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

Grace Bennett-Pierre (gbp@stanford.edu) **Mika Asaba (masaba@stanford.edu)**

Hyowon Gweon (hyo@stanford.edu)
Department of Psychology, Stanford University, Stanford, CA 94063

Abstract

The ability to reason about task difficulty is critical for many real-world decisions. Building on prior work on preschoolers' inferences about the difficulty of novel physical tasks (Gweon et al., 2017), here we ask 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 hard task versus someone who had to complete an easy task, adults and preschoolers offered help with the harder task (Collaborative Goal). When an agent could choose to complete a hard task or an easy task to achieve the same outcome, adults and preschoolers preferentially chose the easier task (Individual Goal). In the absence of explicit information about the relative difficulty of tasks, even young children inferred the expected difficulty of tasks and appropriately allocated effort across agents and across tasks. Beyond expecting agents to choose actions that maximize their own utility in individual contexts, our results show that even preschool-aged children readily understand how deviating from this choice can be desirable in cooperative contexts.

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 are in a rush to complete these tasks but you can help just one of them, who would you help? Although you would be a good friend for helping either of them, you might be more inclined to help the one who is working on the drawer. Without your help, she would have to spend more time and effort (i.e., incur a higher cost) than the friend who is making the table. 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 not only underlies our everyday cooperative decisions but also our normative beliefs about how work should be allocated or shared across individuals (Brown, 1986).

Over generations, humans have developed systems of ideas about what constitutes fairness and social justice(Rawls, 2009). Although their specific contents might differ across cultures and societies (Blake et al., 2015), what underlies these principles may be a set of key cognitive capacities that allow individuals to evaluate their action and its consequences under competing pressures to be efficient versus equitable. Despite abundant research on equity and fairness concerns in allocation of goods and monetary resources, much remains unknown about the cognitive roots of our intuitions about how effort should be allocated to achieve our goals as individuals and as groups. The current study aims to investigate young children's developing understanding of how to allocate one's work in individual and cooperative contexts.

Effective planning involves allocating one's time, effort, and resources to achieve a goal successfully and efficiently. Even early in life, humans expect other agents to act in ways that maximize their utilities (Jara-Ettinger, Gweon, Schulz, & Tenenbaum, 2016; see also Gergely & Csibra, 2003); older children explicitly reason about the costs and rewards of others' actions in light of their 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 maximizing one's utilities or choosing the easiest task. In order to help others effectively in a collaborative context, one must understand how her own actions influence the utilities of other individuals.

Prior work suggests an early-emerging tendency to help others (Warneken & Tomasello, 2006; Barragan & Dweck, 2014). By the end of the preschool years, children selectively provide information that maximizes others' utilities by teaching a toy that is more rewarding to activate and more difficult for a naïve learner to discover on her own (Bridgers, Jara-Ettinger, & Gweon, 2016). Given these results, 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 own 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 sacrifices her own utility.

One way to explain this seemingly irrational behavior is to assume that humans care about equity and punish free-riders even at a cost to themselves (e.g., Fehr & Schmidt, 1999). Consistent with this idea, even infants expect resources to be distributed fairly (Sommerville, Schmidt, Yun, & Burns, 2012; Enright, Gweon, & Sommerville, 2017), and older children actively resist distributional unfairness by discarding resources (Shaw & Olson, 2012) or engaging in costly third-party punishment (McAuliffe, Jordan, & Warneken, 2015). However, unlike goods or resources, the amount of work or effort required for a task is unobservable and often must be inferred by reasoning about the *process* of completing a goal. Given that an explicit understanding of the relationship between task difficulty, agent ability, and effort does not emerge until late childhood (Nicholls & Miller, 1983), appreciating fair allocation of labor may be more challenging for young children than evaluating the fair allocation of goods.

