

Emotions before actions: When children see costs as causal

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ABSTRACT

Adults expect people to be biased by sunk costs, but young children do not. We tested between two accounts for why children overlook the sunk cost bias. On one account, children do not see sunk costs as causal. The other account posits that children see sunk costs as causal, but unlike adults, think future actions cannot make up for sunk costs. These accounts make opposing predictions about whether children should see sunk costs as affecting emotions. Across three experiments, 4–7-year-olds (total $N = 320$) and adults (total $N = 429$) saw stories about characters who collected items that were easy or difficult to obtain, and predicted characters' emotions and actions. At all ages, participants anticipated that characters would feel sadder about high-cost objects, but only adults predicted that characters would keep high-cost objects. Our findings show that children see incurred costs as causal, and that costs are integrated children's and adults' theory of emotions. Moreover, the findings suggest that developmental differences in sunk cost reasoning may rest in children's incomplete mental accounting. We also discuss children's reasoning about rational and irrational action.

When people invest time, money, or effort into a project, they tend to overvalue it. For example, imagine you have two identical frozen dinners—you bought one on sale and the other at full price. Your freezer breaks, causing the dinners to defrost. You can only eat one dinner, the other will have to be thrown out. Which dinner will you eat? You might choose the full-priced dinner because you do not want to waste the money spent on it. That is, you might show the sunk cost bias—the tendency to find items or projects more valuable when you have invested more into them (Arkes, 1996; Arkes & Ayton, 1999; Arkes & Blumer, 1985; Bornstein & Chapman, 1995). Making choices in this way is irrational (e.g., Arkes & Blumer, 1985; Thaler, 1980). While choosing the full-priced meal might seem to avoid wasting money, the money cannot be recouped regardless of which meal is chosen.

Aside from influencing your decision of which dinner to eat, sunk costs may also influence how you feel. Buying an extra meal feels wasteful and you might especially regret or feel upset about having bought the full-price meal (Arkes, 1996; Dijkstra & Hong, 2019; for other work on affect and sunk costs, see Coleman, 2010; Hafenbrack, Kinias, & Barsade, 2014; Van Putten, Zeelenberg, & Van Dijk, 2010). While basing decisions on sunk costs is irrational, feeling frustrated about them, or regretting them, may not be irrational (for a discussion, see Baron, 1985; Zeelenberg, 1999). It could even be adaptive for people

to feel greater disappointment or regretful about sunk costs, as these emotions could help people make better decisions in the future (e.g., being careful not to buy more dinners than necessary; Zeelenberg, 1999).

Here, we investigate whether young children predict people's decisions and emotions based on sunk costs. Previous work has shown that 5–6-year-olds do not expect decisions to be biased by sunk costs. In a series of experiments, children and adults watched sunk cost scenarios. For example, in one scenario, a girl could keep one of two identical flowers she had collected—a 'high cost' flower from a tall hill that was hard for her to climb, or a 'low cost' flower from a short hill that was easy for her to climb. While adults predicted she would be biased by sunk costs and keep the high-cost flower, children chose between the flowers at chance (Sehl, Friedman, & Denison, 2021). Other studies have also found that children aged 5–12 do not anticipate the sunk cost bias (Baron, Granato, Spranca, & Teubal, 1993; Morsanyi & Handley, 2008; Webley & Plaisier, 1998). However, some studies report that older children aged 8–12 years anticipate the sunk cost bias in choices involving whether to persist in a course of action (Klaczynski, 2001; Klaczynski & Cottrell, 2004).¹

Young children's failure to anticipate that sunk costs bias actions might seem to conflict with findings showing that preschool-aged

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¹ These studies on older children do not provide decisive evidence for the sunk cost bias. For instance, in one study, persisting toward a goal was also the course of action that required the least effort in the future (Klaczynski & Cottrell, 2004).

children make sophisticated inferences about costs (e.g., Aboody, Zhou, & Jara-Ettinger, 2021; Ahl, Cook, & McAuliffe, 2023; Bridgers, Jara-Ettinger, & Gweon, 2020; Sommerville et al., 2018; Zhao & Kushnir, 2023). From as young as age five, children infer an agent's preference for an object by considering the costs required to obtain it (Jara-Ettinger, Gweon, Schulz, & Tenenbaum, 2016; Jara-Ettinger, Gweon, Tenenbaum, & Schulz, 2015; Pesowski, Denison, & Friedman, 2016; see also Amemiya, Heyman, & Walker, 2023; Amemiya, Mortenson, Ahn, Walker, & Heyman, 2022). Further, children and even infants, expect agents to pursue goals while minimizing costs (Gönül & Paulus, 2021; Sehl et al., 2021; see also Gergely & Csibra, 2003; Gergely, Nádasdy, Csibra, & Bfó, 1995; Liu & Spelke, 2017; Schuwerk & Paulus, 2016). However, these two lines of work do not conflict. The work on children's understanding of costs centers on the idea that agents' preferences affect their willingness to incur costs. But sunk cost predictions reverse this inference, and instead involve seeing incurred costs as determining agents' preferences.

Why do children overlook the sunk cost bias? One explanation—suggested by the idea that children see incurred costs as resulting from preferences, but not as affecting them—is that children see costs as having a limited causal role. They recognize that incurring costs can secure a desired outcome, but might not see incurring costs as having other consequences. On this account, once the costs have been incurred (i.e., once they are sunk), children see them as having no further causal relevance. If so, children might also neglect other effects of sunk costs, such as sunk costs leading to emotions like regret or sadness. A related explanation is that children might not tag sought-after items with the costs incurred to obtain them. For example, they might not see one flower as the “high cost” item and the other as the “low cost” item. If children do not tag the flowers with their costs, children should view them as equivalent when predicting which one the girl will keep. On this tagging account, children lack abilities requisite for mental accounting—they do not segregate costs into different mental “accounts” (Baron, 2008; Thaler, 1999; as also suggested by Krouse, 1986; Webley & Plaisier, 1998). Work on children's valuation of objects shows that with age, children increasingly tag objects in terms of their histories (for reviews see Pesowski, Nancekivell, Tasimi, & Friedman, 2022; Gelman & Echelbarger, 2019). For example, whereas children aged 4–5 recognize that objects are more valued if they once belonged to famous individuals, it is not until age 11 that children recognize the heightened value of original creations (Gelman, Frazier, Noles, Manczak, & Stilwell, 2015). It is less clear whether children tag objects with the effort invested in obtaining them. Children around age 5 prefer objects they built over identical alternatives (Marsh, Kanngiesser, & Hood, 2018; see also Marsh, Gil, & Kanngiesser, 2022), and other findings suggest children's own effort pursuing goals affects their valuations (Benozio & Diesendruck, 2015; also see Katz, