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Blind to Bias? Young Children Do Not Anticipate that Sunk Costs Lead to Irrational Choices

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Abstract

Young children anticipate that others act rationally in light of their beliefs and desires, and environmental constraints. However, little is known about whether children anticipate others' irrational choices. We investigated young children's ability to predict that sunk costs can lead to irrational choices. Across four experiments, 5- to 6-year-olds (total $N = 185$) and adults (total $N = 117$) judged which of two identical objects an agent would keep, one obtained at a high cost or one obtained at a low cost. In Experiment 1, adults predicted that the agent would choose the high-cost object over the low-cost one, whereas children responded at chance. Experiment 2 replicated these findings in children, but also included another condition which showed they were sensitive to future costs. They predicted that an agent would be more likely to seek out a low-cost item than a high-cost item. Experiments 3 and 4 then found that children do not anticipate the sunk cost bias in first person scenarios, or in interpersonal sunk cost scenarios, where costs are sunk by others. Taken together, our findings suggest that young children may struggle to understand and predict irrational behavior. The findings also reveal an asymmetry between how they consider sunk costs and future costs in understanding actions. We propose that this asymmetry might arise because children do not consider sunk costs as wasted.

Keywords: Sunk cost bias; Theory of mind; Rational action; Action understanding; Judgment and decision making

1. Introduction

People often overvalue items that they spent time, money, or effort pursuing. For example, suppose a girl picks two flowers while visiting a park, one from a small hill that is easy to climb, and the other from a large hill that is strenuous to climb. If the girl can only keep one flower, which will it be? As an adult, you likely think she will keep the flower from the

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big hill. Anticipating this choice suggests you expect others to be biased by *sunk costs*—past investments that cannot be recovered. Importantly, this choice to keep the high-effort flower is irrational. Choosing this flower *seems* to minimize wasting effort, even though choosing it will not recover or justify the effort spent pursuing it (Arkes, 1996; Arkes & Ayton, 1999; Arkes & Blumer, 1985; Thaler, 1980). Hence, anticipating that people are biased by sunk costs may demonstrate an understanding that choices are sometimes irrational.

The present work investigates young children's ability to anticipate that others will be sensitive to sunk costs in their choices. This ability is particularly important as people's actions and choices are often irrational (e.g., Kahneman, 2011). Successfully predicting others' actions, then, requires us to anticipate not only their rational choices, but also their irrational choices. Over the past 40 years, much developmental research has demonstrated that young children come to expect others to behave *rationally* in light of their beliefs and desires, and environmental constraints (e.g., Cushman, 2020; Gergely & Csibra, 2003; Leslie, German, & Polizzi, 2005). For instance, 2-year-olds expect others to continue searching until they find a desired object, but to cease searching once that goal is reached (Wellman & Woolley, 1990). And infants expect others to take the most efficient, and least costly, path to a goal (e.g., Csibra & Gergely, 2007; Liu & Spelke, 2017). However, much less research has investigated whether children anticipate *irrational* behavior (see Goldwater et al., 2020 for an exception).

Investigating whether children anticipate the sunk cost bias will also be informative about their understanding of costs more generally. Recent work shows that children understand that an agent's valuation of an object determines the cost the agent is willing to incur for it (value $\rightarrow$ cost incurred; Jara-Ettinger, Gweon, Schulz, & Tenenbaum, 2016; 2020; for related work in infancy, also see Liu & Spelke, 2017). For example, in one study, 5- to 6-year-olds saw an agent choose between a banana and a watermelon (Jara-Ettinger, Gweon, Tenenbaum, & Schulz, 2015). When the fruits were equally difficult to obtain, children inferred the agent preferred whichever fruit he chose; if he chose the banana, they concluded he liked it better. But children did not infer this in a condition where the fruit he chose was easier to obtain. They presumably recognized the agent might have chosen against his preferences—the benefit of obtaining the preferred fruit might not have warranted the effort (i.e., cost).

The sunk cost bias *reverses* this relation between costs and value. The cost an agent has already incurred for an object increases its value to the agent (cost incurred $\rightarrow$ value). Again, valuing objects based on the costs previously incurred to obtain them is irrational, as past investments are not a meaningful indicator of present value (Arkes, 1996; Arkes & Ayton, 1999; Arkes & Blumer, 1985; Thaler, 1980). Hence, investigating whether young children anticipate the sunk cost bias will show whether they understand the effect of incurring costs on subjective value. Few studies have explored this question. In one study, 5- to 12-year-olds heard a story where they either purchased a circus ticket or received a ticket as a gift (Webb & Plaisier, 1998; see also Krouse, 1986). In the story, their car broke down and when they were asked whether they would pay for a bus to the circus, children mostly chose to pay regardless of how they had acquired the circus ticket. This finding could suggest that children's decisions are not affected by sunk costs. However, young children often have difficulty reasoning about money, so they might be sensitive to other kinds of sunk costs (e.g., Berti & Bombi, 1981). A few other studies have explored sunk costs in much older children,

mostly adolescents, and yielded mixed results (e.g., Baron, Granato, Spranca, & Teubal, 1993; Klaczynski, 2001; Klaczynski & Cottrell, 2004; Morsanyi & Handley, 2008).

