Preschoolers consider expected task difficulty to decide what to do & whom to help

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Abstract
The ability to reason about task difficulty is critical for many real-world decisions. Building on our prior work on preschoolers’ inferences about the difficulty of novel physical tasks (Gweon et al., 2016), here we asked whether this ability further supports rational allocation of effort in collaborative and individual contexts. When an agent could offer help to someone who had to complete a high-cost task versus someone who had to complete a low-cost task, adults and preschoolers offered help with the high-cost task (Exp. 1a & 2a). When an agent could choose to complete a high-cost task or a low-cost task given an identical reward, adults and preschoolers preferentially chose the low-cost task (Exp. 1b & 2b). In the absence of explicit information about the relative difficulty of tasks, even young children inferred the expected difficulty of tasks and rationally decided how to allocate one’s effort: they chose the harder task when deciding whom to help, but chose the easier task when deciding to maximize an individual’s utility.

Keywords: Social cognition; cooperation; difficulty; physical reasoning, Naive Utility Calculus

Introduction
Imagine you have two friends assembling IKEA furniture. One friend is making a simple table while the other is working on a complicated 6-drawer dresser. If both friends need to complete these tasks but you can help just one of them, who would you rather help? Although you’d be a good friend in both cases, you might be more inclined to help the one who is working on the drawer. As adults, we understand that some prosocial acts are more desirable than others; all else being equal, it is better to alleviate the work of someone who has a harder task to complete. This intuition underlies not only our everyday decisions but also our collective beliefs about promoting fairness and social justice by allocating labor equally across individuals (Brown, 1986; Rawls, 2009). Where does this intuition come from, and how does it develop?

Effective planning involves allocating one’s time, effort, and resources to successfully and efficiently achieve a goal. Humans, even early in life, expect other agents to act in ways that maximize their utility (see Jara-Ettinger, Gweon, Schulz, & Tenenbaum, 2016 for a review). Preverbal infants expect agents to minimize the cost of their actions (Liu & Spelke, 2016; Gergely & Csibra, 2003) and older children explicitly reason about the cost and rewards of actions in light of agents’ subjective preferences and competence (Jara-Ettinger, Gweon, Tenenbaum, & Schulz, 2015). However, as in the IKEA example above, effective planning in social contexts involves more than minimizing one’s costs or choosing the easiest task. In order to help others effectively in a collaborative context, a helper must consider how to maximize the utility of the group rather than herself.

Prior work suggests that humans have a strong, early-emerging tendency to help others (Warneken & Tomasello, 2007; Barragan & Dweck, 2014). A recent study suggests that 5- to 7-year-old children teach information that maximizes learners’ utilities by demonstrating a toy that is more rewarding to activate and more difficult for a naive learner to discover on her own (Bridgers, Jara-Ettinger, & Gweon, 2016). Thus, one might expect that children’s decisions about whom to help might also be informed by the drive to maximize others’ utility. However, while teaching or informing can eliminate the cost of exploration or discovery without much impact on the teacher’s costs, offering to cooperate on a physical task doesn’t reduce the overall cost; it simply redistributes the cost across the helper and the helpee. Thus, by deciding to help the agent with the harder task, the helper is willingly sacrificing her own utility for the sake of increasing others’ utility.

Yet, the decision to help with the higher-cost task effectively maximizes the collective utility of the group; it allocates the amount of work for each person in a more equitable way, and the completion of both tasks would be more efficient as a result. Prior work suggests that even infants expect resources to be distributed fairly across agents (Sommerville, Schmidt, Yun, & Burns, 2012; Enright, Gweon, & Sommerville, 2017), and older children even choose to discard resources to avoid distributional unfairness (Shaw & Olson, 2012). However, unlike goods or resources, the amount of work or effort required for a task is unobservable and must be inferred from reasoning about the process of completing a goal. Therefore, appreciating fair allocation of labor may be more challenging than evaluating the fairness of resource allocation.

Although prior work has found that the ability to understand difficulty and ability develops late in childhood (Nicholls & Miller, 1983), more recent studies suggest that younger children can differentiate competence and effort (Jara-Ettinger et al., 2015) and infer the expected difficulty of completing tasks (Gweon, Asaba, & Bennett-Pierre, 2017). In particular, children as young as age 4 can reliably estimate the relative difficulty of simple block-building tasks without the first-hand experience of building them, even when the block structures are matched on superficial cues such as height, shape, or size (Gweon et al., 2017). These results suggest that children can reason about the unobservable process of completing simple engineering tasks, and understand how different dimensions of the tasks influence the relative effort required to complete them.

However, a open question is whether children can incorpo-
rate their inferences about task difficulty into their decisions about how to allocate group effort. Indeed, a recent study suggests that even preschoolers assign easy or hard tasks between themselves and a partner depending on the partner’s age and the social context (Magid, DePascale, & Schulz, 2017). However, while children in this study had direct experience with the task and a clear understanding of which one was harder or easier, real-world decisions about whom to help or how to collaborate must often be made in the absence of first-hand experience.

In this study, we build on these prior studies to ask whether adults and preschool-aged children can reason about task difficulty and use it to make effective decisions about which task to complete (i.e., whom to help) in a collaborative context (Exp. 1a & 2a) and which task to complete in an individual context (Exp. 1b & 2b). To this end, we harnessed similar stimuli used in a previous experiment (e.g., block structures with relative difficulty determined by number of blocks used, see Gweon et al., 2017), and created a “harder” task (i.e., building large block structure) and an “easier” task (i.e., building a small block structure). Critically, participants did not have a priori experience with the actual building task; they saw photos (adults) or real-size models (children) of the building task and had to reason about their expected difficulty to make a decision.

Experiment 1

In Experiment 1, we probed adults’ reasoning about whom to help in a collaborative context (Exp. 1a) and which task to complete in an individual context (Exp. 1b). Both experiments featured the same hard/easy tasks, but we expected that participants would choose the harder task in a collaborative context and the easier task in an individual context.

Experiment 1a: Collaborative Decision

Methods

Participants Ninety-five adults (for half of the sample: 20 female, M age(SD): 36.65(10.99)), Range: 22 - 68) were recruited from Amazon Mechanical Turk (AMT).

Materials Two images of block structures (each showing a different structure) and three images of a puppet were used (showing identical puppets but associated with different names). One block structure was a 15-block pyramid and the other was a 6-block pyramid (see Fig.1).

Procedure Stimuli were presented with Qualtrics survey software. First, participants viewed photos of two puppets (Stacy and Jill), each of whom had to build the tower in front of them. One puppet had the 15-block pyramid in front of her, and the other puppet had the 6-block tower in front of her. Participants were then introduced to the third puppet, Tilly, who could only help one of her friends, and were asked which friend she should help. Finally, as an attention check, participants were shown pictures of the two block structures and were asked to choose which one was harder to make. Participants were also asked to explain each of their choices. Puppet names associated with the tasks and the side of presentation for easy/hard tasks (L/R) were all counterbalanced.

Experiment 1a Results Nearly all adults were able to identify which block structure was harder to build (n=88, 92.6%; p < .001, binomial); those who failed to answer this question accurately were excluded from subsequent analyses. For the critical question, participants showed a clear preference for the agent who had to complete the 15-block structure (85.2%; p < .001, binomial).

We also coded participants’ explanations for their critical question using four categories: 1) the size of the structure or number of blocks in the structure, 2) the difficulty of the structure, 3) helping or cooperating with another agent and 4) the relative speed of completing a structure. Explanations could fall into multiple categories. All but ten of the adult participants gave relevant explanations for their critical question responses and explicitly referring to the size of or number of blocks in the structures (n = 56, 57.1%), the difficulty of the structures (n = 25, 25.5%), helping or cooperation (n=13, 13.3%) and the speed of goal completion (n = 4, 4.1%). Twenty participants referenced two or more of these categories.

Experiment 1b: Individual Decision

Methods

Participants Ninety-seven adults (for half of the sample: 21 female, M age(SD): 36.55(10.68)), Range: 19 - 62) were recruited from Amazon Mechanical Turk (AMT).

Materials The same two images of block structures shown in Experiment 1a, as well as an image of Cookie Monster, a cookie and two black squares identified as doors were used.

Procedure Participants viewed the experiment on AMT. Participants were introduced to Cookie Monster, and learned that he was very hungry and wanted to eat the cookie blocked by the two doors in front of him. Next, they learned that Cookie Monster had to open only one of these doors to get to his cookie, and that it did not matter which door he opened. They were told that Cookie Monster wanted to get to his cookie as fast as he could, and were asked to choose which tower he should complete to do so. Finally, participants were shown pictures of just the two structures and were asked which one was harder to make and why.

Experiment 1b Results Almost all adults were able to identify which block structure was harder to build (98%; p < .001, binomial); those who answered incorrectly were excluded from analyses. For the critical question, participants overwhelmingly chose the 6-block tower (93.7%; binomial, p < .001, binomial).

We again coded participants’ critical question explanations using the same coding scheme as in Exp.1a. However, because cooperation was irrelevant to the task, people’s explanation fell within one of three categories: 1) the size of the
Figure 1: Materials and Procedure for Experiments 1 & 2; Responses to critical question for Experiments 1 & 2.

structure or number of blocks in a structure, 2) the difficulty of building the structure, 3) the speed or amount of time necessary to complete the structure (explanations could fall into multiple categories). All but seven participants gave relevant explanations for their choice on the critical question, and 33 participants gave explanations that drew on two or more of the dimensions we coded. Participants cited the size of or number of blocks in the structures (n = 59, 48.8%), the difficulty of the structures (n = 18, 36.4%), and the speed of goal completion (n = 44, 36.4%).

Discussion
Experiments 1a and 1b suggest that adults readily infer the relative difficulty of simple, physical tasks, and allocate effort effectively in collaborative and individual contexts. Notably, participants’ choice of tasks differed across experiments; 85.2% chose the harder task when deciding whom to help, while 93.7% chose the easier task when deciding which task to complete (p < .001, Fisher’s Exact). These results suggest that adults expect an agent to maximize her own utility in an individual context, but to maximize the collective utility in a collaborative context, even when it means choosing a task that is more costly for her to complete.

Experiment 2

In Experiment 2, we used analogous tasks with preschoolers to probe their ability to infer the difficulty of tasks and to decide how to allocate effort in collaborative (Exp. 2a) and individual (Exp. 2b) contexts. While adults participated in an online task, children were presented with real-size model structures and real puppets. One important prerequisite for making these decisions was the ability to understand what it means for someone to have a particular task that she must complete. To ensure this, we created a warm-up task where children saw a model block structure (different from the easy/hard structures in the main task) and had to build one that “looks just like this one.”

Experiment 2a: Collaborative Decision

Methods

Participants
One hundred and eight preschoolers (64 female, M_{age}(SD): 4.52(0.77)), Range: 3.03 - 5.96) were recruited from a local childrens museum and a laboratory preschool. Eighteen additional children were excluded from the final sample for failing the warm-up task (N=11, see Procedure), parental or sibling interference (N = 4) or experimenter error (N = 3). Similar numbers of 3, 4 and 5-year olds were included in the final sample (3-year olds, n = 27; 4-year olds, n = 34; 5-year olds, n = 29).

Materials
For the warm-up task, we used a 13” x 7” orange box that covered a pre-assembled vertical tower of 4, 1-inch wooden blocks glued onto a foamboard platform, as well as a bucket of 15 loose blocks. For the main task, we used three identical puppets. (Although we used identical puppets to minimize the possibility of children choosing a puppet because of its perceptual features, they were identified with different names and slightly different clothing.) We also used two 13” x 7” green boxes, which were removed to reveal a pre-assembled 6-block pyramid and 15-block pyramid attached to foamboard platforms.

