall than infants in the No Effort condition (see Table S1). However, the effect was weak: In contrast to the previous studies, (i) the main result was not robust to removing outliers (β = .72, t(75) = 1.86, p = .07, 95% CI [-0.04, 1.47]; W = 561, p = .07, r = -.21), (ii) bootstrapped 95% confidence intervals on medians in the Effort and No Effort conditions largely overlapped, and (iii) there was no effect of condition on the number of button presses before first hand-off . Additionally, although the tendency to hand off the toy did not differ between conditions (X^2(3, N=80) = 5.17, p = .16), there was a difference in overall playtime between conditions, with children in the Effort condition playing for longer than children in the No Effort condition (t(78)=2.80, p=.007, d = .63). These results suggest that the absence of ostensive cues made the effect both weaker and less specific. Note also that in order to match the modeled behavior in the pedagogical conditions of Experiment 1, the experimenter talked and gestured (to herself) in the non-pedagogical conditions in Experiment 2. Entirely eliminating all communicative information might have further attenuated the effect.

Overall however, these studies suggest that seeing just two examples of an adult working hard to achieve her goals can lead infants to work harder at a novel task relative to infants who see an adult succeed effortlessly. Critically, the adult examples affected infants' persistence even though the adult had different goals and performed different actions than the infants. These results are in line with a growing body of work suggesting that infants and toddlers are sensitive to the effort that agents use in performing goal-directed actions (*27, 28*); they go beyond such work in suggesting that infants can also learn to try harder themselves.

Of course, repeatedly attempting to achieve a goal is only a good idea when it is reasonable to assume that persistence will pay off. A number of features of this design made that assumption plausible here: the toy was designed to look like a developmentally appropriate infant toy, infants had heard the toy activate, they were given the toy by a friendly, presumably helpful adult, and, as noted, they had previously seen the adult successfully achieve her own goals. Absent any of these factors, adult persistence might be less likely to increase infants' persistence; however, precisely such factors might help infants distinguish between (valuable) persistence and (pointless) perseveration. Future work might look at how demonstrations of the effort involved in goal achievement affect infants' persistence, not just immediately and within a single setting, but across contexts, over time, and with respect to children's explicit attitudes towards challenges (e.g., *6*)

The precise nature and scope of infants' inferences remains a question for future research. Infants might have learned something about the value of effort generally or they might have made relatively specific assumptions about the value of effort in this context. For instance, infants in the Effort condition might have inferred that the toy was hard to operate and thus required persistence whereas infants in the No Effort condition may have inferred that the toy should work easily; when it did not, they may have assumed the toy was broken rather than that more effort was required (see e.g. *17*). Additionally, we looked only at cases where the adult model succeeded at the task. (Pilot work suggested that it was difficult to sustain infants' attention to both demonstrations when the adult failed.) If an adult fails to achieve a goal after trying only slightly, infants might infer that the goal may be achievable with more effort. If so, the current results might reverse: infants might persist more when they see an adult fail after trying a little than a lot. Alternatively, if an adult fails to achieve a goal, infants might conclude that the task is beyond their abilities, regardless of adult effort. Future work might investigate these predictions.

The tasks used in this study were designed to be readily comprehensible to infants. Whether infants would be sensitive to adult persistence in contexts where the adult's goals and goal-directed actions were more opaque to the child remains an empirical question. The infant task also appeared deceptively simple: the only salient feature of the box was a large, easy to press button. This design was useful in constraining infants' actions and operationalizing persistence; however, it leaves open the question of how infants' persistence might be affected in less constrained contexts.

The generalizability of the results may be limited insofar as the infants in the current study were recruited from a relatively privileged sample of parents at an urban children's museum. Some work suggests that inferences relevant to the current work may hold broadly (e.g., assumptions about pedagogical sampling hold even in traditional Mayan communities where formal instruction is rare; *29*). However, different prior beliefs about the competence and trustworthiness of adults (see e.g., *30*) or the reliability of expected rewards (e.g., *31*) may support different inferences about both the utility of learning from adult models and the utility of persistence itself. Future research might investigate the degree to which observations of adult effort increase infants' persistence in a broader range of cultural and socio-economic environments.