We investigated young children's ability to anticipate the sunk cost bias in four experiments. We tested children between 5- to 6-years-old, since children at this age understand that agents are willing to incur greater costs to obtain more highly valued objects (e.g., Jara-Ettinger et al., 2015). Some past experiments have examined the sunk cost bias in "progress" decisions where people choose to continue investing resources into a failing project (e.g., Arkes & Blumer, 1985, Experiment 8; Barsky & Zyphur, 2016). Other experiments have examined the bias in "adoption" decisions where people choose between two projects they already invested in (e.g., choosing between two purchased ski trips; Arkes & Blumer, 1985, Experiment 1; Baron et al., 1993; for a further description about this distinction, see Moon, 2001; Roth, Robbert, & Straus, 2015). Although both approaches involve choices about sunk costs, we used adoption decisions in our experiments to specifically test if sunk costs impact children's valuation of objects.

In each experiment, children were shown stories where an agent collects two identical objects, one easier to obtain and the other difficult. Experiment 1 examined which objects 5- to 6-year-olds and adults expected the agents to keep. Choosing the high-cost object would suggest that participants expect others to value these objects more than low-cost alternatives. Experiment 2 then compared whether 5- to 6-year-olds' predictions differ depending on whether they are considering sunk costs, or instead considering costs that lie in the future. Experiment 3 explored if 6-year-olds anticipate the sunk cost bias in first-person scenarios. Finally, Experiment 4 explored if 6-year-olds anticipate the sunk cost bias in first-person scenarios where the costs are incurred by other people.

2. Experiment 1

2.1. Method

2.1.1. Participants

We tested 60 children ($M_{\text{age}} = 5;11$ [years; months], range = 5;0–6;10, 29 female), and 117 adults ($M_{\text{age}} = 38$, range = 22–72, 44 female). Data were excluded from an additional 36 adult participants who failed either one or both attention checks. These were simple questions to ensure that adults attended to the stimuli.

In this experiment, children were tested individually in child-care centers and schools in the Waterloo region (Canada). The region is predominantly middle-class, and approximately 79% of residents are White, with Chinese and South Asians as the most visible minorities. Adults were recruited from Amazon Mechanical Turk (<http://www.mturk.com/>) and were located throughout the United States and had a HIT (Human Intelligence Task) rate of above 95%.

2.1.2. Materials and procedure

Participants completed two trials. In each trial, they were told a story about a child who obtained two identical objects—one easy to obtain and the other difficult (see Fig. 1). In the

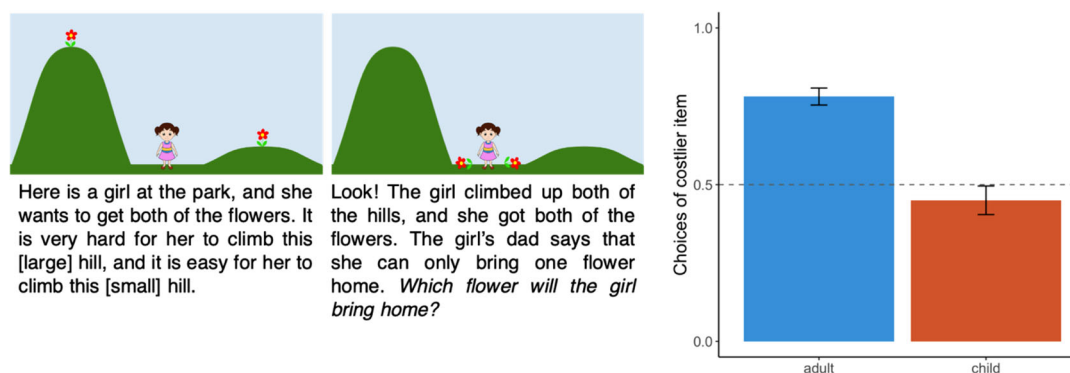


Fig 1. Sample story and results for Experiment 1. For all figures, the bar graph represents the proportion of choices for the costlier item, and error bars show ± 1 standard error.

first story, a boy retrieved a rock from a deep pit and another rock from a shallow pit. In the second story, a girl retrieved a flower from a tall hill and another from a short hill. The character then learned that they could only keep one object, and children were asked which they would keep (e.g., “The boy’s mom says that he can only bring one rock home. Which rock will the boy bring home?”). If participants are sensitive to sunk costs, they should choose the item that was harder to retrieve.

For children, these stories were told with corresponding pictures on a laptop. To adapt this procedure to an online format, adults read the stories with the corresponding pictures, and answered the same test question. They then completed two four-option multiple-choice attention checks to ensure that participants read the stories and saw the pictures. In Experiments 1–3, the item that was difficult to obtain (rock in deep pit; flower on tall hill) was on the right in the first story, and on the left in the second story.

2.2. Results

In each experiment, we analyzed the results using generalized estimating equations (GEE) models (binary logistic, independent correlation matrices). The raw data from all experiments are available online at: <https://osf.io/s79re/>.

In this experiment, children’s and adults’ responses were analyzed in the same model, with age (child, adult) as a predictor, see Fig. 1. There was a significant effect of age, Wald $\chi^2(1) = 23.36, p < .001$, as adults were more likely than children to choose the high-effort item. Single-sample tests were conducted using an intercept-only GEE model to examine if children and adults chose the high-effort item significantly above chance. Children’s choices of the high-effort item (45% of responses) did not significantly differ from chance, Wald $\chi^2(1) = 0.90, p = .342$. In contrast, adults were more likely to choose the high-effort item (78% of responses) than the low-effort item, Wald $\chi^2(1) = 34.28, p < .001$.

Although children’s responses did not significantly differ from chance, one might wonder whether findings would differ with a larger sample. However, in this experiment and those following, supplementary single-sample Bayesian t -tests favored the null hypothesis over one

holding that children appreciate sunk costs (i.e., Experiment 1, $BF_{01} = 12.92$; Experiment 2, $BF_{01} = 12.44$; Experiment 3, $BF_{01} = 5.22$; Experiment 4, $BF_{01} = 14.23$).

2.3. Discussion

Adults anticipated the sunk cost bias, but children did not. Whereas adults predicted that each character would choose to keep the high-cost item, children's predictions did not depart from chance. In relation to previous work, these findings suggest that while children recognize that value determines willingness to incur costs (Jara-Ettinger et al., 2015), they do not believe that sunk costs influence value. This conclusion is only tentative though, as our experiment did not examine both kinds of costs.

We addressed this issue in the next experiment by including an additional between-subjects "future cost" condition. In the scenarios in this condition, after the character collected both objects, two new ones appeared. Then, children predicted which of the two objects the character would retrieve. Previous work shows that from infancy we expect others to take the least costly path to a goal (e.g., Csibra & Gergely, 2007; Liu & Spelke, 2017). So, if children are sensitive to costs in our vignettes, they should expect the character to retrieve the low-effort object over the high-effort alternative. Additionally, we added comprehension checks to ensure that children could accurately identify how much effort the character incurred when collecting both objects.

3. Experiment 2

3.1. Method

3.1.1. Participants

We tested a total of 60 5- to 6-year-olds ($M_{\text{age}} = 6;0$, range = 5;0–6;11, 30 female). We aimed to test 30 children in each between-subjects condition. We were disrupted by COVID-19 and continued data collection online. The first 22 children ($M_{\text{age}} = 6;5$, range = 6;0–6;11, 12 female) were tested in-person at their daycares and preschools; the remaining 38 children ($M_{\text{age}} = 5;10$, range = 5;0–6;11, 18 female) were tested online using video conferencing software. Initially, children were not randomly assigned to a between-subjects condition as we were only testing the sunk cost condition ($N = 13$). After we introduced the control condition ("future costs"), children were randomly assigned to one of the two conditions. Random assignment ceased once thirty children were tested in the sunk cost condition, so the remaining children in our sample were assigned to the future cost condition.

3.1.2. Materials and procedure

As in Experiment 1, children first heard a story about a boy who retrieved two rocks, and a second story about a girl who retrieved two flowers (see Figure 2). In each story, one object was difficult to retrieve and the other was easy to retrieve. To ensure children were aware of this difference, each story included two comprehension questions about the effort required to

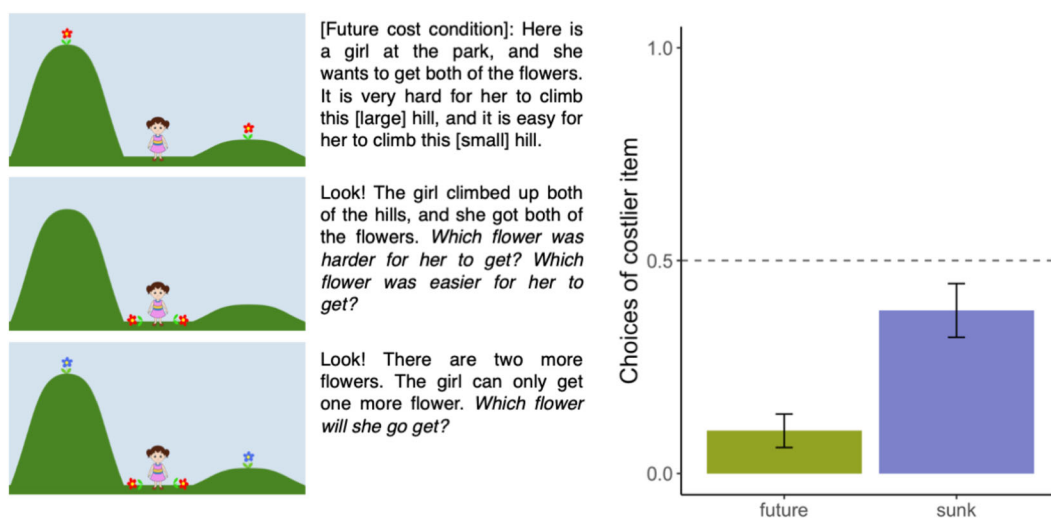


Fig 2. Sample story and results for Experiment 2. Error bars show ± 1 standard error.

obtain each item (e.g., Which hole was easy to climb into? Which hole was hard to climb into?). Two children failed these comprehension questions, but correctly responded after they were retold the stories.

Children saw the stories in one of two between-subjects conditions. In the sunk costs condition, after each character retrieved the objects, children were told the character could only keep one, and were asked which the character would keep. In the future costs condition, two more objects appeared. The character learned that they could only obtain one more object, and children were asked which object the character would retrieve. Hence, the character was faced with a choice between an object that would be costly to retrieve (e.g., flower on large hill) and one that would be less costly to retrieve (e.g., flower on small hill).

3.2. Results

All but two children passed both comprehension checks. After they were retold the stories, they provided the correct answer.

A GEE model with the predictor condition (sunk cost, future cost) revealed that children were more likely to choose the high-effort item in the sunk cost than the future cost condition, Wald $\chi^2(1) = 9.28, p = .002$ (see Fig. 2). Single-sample tests, conducted using an intercept-only GEE model, revealed that children's choices of the high-cost item in the sunk cost condition (38%) did not significantly differ from chance, Wald $\chi^2(1) = 2.62, p = .106$; whereas most children in the future cost condition chose the low-cost item (90% of responses), Wald $\chi^2(1) = 20.70, p < .001$.

3.3. Discussion

Children again showed no sensitivity to sunk costs, and did not anticipate that characters would value high-cost items over low-cost ones. However, children were sensitive to future costs and predicted that the character would retrieve low-effort objects. Thus, it is unlikely that children in our experiments fail to predict sunk cost choices because they do not appreciate the costs at all in this paradigm. Almost all children identified the effort associated with each object, providing further support that they can identify where greater effort was invested.

In the experiments so far, children considered third-person scenarios and predicted whether others would be sensitive to sunk costs. However, most sunk cost studies on adults have used first-person scenarios, which asked participants to predict their own hypothetical choices (e.g., Arkes, 1996; Arkes & Blumer, 1985; Frisch, 1993; Garland, 1990; Garland & Newport, 1991; Strough, Mehta, McFall, & Schuller, 2008, 2014; for exceptions see Arkes & Blumer, 1985; Bornstein & Chapman, 1995; Olivola, 2018). Thus, in the next experiment we explored whether children are sensitive to sunk costs in first-person scenarios.

4. Experiment 3

4.1. Method

4.1.1. Participants

We tested 31 6-year-olds ($M_{\text{age}} = 6;5$, range = 6;0–6;11, 12 female). In the next two experiments, children were tested individually at schools and daycares in the Waterloo region (Canada).

4.1.2. Materials and procedure

Children were tested in a single condition in which they heard two stories where they were the protagonist (see Fig. 3). Before the stories began, children were told that the stories were about them, and were instructed to imagine the stories were real. The stories were based on the sunk-cost stories from the preceding experiments, but the pictures did not show any characters. The first story described children obtaining the two rocks, and the second story described them obtaining two flowers. The stories, including the comprehension and test questions, were all in second-person (i.e., “*Your* teacher says that *you* can only bring one rock home. Which rock will *you* bring home?”). All children passed the comprehension questions.

4.2. Results

All children passed the comprehension questions. An intercept-only GEE revealed that children’s choices of the high-cost item (50% of responses) did not significantly differ from chance, Wald $\chi^2(1) = 0.00$, $p > .999$ (see Fig. 3).

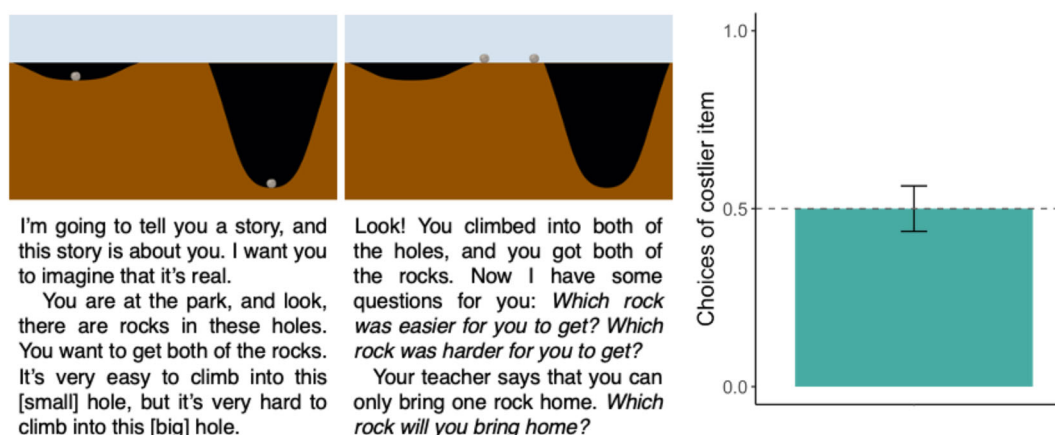


Fig 3. Sample story and results for Experiment 3. Error bar shows ± 1 standard error.

4.3. Discussion

As in the previous experiments, children were not sensitive to sunk costs. This shows that the findings from our first two experiments replicate even when children respond to first-person scenarios. In our final experiment, we explored a further factor known to affect sunk cost judgments in adults. Past research has mostly examined intrapersonal sunk costs where a person's valuation of an object depends on costs *they* have sunk. However, adults are also sensitive to sunk costs in interpersonal contexts, where costs are sunk by *others*. For instance, in one study, adults were told that two friends had each purchased a trip for them on the same day, one that was cheaper and more enjoyable, and the other expensive and less enjoyable (Olivola, 2018). Adults were more likely to choose the less enjoyable trip when it was more expensive, rather when it was cheaper, suggesting they were sensitive to others' sunk costs in their own choices.

5. Experiment 4

5.1. Method

5.1.1. Participants

We tested 34 6-year-olds ($M_{\text{age}} = 6;7$, range = 6;0 – 6;11, 18 female).

5.1.2. Materials and procedure

Children were told two stories (see Fig. 4). In both stories, two characters collected objects (shells in story 1, rocks in story 2), and children were told the objects were for them. One of the characters worked harder to collect their item than the other character. Children decided which of the two objects they would keep.

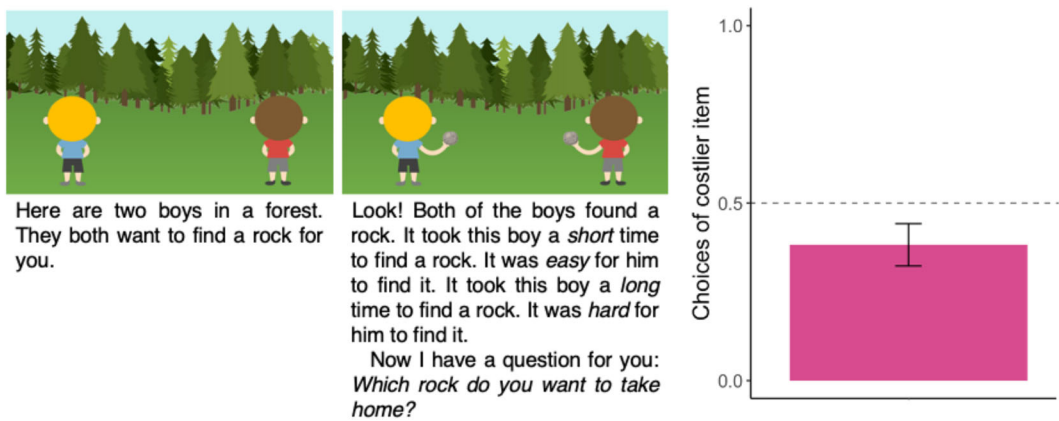


Fig 4. Sample story and results for Experiment 4. Error bar shows ± 1 standard error.

Characters were described from left to right in each story. The location of the low- and high-effort characters were counterbalanced across stories (i.e., left character in first story and right character in second story), and across children (i.e., left character in first story or right character in first story).

5.2. Results

An intercept-only GEE revealed that children's choices of the high-cost item (38% of responses) did not significantly differ from chance, Wald $\chi^2(1) = 3.27$, $p = .070$ (see Figure 4).

5.3. Discussion

We again found that children did not appreciate sunk costs. Children had no clear preference for which object they would keep, indicating that they may be insensitive to others' sunk costs.

6. General discussion

Across four experiments, children were insensitive to sunk costs. For example, children expected that a girl would be no more likely to choose a flower that was difficult to obtain than a flower that was easily obtained, though adults expected the girl to choose the high-cost flower. Children also were not sensitive to sunk costs when they chose between the objects themselves, or when they chose between objects that others collected for them. However, children anticipated that others would minimize costs when obtaining objects. For instance, they anticipated that a girl would be more likely to retrieve a flower from a small hill that was easy to climb, than from a larger one that would require more effort. Together these results show that although children are sensitive to future costs, they do not expect sunk costs to influence decision-making.

Our findings suggest an asymmetry in how young children consider costs when understanding others' actions. The findings from our "future cost" condition join recent work in showing that children expect an agent's valuations and preferences to determine the costs the agent is willing to incur to obtain objects (Jara-Ettinger et al., 2015, 2016, 2020). Specifically, we found that when offered two identical rewards, children predicted an agent would pursue the one that would be less costly to obtain. Likewise, previous work shows that when potential rewards differ from one another, young children understand that agents will incur greater costs for the reward they prefer (Jara-Ettinger, Floyd, Tenenbaum, & Schulz, 2017). However, our experiments also suggest that children do not expect the opposite relation to be true. They do not expect agents' valuations and preferences for objects to depend on the costs incurred to obtain them.