Procedure
Children were tested individually in a quiet room seated across from the experimenter. In the warm-up task, children were presented with a four-block tower and were asked to build one just like it. Children who failed to complete this task were excluded from further analyses.

In the main task, children were presented with two identical green boxes, and were introduced to two identical puppets, each of whom was assigned to a box. Half of participants were presented with two female puppets and the other half two male puppets. Next, the child and the experimenter worked together to open the boxes, revealing the 6-block and 15-block towers. This was to indicate random assignment of the easy/hard tasks to avoid implying that there was a reason one character was given a harder task than the other (e.g., differing competence). Children were told that each puppet

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1Most children who failed at this task simply wanted to build something else, suggesting that they might not understand what it means for someone to have a particular task that she must complete.
had to make a tower just like the one in front of them. Children were then introduced to a third, gender-matched puppet who wanted to help, with the important caveat that the puppet could only help one of the other two puppets. Children were asked who the puppet should help and why.

Finally, all puppets were removed from the table and children were asked to identify which tower was harder or easier to make and why. Question type was counterbalanced across participants.

**Experiment 2a Results** In Experiment 2a, 83.3% of children correctly identified which tower is harder or easier to build \((p < .001, \text{binomial})\). This is consistent with prior work showing preschoolers’ ability to infer the relative difficulty of simple block-building tasks (Gweon et al., 2017). As we did with adults in Exp.1a, children who failed this manipulation check were excluded from the main analyses. Consistent with what we found with adults, in the critical test question, children preferentially chose the agent who had to build the 15-block structure \((67.8\%; p < .001, \text{binomial})\). Age did not predict performance on the critical question \((B = .301, z = 1.011, p = .312, \text{logistic regression})\).

As an exploratory analysis, we coded children’s explanations for their responses to the critical question using the same coding scheme as in Experiment 1a. Fifty-one children \((56.7\%)\) gave relevant verbal explanations for their critical question choice \((4\) children gave responses that fell into more than one category). Children’s explanations broadly fell into three categories: references to the size of or number of blocks in the structure \((n = 25, 49\%), \) the difficulty of the structure \((n = 17.33\%), \) and helping or cooperating with another agent \((n = 13, 25.5\%); \) no children referenced relative speed.

Although we had made an a priori decision to exclude children who failed the difficulty question, given the relatively high exclusion rate, we ran an exploratory analysis including these children. This did not change the qualitative result: 68.5% chose the agent with the 15-block pyramid, \((p < 0.001, \text{binomial})\). We also found that children were generally more accurate when they were asked “which one is harder to make” \((92.9\% \text{ answered accurately, } p < .001, \text{binomial})\) than “which one is easier to make” \((70.3\%, \text{ binomial, } p = .003; \text{Harder vs. Easier: } p = .002, \text{ Fisher’s Exact})\). This might reflect their understanding of the words “easy” and “hard”, or a general preference for choosing the larger structure. Finally, age did not predict performance on the manipulation check question \((B = .357, z = 1.031, p = .303, \text{logistic regression})\).

**Experiment 2b: Individual Decision**

**Methods**

**Participants** One hundred and ten preschoolers \((57\text{ female, } M_{\text{age}}: 4.56(0.67), \text{Range: } 3.27 - 5.99)\) were recruited from a local children’s museum and a laboratory preschool. Thirteen additional children were excluded from the final sample for failing to complete the warm-up structure \((N=10)\) or parental or sibling interference \((N=3)\). Again, similar numbers of 3, 4 and 5 year olds were included in the final sample \((3\text{-year olds, } n = 26; 4\text{-year olds, } n = 37; 5\text{-year olds, } n = 27)\).

**Materials** Stimuli for the warm-up task was similar to Exp. 2a except that we also used a male puppet, a cardboard juice-box, and a foam-board tunnel with a sliding door on one end and an open platform on the other. Stimuli in the main task was also similar to Exp.2a, except that we used a Cookie Monster puppet instead of three identical puppets. Additionally we used a cardboard cookie, and two parallel foam-board tunnels with two sliding doors on one end and a platform on the other end.