Cultural factors may also affect the extent to which children have opportunities to see adults working hard to achieve their goals. In some communities, children learn predominantly by observing and participating in the challenging tasks of adult life (*32*). By contrast, in modern, industrialized cultures, children learn primarily by being instructed in knowledge and skills that adults have already mastered; in such contexts, children may assume that most things come easily to adults. In investigating infants' ability to learn persistence from adult models, we do not mean to suggest that observing adult models is the only or best way for children to learn the value of persistence; its value may also be communicated by explicit messages about the importance of hard work or simply observing that adults fulfill their responsibilities. Nonetheless, the current study suggests the potential value in letting children "see you sweat": showing children that hard work works might encourage them to work hard too.

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Fig. 1. Schematic of study design. Infants were assigned to one of three conditions: Effort, No Effort or Baseline. In the Effort condition, the experimenter struggled for 30 seconds before achieving each of two goals. In the No Effort condition, the experimenter achieved her goals effortlessly three times over 30 seconds. In the Baseline condition, there was no experimenter demonstration. The experimenter then introduced the infant to a novel toy, activated the toy out of the infant's sight so that it played a 5 second tune, gave the infant the toy, and left the room for two minutes. The dependent variables were the number of times infants pressed the large (inert) button on the music toy in total and before the first handoff.

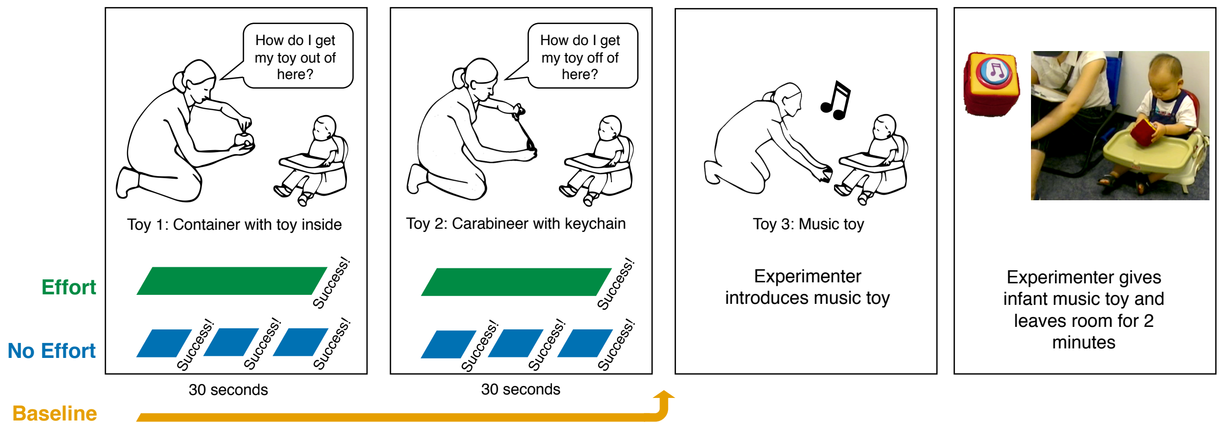

Fig. 2. **Results from Experiment 1, the Replication, and Experiment 2**. The top and the bottom of the box correspond to the first and third quartiles (the 25th and 75th percentiles). The upper whisker (vertical black line) extends from the third quartile to the largest value no further than 1.5 interquartile ranges from the third quartile; the lower whisker extends from the 25th percentile down to the smallest value at most 1.5 interquartile ranges from the first quartile (i.e., the largest and smallest values that are not outliers). The dark dots are values more than 1.5 times the interquartile range above the third quartile (outliers). See text for statistical analyses.