The present work also suggests that young children may struggle to understand and predict irrational behavior. The sunk cost bias is considered irrational, since choosing the high-cost object will not recover or justify the effort spent pursuing it (Arkes, 1996; Arkes & Ayton, 1999; Arkes & Blumer, 1985; Thaler, 1980). In our experiments, adults anticipated this irrational behavior, but children did not. This finding is consistent with recent work suggesting that 5- to 6-year-olds have difficulty understanding that habitual behavior can lead to suboptimal actions, but understand this by age 7 (Goldwater et al., 2020). It is possible that both findings (i.e., our sunk cost findings, and young children's difficulty anticipating nonoptimal habitual behaviors) arise because young children expect others to behave rationally in light of their beliefs and desires, and environmental constraints (e.g., Gergely & Csibra, 2003; Jara-Ettinger et al., 2016; Leslie et al., 2005).

However, this account may not explain why children were insensitive to sunk costs in the final experiment, where children chose between objects that others expended time and effort to obtain. In interpersonal sunk cost scenarios, respecting sunk costs might be considered *rational* (i.e., rather than irrational as in regular intrapersonal scenarios). Rejecting the high-cost object in favor of the low-cost one would likely offend the friend who invested more, so it is arguably rational to consider sunk costs in this situation. This proposal is consistent with findings that people expect others to appreciate expensive gifts more than inexpensive ones (Flynn & Adams, 2009; Zhang & Epley, 2012). Future work needs to be conducted to confirm this speculation by further examining children and adults' interpersonal choices.

Children's insensitivity to sunk costs could also stem from their conceptions of waste. Adults may feel that choosing a high-cost object prevents wasting the cost that was sunk to obtain it (Arkes, 1996; Arkes & Ayton, 1999; Arkes & Blumer, 1985; Bornstein & Chapman, 1995). For example, adults might have felt that if the girl chose the flower from the small hill, the cost she incurred in climbing the big hill would all be for nothing. However, children might not have viewed the costs as going to waste. This account could explain why children in our third experiment, and in previous work (e.g., Morsanyi & Handley, 2008), did not show the sunk cost bias themselves. If children do not view sunk costs as wasted, then this might not only prevent them from anticipating it in others, but also prevent them from being susceptible to the bias in their own choices.

The key claim of this account is that children might not view sunk costs as wasted. This account does not claim that children are oblivious to waste, and indeed some recent work shows that young children do have some aversion to waste. For example, 6–8-year-olds are

less willing to throw away valuable resources than cheaper ones when avoiding inequitable allocation of resources (Choshen-Hillel, Lin, & Shaw, 2020), suggesting that young children are sensitive to waste (see Rossano, Rakoczy, & Tomasello, 2011 for evidence of 3-year-olds' negative response to throwing away resources). However, children might have difficulty viewing time and effort as going to waste in sunk cost situations.

Other accounts might also explain why children did not share adults' sensitivity to sunk costs. For example, adults may have reasoned that if a character incurred high costs to obtain an object, it must have been initially more valuable to the character. Children by contrast might not have drawn this inference—they might believe that identical-looking objects are always similarly valued. We doubt this account for two reasons but acknowledge that future work will be needed for definitive answers. First, it is unlikely that adults thought the character preferred one object from the outset, as the character collected both objects before discovering they could only keep one. Second, previous findings show that young children do recognize that identical-looking objects can be valued differently. Children value objects they make over identical-looking objects (Marsh, Kanngiesser, & Hood, 2018; also see Li, Shaw, & Olson, 2013), and also value objects with distinctive histories over identical ones with mundane histories (Frazier & Gelman, 2009; Gelman, Frazier, Noles, Manczak, & Stilwell, 2015; Hood & Bloom, 2008; Pesowski & Friedman, 2019; for a review, see Gelman & Echelbarger, 2019).

To conclude, our findings suggest that young children expect future costs, but not sunk costs, to influence decision-making. These findings are suggestive of an asymmetry in how children view the relation between costs and valuation of objects. Together, this work advances our knowledge of how children reason about sunk costs, and their ability to predict irrational actions in general.

Note

- 1 The results are not impacted if all adult data are retained in the analysis. There is still a significant effect of age, Wald $\chi^2(1) = 11.96$, $p < .001$, and adults were still more likely to choose the high-effort item (67%) than the low-effort item, Wald $\chi^2(1) = 19.62$, $p < .001$.

Data Availability Statement

The data that support the findings of this study are openly available via the Open Science Framework and can be accessed at <https://osf.io/s79re/>.

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References

- Arkes, H. R. (1996). The psychology of waste. *Journal of Behavioral Decision Making*, 9(3), 213–224. [https://doi.org/10.1002/\(sici\)1099-0771\(199609\)9:3<213::Aid-bdm230>3.0.co;2-1](https://doi.org/10.1002/(sici)1099-0771(199609)9:3<213::Aid-bdm230>3.0.co;2-1)
- Arkes, H. R., & Ayton, P. (1999). The sunk cost and Concorde effects: Are humans less rational than lower animals? *Psychological Bulletin*, 125(5), 591–600. <https://doi.org/10.1037/0033-2909.125.5.591>
- Arkes, H. R., & Blumer, C. (1985). The psychology of sunk cost. *Organizational Behavior and Human Decision Processes*, 35(1), 124–140. [https://doi.org/10.1016/0749-5978\(85\)90049-4](https://doi.org/10.1016/0749-5978(85)90049-4)
- Baron, J., Granato, L., Spranca, M., & Teubal, E. (1993). Decision-making biases in children and early adolescents: Exploratory studies. *Merrill-Palmer Quarterly*, 39, 23–47.
- Barsky, A. P., & Zyphur, M. J. (2016). Disentangling sunk-costs and completion proximity: The role of regulatory focus. *Journal of Experimental Social Psychology*, 65, 105–108. <https://doi.org/10.1016/j.jesp.2016.04.006>
- Berti, A. E., & Bombi, A. S. (1981). The development of the concept of money and its value: A longitudinal study. *Child Development*, 52(4), 1179–1182. <https://doi.org/10.2307/1129504>
- Bornstein, B. H., & Chapman, G. B. (1995). Learning lessons from sunk costs. *Journal of Experimental Psychology: Applied*, 1(4), 251–269. <https://doi.org/10.1037/1076-898x.1.4.251>
- Choshen-Hillel, S., Lin, Z., & Shaw, A. (2020). Children weigh equity and efficiency in making allocation decisions: Evidence from the US, Israel, and China. *Journal of Economic Behavior & Organization*, 179, 702–714. <https://doi.org/10.1016/j.jebo.2019.04.006>
- Csibra, G., & Gergely, G. (2007). ‘Obsessed with goals’: Functions and mechanisms of teleological interpretation of actions in humans. *Acta Psychologica*, 124(1), 60–78. <https://doi.org/10.1016/j.actpsy.2006.09.007>
- Cushman, F. (2020). Rationalization is rational. *Behavioral and Brain Sciences*, 43, e28. <https://doi.org/10.1017/s0140525x19001730>
- Flynn, F. J., & Adams, G. S. (2009). Money can’t buy love: Asymmetric beliefs about gift price and feelings of appreciation. *Journal of Experimental Social Psychology*, 45(2), 404–409. <https://doi.org/10.1016/j.jesp.2008.11.003>
- Frazier, B. N., & Gelman, S. A. (2009). Developmental changes in judgments of authentic objects. *Cognitive Development*, 24(3), 284–292. <https://doi.org/10.1016/j.cogdev.2009.06.003>
- Frisch, D. (1993). Reasons for framing effects. *Organizational Behavior and Human Decision Processes*, 54(3), 399–429. <https://doi.org/10.1006/obhd.1993.1017>
- Garland, H. (1990). Throwing good money after bad: The effect of sunk costs on the decision to escalate commitment to an ongoing project. *Journal of Applied Psychology*, 75(6), 728–731. <https://doi.org/10.1037/0021-9010.75.6.728>
- Garland, H., & Newport, S. (1991). Effects of absolute and relative sunk costs on the decision to persist with a course of action. *Organizational Behavior and Human Decision Processes*, 48(1), 55–69. <https://doi.org/10.1093/acrefore/9780190228637.013.1022>
- Gelman, S. A., & Echelbarger, M. E. (2019). Children, object value, and persuasion. *Journal of Consumer Psychology*, 29(2), 309–327. <https://doi.org/10.1002/jcpsy.1097>
- Gelman, S. A., Frazier, B. N., Noles, N. S., Manczak, E. M., & Stilwell, S. M. (2015). How much are Harry Potter’s glasses worth? Children’s monetary evaluation of authentic objects. *Journal of Cognition and Development*, 16(1), 97–117. <https://doi.org/10.1080/15248372.2013.815623>
- Gergely, G., & Csibra, G. (2003). Teleological reasoning in infancy: The naïve theory of rational action. *Trends in Cognitive Sciences*, 7(7), 287–292. [https://doi.org/10.1016/s0010-0277\(97\)00004-8](https://doi.org/10.1016/s0010-0277(97)00004-8)
- Goldwater, M. B., Gershman, S. J., Moul, C., Ludowici, C., Burton, A., Killer, B., Kuhnert, R. L., & Ridgway, K. (2020). Children’s understanding of habitual behaviour. *Developmental Science*, 23(5), e12951. <https://doi.org/10.1111/desc.12951>
- Hood, B. M., & Bloom, P. (2008). Children prefer certain individuals over perfect duplicates. *Cognition*, 106(1), 455–462. <https://doi.org/10.1016/j.cognition.2007.01.012>