**Procedure** In the warm-up phase, children saw a puppet (John) who wanted to drink a juice box placed on the platform at the end of the a tunnel. To open the door, the child had to build a tower hidden under the orange box. The model tower was revealed and the child was asked to build a tower just like the it. Once the child completed building, the experimenter demonstrated that the door opened and asked the child to pass the juice box to the puppet. This ensured that children understood the goal of the task.

In the main task, children were introduced to Cookie Monster who wanted to eat a cookie located at the end of the double tunnel. The green boxes were lifted to reveal the 6- and 15-block towers and the experimenter told children that the door on the right would open if Cookie Monster built the tower on the right side of the tunnel, and that the door on the left would open if he built the tower positioned on the left side of the tunnel. Towers were referred to neutrally (e.g., “this one”) and no mention was made regarding their shape or difficulty. The position (L/R) of the block structures were counterbalanced.

Crucially, children were told that Cookie Monster wanted to get to his cookie as fast as he could, and that although both doors would lead Cookie Monster to the cookie, he only had to open one of the doors. Children were then asked the critical question: Which tower should Cookie Monster make? They were also asked to explain their choice. As in Exp.2a, after the critical question, all puppets and boxes were removed from the table and children were asked to identify which tower was harder or easier to make and why. Question type (“harder” or “easier”) was counterbalanced across participants.

**Experiment 2b Results** A majority of children \((81.8\%)\) correctly identified which tower is harder or easier to build \((p < .001, \text{binomial})\). Children who gave inaccurate responses were excluded from the main analyses. As predicted, children preferentially chose the easier structure on the critical question \((65.6\%; p = .004, \text{binomial})\). As in Exp.2a, age did not predict performance on the critical question \((B = .423, z = 1.256, p = 0.209, \text{logistic regression})\). As an exploratory analysis, we also examined children’s
explanations for their critical question choice. Children’s explanations were coded within the same non-exclusive four categories used in Experiment 1b. Sixty-one children (67.8%) gave relevant verbal explanations of their critical question choice, with five children giving responses that fell into multiple categories. Similar to Experiment 1, children referred to the size of or number of blocks in the structure (n = 25, 41%) and the difficulty of the structure (n = 16, 26.2%). However, 25 children (41%) explained their choice by referring to the relative speed of building their chosen tower.

We again conducted an exploratory analysis including children who failed the difficulty question. Unlike Experiment 2a, this did change the result: 57.3% chose the agent with the 6-block pyramid, (p = .15, binomial). However, Question type did not influence performance on the manipulation check question in Experiment 2b (p = 1, Fisher’s Exact). Finally, age did predict performance on the manipulation check question (B = 1.032, z = 2.605, p = .009, logistic regression). However, even 3 year olds passed the manipulation check above chance (70.3%; p = .02, binomial).

Discussion

In Experiments 2a and 2b, we confirm that children, like adults, infer the relative difficulty of physical tasks and use difficulty to allocate effort within collaborative and individual goal-completion contexts. Across experiments, children’s choice on the critical question differed significantly: in Experiment 2a, 67.8% of chose to help with the ”harder” tower, while 65.6% of children in Experiment 2b chose to help with the ”easier” tower (Fisher’s Exact, p < .001). Furthermore, many children were able to explicitly appeal to dimensions of the tasks that were relevant to their relative difficulty (size, time, number of blocks). Age did not predict children’s choices on the critical question in either experiment. Taken together, these results suggest that children can use their inferences about difficulty of tasks to rationally decide who should receive help (Exp.2a) or which task one should complete (Exp.2b); children expect an agent to maximize her own utility in an individual context, but to maximize the collective utility in a collaborative context, even when it means choosing a task that is more costly for her to complete.

General Discussion

Across four experiments, we found that adults and preschoolers readily infer the relative difficulty of simple, physical tasks and leverage that inferred difficulty to decide how to allocate effort. In a cooperative context, where participants were asked to choose whom to help between two agents who had to complete different tasks, they chose the task that had a higher expected difficulty. However, in an individual context where a single agent had to complete one of two tasks to reach a time-constrained goal, they chose the task that had a lower expected difficulty. Remarkably, even children made explicit references to task difficulty and other difficulty-relevant variables (e.g., tower size, completion time, number of blocks) to justify their choices.

Our results suggest that even preschool-aged children understand how to allocate effort or divide labor across tasks in a way that is effective and efficient. One possibility is that children made decisions that are appropriate with respect to the overarching goal in the context, maximizing the collective utility of agents when the goal was to complete all tasks, but maximizing the individual’s utility when the goal was to complete an individual task with a given reward. However, an alternative explanation is that children’s preference to help with the larger tower in the collaborative context is driven by a normative rule or a heuristic about who deserves more help (i.e., one should always help the person with more work to do). Given children’s sensitivity to the relative competence of agents (Jara-Ettinger et al., 2016) and their ability to consider it in assigning tasks to themselves or others (Magid et al., 2017), future work might investigate whether children would integrate their consideration of agent competence in allocating effort across tasks.

Children in our study rationally decided that the helper agent should offer help with the higher-cost task in a collaborative context. However, it is possible that children’s decisions (or even adults’) might differ if they were the helpers themselves. If the choice that allocates effort more equitably across agents means incurring a higher individual cost, it is possible that people might forego this opportunity to maximize collective utility and instead choose the easier task for themselves. Furthermore, participants (especially children who were facing an experimenter) might have been sensitive to the fact that their decisions were being observed, and wanted to appear “nice” or “helpful”. Indeed, our prosocial actions in real life are not only driven by the genuine desire to help or pursuit of fairness or social justice, but also by our desire to broadcast our generosity. Thus, our results are only a small step towards understanding how children might learn to balance the complex trade-offs between different utilities, such as their own versus the group’s utility. In particular, these considerations might also manifest differently depending on the cultural context or socioeconomic factors.

In the current work, we used simple physical tasks for which it was relatively easy to determine expected difficulty; the two structures differed with respect to their overall size, height, and number of blocks. Although prior work suggests that children are not relying on any one particular perceptual cue to infer difficulty of these structures (Gweon et al., 2017), here our stimuli confounded genuine difficulty inference with sensitivity to these perceptual cues to difficulty. Thus, future work should replicate these findings with tasks that are better matched in terms of perceptual cues yet nonetheless differ in their expected costs for completion. Furthermore, children and adults take on many tasks that are more abstract than block building (e.g., math problems) and which lack observable, distinguishing features (e.g., cooking). The extent to which we can determine the relative difficulty of tasks and how it influences our ability to make decisions about allocating effort is an interesting question for future work.
The absence of an age effect provides suggestive evidence that the ability to understand how to allocate effort might develop quite early in life; to the extent that children could determine the relative difficulty of tasks, even young children could make appropriate decisions to allocate effort across tasks and across agents. This suggests that our adult intuitions about whom to help, what to do, and how to divide effort to make effective planning decisions do not develop in a vacuum—rather, they require an integration of expected task difficulty and cost of actions as well as different goal structures that involve competing interests of individuals who differ in their competence and group membership. Indeed, we often fail to consider some or many of these factors and, as a result, make suboptimal decisions. How we navigate different goals of multiple individuals and groups to make nuanced prosocial and collaborative decisions is an important question for future work.

Although we routinely think about how hard or easy it is to achieve a goal, these inferences are often made in the context of making a larger decision. In particular, an understanding of difficulty is critical to deciding whom to help (or who deserves more help). On a whole, these experiments demonstrate that children can integrate information from the physical and social worlds to infer the relative difficulty of tasks and to allocate effort efficiently depending on the social context, suggesting the beginnings of our ideas about how to promote fairness or social justice. Even though children are just learning about what is easy and hard, they can use their understanding to make effective decisions that bode well for their learning and social interactions.

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References