However, an emerging body of work suggests that the ability to distinguish between competence and effort may develop earlier (Jara-Ettinger et al., 2015). Even preschoolers can assign easy or hard tasks between themselves and a partner depending on the partner's age and the social context (Magid, DePascale, & Schulz, 2017). 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. Notably, children as young as age 4 can judge the relative difficulty of various block-building tasks without actually engaging in the task, even when the block structures are matched on perceptual cues such as height, shape, or size (Gweon, Asaba, & Bennett-Pierre, 2017). By reasoning about the unobservable process of completing simple engineering tasks, they can infer how different dimensions of these tasks can influence the amount of effort required to complete them.

The current study builds on this prior work to ask whether adults and preschool-aged children can not only reason about task difficulty but also *use* it to make flexible decisions about which task to complete in a cooperative context (i.e., whom to help) versus an individual context (i.e., what to do). To this end, we harnessed stimuli that are similar to those used in a previous study (Gweon et al., 2017): A pair of block structures that differ in the effort required to complete them. We created a "harder" task (i.e., building a large structure made of 15 blocks) and an "easier" task (i.e., building a small structure made of 6 blocks). Critically, participants did not have prior experience with the actual building task; they saw photos (adults; Exp.1) or real-size models (3-5 year olds; Exp.2) of the structure and had to reason about their expected difficulty to make a decision. To minimize reputational concerns to appear generous or competent, in this initial study we probed participants' third-party judgments.

Experiment 1

Exp.1 explored adults' reasoning about whom to help in a cooperative context and which task to complete in an individual context. Even though both conditions involved a choice between the same structures (hard vs. easy), we predicted that participants would choose the harder task in a cooperative context and the easier task in an individual context.

Methods

Participants A total of 183 participants were recruited from Amazon Mechanical Turk (Collaborative Goal: N=88; Individual Goal: N=95; M_{Age}(SD) = 36.59(10.76), Range: 19 - 68)[1]. An additional 9 participants provided an incorrect answer to the attention check question and were excluded from further analyses. Participants received $0.35 for completing the study.

Materials Two images of block structures were used. One block structure was a 15-block tower and the other was a 6-block tower (see Fig.1). In the Collaborative Goal condition, images of 3 identical puppets were used. In the Individual Goal condition, an image of Cookie Monster, a cookie, and two black squares (presented as doors) were used.

[1]Due to a technical error demographic information was collected from only half of the participants.

Procedure Stimuli were presented with Qualtrics survey software. In the Collaborative Goal condition, participants were introduced to two puppets (Stacy and Jill), each of whom had to build the tower in front of them. One puppet had the 15-block tower 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; participants were asked which friend she should help and why. In the Individual Goal condition, participants were introduced to Cookie Monster. Participants were told that Cookie Monster was very hungry and wanted to eat the cookie as fast as he could. The cookie was blocked by two doors in front of him, each of which was associated with a block structure; one door would open if he built the 15-block tower, and the other would open if he built the 6-block tower. Critically, it did not matter which door he opened; opening either door would allow him to get the cookie. They were asked which tower he should complete and why.

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 and why. Throughout the task, the size or difficulty of tasks was never mentioned; puppet names associated with the tasks and the side of presentation for easy/hard tasks (left/right) were counterbalanced.

Results and Discussion

As predicted, participants' choice of tasks differed across conditions. In the Collaborative Goal condition, participants showed a clear preference for the harder task (% choice for the 15-block structure; 85.2%; $p < .001$, Binomial), whereas in the Individual Goal condition only 6.3% chose the harder task ($p < .001$, Binomial). The difference between conditions was significant ($p < .001$, Fisher's Exact).

As an exploratory analysis, we coded participants' justification of their task choice. After excluding 17 participants for giving clearly irrelevant explanations, we coded participants' responses using four categories: 1) the size of the structure or number of blocks in the structure, 2) the difficulty of the structure, 3) the relative speed of completing the structure, and 4) mentions of helping or cooperating with another agent. These categories were not mutually exclusive; 53 participants (20 in Collaborative, 33 in Individual) gave explanations that fell into more than one category. In the Collaborative Goal condition, a majority of participants mentioned the size of or number of blocks in the structures (N=56, 72%) or the difficulty of the structures (N=25, 32%); some participants explicitly mentioned helping or cooperation (N=13, 17%) and the speed of goal completion (N=4, 5%). In the Individual Goal condition, participants appealed to the size of structures or the number of blocks in the structures (N=59, 67%), the difficulty of the structures (N=18, 20%), and the speed of goal completion (N=44, 65%). Unsurprisingly, none mentioned helping or cooperation.