- Jara-Ettinger, J., Floyd, S., Tenenbaum, J. B., & Schulz, L. E. (2017). Children understand that agents maximize expected utilities. *Journal of Experimental Psychology: General*, 146(11), 1574–1585. <https://doi.org/10.1037/xge0000345.supp>
- 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. <https://doi.org/10.1016/j.tics.2016.08.007>
- Jara-Ettinger, J., Schulz, L. E., & Tenenbaum, J. B. (2020). The naive utility calculus as a unified, quantitative framework for action understanding. *Cognitive Psychology*, 123. <https://doi.org/10.1016/j.cogpsych.2020.101334>
- Jara-Ettinger, J., Gweon, H., Tenenbaum, J. B., & Schulz, L. E. (2015). Children's understanding of the costs and rewards underlying rational action. *Cognition*, 140, 14–23. <https://doi.org/10.1016/j.cognition.2015.03.006>
- Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.
- Klaczynski, P. A. (2001). Framing effects on adolescent task representations, analytic and heuristic processing, and decision making: Implications for the normative/descriptive gap. *Journal of Applied Developmental Psychology*, 22(3), 289–309. [https://doi.org/10.1016/s0193-3973\(01\)00085-5](https://doi.org/10.1016/s0193-3973(01)00085-5)
- Klaczynski, P. A., & Cottrell, J. M. (2004). A dual-process approach to cognitive development: The case of children's understanding of sunk cost decisions. *Thinking & Reasoning*, 10(2), 147–174. <https://doi.org/10.1080/13546780442000042>
- Krouse, H. J. (1986). Use of decision frames by elementary school children. *Perceptual and Motor Skills*, 63(3), 1107–1112. <https://doi.org/10.2466/pms.1986.63.3.1107>
- Leslie, A. M., German, T. P., & Polizzi, P. (2005). Belief-desire reasoning as a process of selection. *Cognitive Psychology*, 50(1), 45–85. <https://doi.org/10.1016/j.cogpsych.2004.06.002>
- Li, V., Shaw, A., & Olson, K. R. (2013). Ideas versus labor: What do children value in artistic creation? *Cognition*, 127(1), 38–45. <https://doi.org/10.1016/j.cognition.2012.11.001>
- Liu, S., & Spelke, E. S. (2017). Six-month-old infants expect agents to minimize the cost of their actions. *Cognition*, 160, 35–42. <https://doi.org/10.1016/j.cognition.2016.12.007>
- Marsh, L. E., Kanngiesser, P., & Hood, B. (2018). When and how does labour lead to love? The ontogeny and mechanisms of the IKEA effect. *Cognition*, 170, 245–253. <https://doi.org/10.1016/j.cognition.2017.10.012>
- Moon, H. (2001). Looking forward and looking back: Integrating completion and sunk-cost effects within an escalation-of-commitment progress decision. *Journal of Applied Psychology*, 86(1), 104–113. <https://doi.org/10.1037/0021-9010.86.1.104>
- Morsanyi, K., & Handley, S. J. (2008). How smart do you need to be to get it wrong? The role of cognitive capacity in the development of heuristic-based judgment. *Journal of Experimental Child Psychology*, 99(1), 18–36. <https://doi.org/10.1016/j.jecp.2007.08.003>
- Olivola, C. Y. (2018). The interpersonal sunk-cost effect. *Psychological Science*, 29(7), 1072–1083. <https://doi.org/10.1177/0956797617752641>
- Pesowski, M. L., & Friedman, O. (2019). Children value objects with distinctive histories. *Journal of Experimental Psychology: General*, 148(12), 2120. <https://doi.org/10.1037/xge0000606>
- Rossano, F., Rakoczy, H., & Tomasello, M. (2011). Young children's understanding of violations of property rights. *Cognition*, 121(2), 219–227. <https://doi.org/10.1016/j.cognition.2011.06.007>
- Roth, S., Robbert, T., & Straus, L. (2015). On the sunk-cost effect in economic decision-making: A meta-analytic review. *Business Research*, 8(1), 99–138. <https://doi.org/10.1007/s40685-014-0014-8>
- Strough, J., Mehta, C. M., McFall, J. P., & Schuller, K. L. (2008). Are older adults less subject to the sunk-cost fallacy than younger adults? *Psychological Science*, 19(7), 650–652. <https://doi.org/10.1111/j.1467-9280.2008.02138.x>
- Strough, J., Schlosnagle, L., Karns, T., Lemaster, P., & Pichayayothin, N. (2014). No time to waste: Restricting life-span temporal horizons decreases the sunk-cost fallacy. *Journal of Behavioral Decision Making*, 27(1), 78–94. <https://doi.org/10.1002/bdm.1781>
- Thaler, R. (1980). Toward a positive theory of consumer choice. *Journal of Economic Behavior & Organization*, 1(1), 39–60. [https://doi.org/10.1016/0167-2681\(80\)90051-7](https://doi.org/10.1016/0167-2681(80)90051-7)

- Webley, P., & Plaisier, Z. (1998). Mental accounting in childhood. *Citizenship, Social and Economics Education*, 3(2), 55–64. <https://doi.org/10.2304/csee.1998.3.2.55>
- Wellman, H. M., & Woolley, J. D. (1990). From simple desires to ordinary beliefs: The early development of everyday psychology. *Cognition*, 35(3), 245–275. [https://doi.org/10.1016/0010-0277\(90\)90024-e](https://doi.org/10.1016/0010-0277(90)90024-e)
- Zhang, Y., & Epley, N. (2012). Exaggerated, mispredicted, and misplaced: When “it’s the thought that counts” in gift exchanges. *Journal of Experimental Psychology: General*, 141(4), 667. <https://doi.org/10.1037/a0029223>