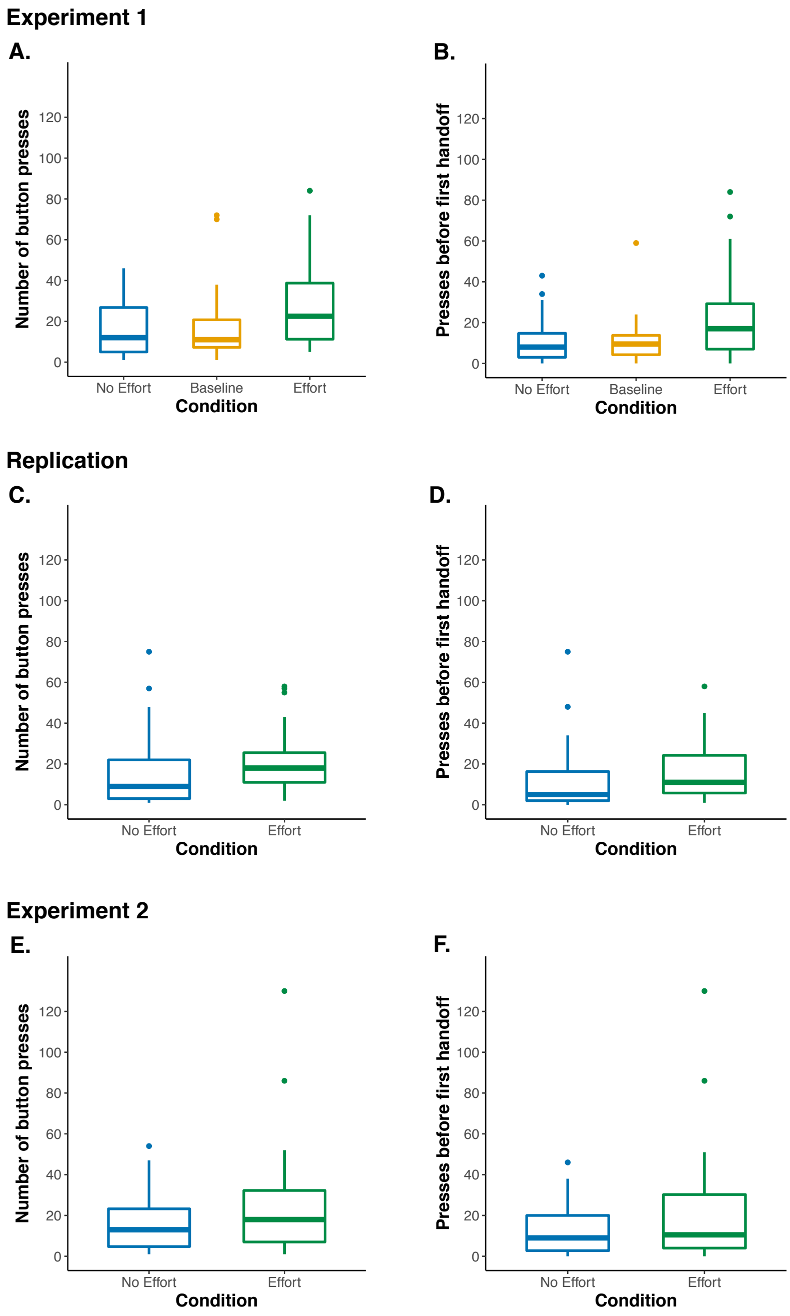

Table 1. Linear models for each condition contrast in Experiment 1, the Replication, and Experiment 2. The 95% confidence intervals are from a bootstrap of the beta coefficients with 10,000 samples for the total button presses and the number of button presses before the first handoff in each condition. For all models, the data were transformed to the 0.5 power to better adhere to a normal distribution.

	Experiment 1	R^2	***B***	***t***	***df***	***p***	**95% CI**
Effort vs. Baseline	Total button presses	.10	1.20	2.73	66	.008	0.35, 2.10
	Presses before first handoff	.10	1.16	2.66	66	.01	0.31, 1.99
Effort vs. No Effort	Total button presses	.10	1.24	2.71	66	.008	0.36, 2.11
	Presses before first handoff	.09	1.14	2.48	66	.02	0.24, 2.03
No Effort vs. Baseline	Total button presses	.00	0.03	0.08	66	.94	-0.81, 0.85
	Button presses before handoff	.00	-0.02	-0.04	66	.97	-0.76, 0.71
	Replication						
Effort vs. No Effort	Total button presses	.05	0.82	2.08	78	.04	0.85, 2.44
	Button presses before handoff	.04	0.79	1.91	78	.06	0.75, 2.44
	Experiment 2						
Effort vs. No Effort	Total button presses	.05	0.93	2.11	78	.04	0.05, 1.77
	Button presses before handoff	.02	0.66	1.40	78	.17	-0.28, 1.58

Table 2. Medians and 95% confidence intervals from a bootstrap with 10,000 samples for the two main outcome measures for each condition in Experiment 1, the Replication and Experiment 2.

		Total button presses		**Presses before first handoff**	
		Median	**95% CI**	**Median**	**95% CI**
Exp.	No Effort	12	-2, 17.0	8	3, 12
	Baseline	11	4, 13	9.5	8, 13
	Effort	22.5	15, 29	17	11, 24
Rep.	No Effort	9	0, 13	5	0, 7
	Effort	18	12.5, 23	11	5, 14
Exp. 2	No Effort	13	8, 19.5	9	2, 13
	Effort	18	5, 25.5	10.5	1.5, 15