In sum, these results suggest that adults readily infer the relative difficulty of simple, physical tasks, and allocate effort effectively in collaborative and individual contexts. More specifically, even though adults expect an agent to maximize her own utility in an individual context (i.e., choose an easier, low-cost task to attain a given reward), they nevertheless expect her to incur a higher cost for herself by helping someone who has to complete a harder task. While participants' explanations should be interpreted with caution, they suggest that even though people make seemingly opposite decisions depending on the context, similar representations (i.e., physical properties of the tasks or expected effort to complete them) underlie their decisions.

Experiment 2

In Exp.2, we used analogous tasks with 3- to 5-year-olds to probe their ability to infer the difficulty of tasks and decide how to allocate effort in collaborative and individual contexts. While adults participated in an online task, children were presented with real-size model structures and physical props (e.g., puppets, doors). One important prerequisite for making these decisions is the ability to understand what it means for someone to have a particular task to complete. To help children understand this idea, we used a warm-up task where children saw a model block structure (different from the easy/hard structures in the main task) and they themselves had to build one that looked just like the model.

Methods

Participants A total of 218 preschoolers were recruited from a local children's museum and a university preschool. We recruited 108 children in the Collaborative Goal condition (M_{Age}(SD) = 4.52(0.77), Range: 3.03 - 5.96, 64 female) across 3 (N=34), 4 (N=42), and 5-year-olds (N=32), and 110 children in the Individual Goal condition (M_{Age}(SD) = 4.56 (0.67), Range: 3.27 - 5.99, 57 female), across 3 (N=37), 4 (N=42), and 5-year-olds (N=31). Some children failed the Difficulty Inference check which was one of our exclusion criteria; the final sample size for main analyses was N=90 per condition, N=26-37 in each age bin (but see Results for additional analyses with the full sample). Thirty-one additional children were excluded from the final sample for failing the warm-up task (N=21, see Procedure), parental or sibling interference (N=7), or experimenter error (N=3).

Materials For the warm-up task, we used a bucket of 15 wooden blocks (1" cubes) and an orange box (13" x 7" x 7") that covered a pre-assembled vertical tower of 4 wooden blocks glued onto a foamboard platform. For the main task, we used two green boxes (identical in size to the orange box); one covered a 6-block tower (easy task) and the other covered a 15-block tower (hard task).

In the Collaborative Goal condition, two sets of three identical puppets were used (one set was 3 female puppets, the other set was 3 male puppets). We used identical puppets to minimize the possibility of children using the puppets' perceptual features to make a choice. However, each puppet had slightly different clothing and was identified with different names during the task).

In the Individual Goal condition, the warm-up task additionally involved 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. In the main task, we used a Cookie Monster puppet, and a toy cookie on a platform; two parallel foam-board tunnels were connected with the platform, each of which had sliding doors on the other end.

Procedure Children were tested individually in a quiet room seated across from the experimenter.

1. Warm-up Task: In the Collaborative Goal condition, children were presented with an orange box that was lifted to reveal a 4-block tower and were asked to build one just like it. In the Individual Goal condition, the task was identical but we changed the context and the cover story to ensure that children understood how to open the doors that led to the platform. Children saw a puppet (John) who wanted to drink a juice box placed on the platform at the end of the tunnel, and were told that the child could open the door by building the tower hidden under the orange box. The box was lifted to reveal the same 4-block tower and children were asked to build one just like 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. Children who failed to complete this task were excluded from further analyses[2].

2. Main Task: In the Collaborative Goal condition, children were introduced to two identical puppets (Stacy and Jill, or Steve and John), each of whom was assigned to one of two identical green boxes. The child and the experimenter lifted each box simultaneously, one of which revealed a 6-block tower and the other a 15-block tower. This was to indicate random assignment of the easy/hard tasks to avoid implying that there was a reason why one character was given a harder task than the other (e.g., different abilities). Children were told that each puppet had to make a tower just like the one in front of them. Children were then introduced to a third puppet who wanted to help (Tilly, or Tom) but could only help one of the other two friends. Children were asked: "Which friend should Tilly/Tom help?" Children were also asked to explain their choice. Half of participants were presented with female puppets, and the other half saw male puppets.

In the Individual Goal condition, children were introduced to Cookie Monster, who was hungry and wanted to eat a cookie located at the end of the double tunnel. Each tunnel had a green box on its side. As in the Collaborative Goal condition, the experimenter lifted the green boxes simultaneously to reveal a 6-block tower and a 15-block tower. Children were told that the door on the left would open if Cookie Monster built the tower on the left, and the door on the right would

[2]Most 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 involves creating an object that looks the same as the model object.

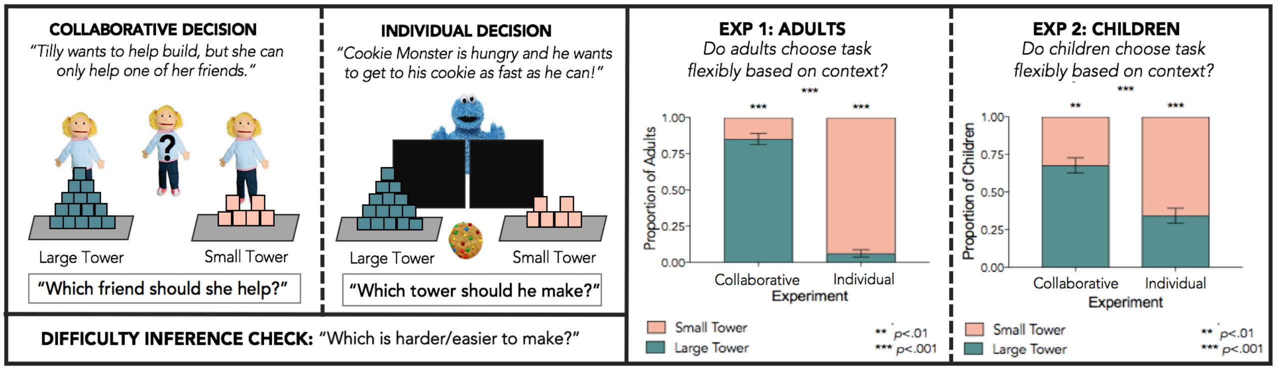

Figure 1: Left: Schematics of procedure for Experiments 1 & 2. Right: Responses to critical question for Experiments 1 & 2.

open if he built the tower on the right. They were also told that Cookie Monster wanted to get to his cookie as fast as he could, and although both doors would lead Cookie Monster to the cookie, he only had to open one of the doors. Children were then asked: "Which tower should Cookie Monster make?" Children were also asked to explain their choice.

3. Difficulty Inference Check: After the main task, the experimenter removed all puppets and boxes from the table and only left the 6-block tower and the 15-block tower. Children were asked to identify which tower was harder or easier to make and why. Question type ("harder" or "easier") was counterbalanced across participants.

Throughout the experiment, the position (left/right) of the block structures was counterbalanced. No mention was made regarding the block structures' shape or difficulty, and pronouns were used to refer to each structure (e.g., "this one").

Results and Discussion

Before the main analyses, we first analyzed children's responses to the Difficulty Inference check question to identify children who were unable to identify which tower is harder or easier. Children showed comparable accuracy across conditions: 83.3% of children in the Collaborative Goal condition ($p < .001$, Binomial) and 81.8% in the Individual Goal condition ($p < .001$, Binomial) correctly identified which tower is harder or easier to build. This rate is similar to children's performance in prior work showing preschoolers' ability to infer the relative difficulty of simple block-building tasks (Gweon et al., 2017); consistent with prior results, children's accuracy on this question improved with age (effect of Age (continuous): $B = .668$, $z = 2.575$, $p = .010$) with no effect of condition ($B = -.113$, $z = -.310$, $p = .757$, Logistic regression). As we did with adults in Exp.1, children who provided inaccurate answers were excluded from the main analyses (but see below for additional analyses that include these children).

For our main analysis, we examined children's responses to the critical test question. As predicted, a majority of children in the Collaborative Goal condition chose the agent with the harder task (% choice for 15-block structure: 67.8%; $p < .001$, Binomial), whereas children in the Individual Goal condition chose the easier task (% choice for 15-block structure: 34.4%, $p = .004$, Binomial). The difference between the two conditions was significant ($p < .001$, Fisher's Exact).

Given that we recruited evenly from a relatively broad age range, we explored whether there is an effect of age. Logistic regression with Condition (categorical) and Age (continuous) showed an effect of Condition ($B = 1.387$, $z = 4.382$, $p < .001$) but not age ($B = .017$, $z = .220$, $p = .937$).

As in Exp.1, we also explored how children justified their choices. Unsurprisingly, many children gave explanations that were irrelevant (e.g., "because I like that tower"; N=40, 22.2%) or were unable to provide an answer (N=30, 16.7%)[3]; the rest of the explanations were coded using the same categories as in Exp.1. Eleven explanations (4 in Collaborative and 7 in Individual) fell into more than one category. In the Collaborative Goal condition (N=51), many children appealed to structure size or the number of blocks (N=25, 49%) or the difficulty of building the structures (N=17, 33%) to justify their answers, while none mentioned time. Some explicitly mentioned helping or cooperating with another agent (N=13, 26%). In the Individual Goal condition (N=59), children appealed to structure size or number of blocks (N=25, 42%) or difficulty (N=16, 27%); while none mentioned helping, children did frequently mention the relative speed or time for completing the task (N=25, 42%). Overall, these results mirror the pattern of explanations we observed in Exp.1.

We had made an a priori decision to exclude children who failed the difficulty question. However, given the relatively high exclusion rate (21.1%), we ran exploratory analyses including these children. The proportion of choices for the harder task was still higher in the Collaborative Goal condition than in the Individual Goal condition (68.5% vs. 42.7%, $p < .001$, Fisher's Exact). Including these children did not change the results in the Collaborative Goal condition ($p < .001$, Binomial) but it did weaken their preference for the easier task in the Individual Goal condition (57.3% chose

[3]Logistic regression on whether children gave a relevant explanation found no effect of Condition but a strong effect of age (Condition: $B = .367$, $z = 1.122$, $p = .262$; Age: $B = 1.054$, $z = 4.361$, $p < .001$).

the 6-block tower, ($p = .152$, Binomial). Consistent with our main analysis, age did not predict tower choice even in this larger sample (Condition: $B = 1.086$, $z = 3.811$, $p < .001$, Age: $B = .287$, $z = 1.467$, $p = .142$, Logistic regression).

In sum, these results suggest that preschool-aged children readily infer the relative difficulty of physical tasks and effectively allocate effort in collaborative and individual contexts. Children expected an agent to offer help on a task that required more effort to complete, but to choose a task that required less effort to complete when the agent would obtain the same individual reward by completing either task. Many children explicitly appealed to dimensions that are relevant to task difficulty, and their responses mirrored the pattern observed in adults. Although we cannot draw strong conclusions from these explanations, they suggest that children's choices, while seemingly opposite across conditions, might still be based on similar representations of the tasks.

Despite a relatively broad age range (3- to 5-year-olds) we did not find a clear effect of age in children's task choices. Prior to this decision, however, children need to infer the relative difficulty of tasks; this might be a potential source of developmental change. While even the 3-year-olds showed an above-chance accuracy on the Difficulty Inference check (74.6%, $p < .001$, Binomial), children's accuracy did improve with age. This is consistent with our prior work using similar stimuli (Gweon et al., 2017), and further suggests that children's ability to *use* difficulty information to decide how to effectively allocate effort in collaborative vs. individual contexts might already be present early in life.

General Discussion

Across two experiments, we found that adults and preschoolers infer the relative difficulty of simple, physical tasks and leverage this information to decide how to allocate effort. When an agent had to choose whom to help between two friends who had to complete different tasks, participants expected the agent to offer help on the harder task; by contrast, when an agent had to choose between two tasks to obtain the same reward, participants expected the agent to complete the easier task. These decisions were made without any explicit information about which task is harder/easier; yet, participants explicitly appealed to task difficulty and other relevant variables (e.g., tower size, number of blocks, completion time) to justify their choices, suggesting that despite their choices of different tasks across contexts, similar representations about task difficulty might underlie these decisions.

Children's responses in the individual context suggest that preschool-aged children expect an agent to maximize her own utility, choosing a more efficient action plan to achieve a given reward; this is consistent with recent studies showing remarkably early-emerging understanding of others' utilities (e.g., Liu & Spelke, 2017). Critically, our results further show that children understand how *deviating* from this choice can be more desirable in a cooperative context. Given the early-emerging ability to reason about agents' actions in light of their underlying costs and rewards (Jara-Ettinger et al., 2016), one possibility is that children in our task considered the collective utility of all agents and chose an option that is more appropriate with respect to the overarching goal in the context (i.e., completing both structures in the most effective way). Choosing to help someone with a harder task would distribute the work more equitably across three agents and enable efficient completion of all tasks by allowing one agent to finish the easier task while the other two work on the harder task.

However, it is also possible that children's choices in the collaborative context are driven by normative beliefs or heuristics about whom we ought to help (i.e., one should always help the person with more work to do). In particular, we note that the time-constraint for goal completion was not made explicit in the cooperative context; even though we generally assume that agents would want to spend less time on a task, replicating the results with matched time constraints would help us better understand the reasoning behind participants' decisions. Given comparably strong emphasis on the time constraint in both contexts, we expect the results to be similar, if not stronger. Under no time constraint (i.e., little motivation to maximize utility), however, we might see more variable choices; while it is generally desirable to do "less work", these building tasks could be considered fun, and even more so when it involves making a larger, "cooler" structure.

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 they can determine the relative difficulty of tasks, children can appropriately allocate effort across agents (cooperative) and across tasks (individual). However, the age-related improvement in children's inferences about the difficulty of these tasks suggests that children's real-world decisions about whom to help and what to do in complex social contexts might still undergo significant developmental changes. To plan, help, and collaborate effectively, one must reason about expected task difficulty and use it appropriately based on the goal structure in the context, which likely involves coordinating utilities of multiple individuals who might differ in their competence, individual goals, and even group membership. Thus, these decisions require the integration of a host of cognitive capacities that might show different developmental trajectories; even as adults, we often fail to consider some of these factors and make suboptimal decisions. How children learn to navigate various social contexts to make nuanced collaborative or competitive decisions is an important question for future work. Given recent work on preschoolers' ability to consider agents' age to assign easy or hard tasks to themselves versus a partner (Magid et al., 2017), follow-up studies might examine whether children integrate their understanding of agent competence to allocate effort effectively in individual, cooperative, and competitive contexts.

Although the current study used a third-party decision to minimize reputational concerns, participants might still have considered the agents' social benefits of appearing generous or competent. Especially in the cooperative context, they might have been sensitive to the fact that their decisions were being observed, and wanted to appear "nice" or "helpful". Indeed, prosocial behaviors in real life are not always driven by pure altruism or genuine concerns about fairness and social justice; people are also influenced by the desire to broadcast their generosity. Additionally, even though participants expected an agent to offer help with a harder task, they might make different decisions if they were the helpers themselves. Because the choice that allocates effort more equitably across agents incurs a higher cost for themselves, people might be more inclined to prioritize their own utility. The current study is only a small step towards understanding how we learn to balance the complex trade-offs between our own and others' competing goals, and how they might manifest differently depending on cultural or socioeconomic factors.

Our experiments involved simple physical tasks, making it relatively easy to determine their 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 engage in many tasks that are more abstract than block building (e.g., math problems) and those that lack observable, distinguishing features (e.g., cooking). How children estimate the difficulty of these abstract tasks and allocate their time and mental effort remains an open question with important implications for education.

We routinely think about how hard or easy it is to achieve a goal. These inferences are not made in isolation, but often in the context of making larger decisions such as whom to help or how best to achieve our own goals. The current study demonstrates that even young children infer the relative difficulty of tasks and allocate effort effectively depending on the social context. Even though they are just learning to tell what is easy and hard, they can use these inferences to make effective decisions that bode well for their learning and social interactions. Such seamless integration of information from the physical and the social world suggests that our intuitions about fairness in allocation of effort emerge early in life.

Acknowledgements

Thanks to Huda Akef for her help with data collection and stimuli creation. We also thank Bing Nursery School and Palo Alto Junior Museum and Zoo for their support.

References

Barragan, R. C., & Dweck, C. S. (2014). Rethinking natural altruism: Simple reciprocal interactions trigger children's benevolence. *Proceedings of the National Academy of Sciences*, *111*(48), 17071–17074.

Blake, P., McAuliffe, K., Corbit, J., Callaghan, T., Barry, O., Bowie, A., ... Vongsachang, H. (2015). The ontogeny of fairness in seven societies. *Nature*, *528*(7581), 258.

Bridgers, S., Jara-Ettinger, J., & Gweon, H. (2016). Children consider others expected costs and rewards when deciding what to teach. In *Proceedings of the 38th annual conference of the cognitive science society* (pp. 559–564).

Brown, R. (1986). *Social psychology: The second edition*. Free Press, New York.

Enright, E. A., Gweon, H., & Sommerville, J. A. (2017). 'To the victor go the spoils': Infants expect resources to align with dominance structures. *Cognition*, *164*, 8–21.

Fehr, E., & Schmidt, K. M. (1999). A theory of fairness, competition, and cooperation. *The Quarterly Journal of Economics*, *114*(3), 817-868.

Gergely, G., & Csibra, G. (2003). Teleological reasoning in infancy: The naıve theory of rational action. *Trends in cognitive sciences*, *7*(7), 287–292.

Gweon, H., Asaba, M., & Bennett-Pierre, G. (2017). Reverse-engineering the process: Adults' and preschoolers' ability to infer the difficulty of novel tasks. In *Proceedings of the 39th annual conference of the cognitive science society.*

Jara-Ettinger, J., Gweon, H., Schulz, L. E., & Tenenbaum, J. B. (2016). The naïve utility calculus: Computational principles underlying commonsense psychology. *Trends in cognitive sciences*, *20*(8), 589–604.

Jara-Ettinger, J., Gweon, H., Tenenbaum, J. B., & Schulz, L. E. (2015). Childrens understanding of the costs and rewards underlying rational action. *Cognition*, *140*, 14–23.

Liu, S., & Spelke, E. S. (2017). Six-month-old infants expect agents to minimize the cost of their actions. *Cognition*, *160*, 35–42.

Magid, R. W., DePascale, M., & Schulz, L. E. (2017). Preschoolers appropriately allocate roles based on relative ability in a cooperative interaction. In *Proceedings of the 39th annual conference of the cognitive science society.*

McAuliffe, K., Jordan, J. J., & Warneken, F. (2015). Costly third-party punishment in young children. *Cognition*, *134*, 1–10.

Nicholls, J. G., & Miller, A. T. (1983). The differentiation of the concepts of difficulty and ability. *Child development*, 951–959.

Rawls, J. (2009). *A theory of justice: Revised edition*. Harvard university press.

Shaw, A., & Olson, K. R. (2012). Children discard a resource to avoid inequity. *Journal of Experimental Psychology: General*, *141*(2), 382–395.

Sommerville, J. A., Schmidt, M. F. H., Yun, J.-e., & Burns, M. (2012, May). The Development of Fairness Expectations and Prosocial Behavior in the Second Year of Life. *Infancy*, *18*(1), 40–66.

Warneken, F., & Tomasello, M. (2006, March). Altruistic helping in human infants and young chimpanzees. *Science*, *311*(5765), 1301–1303.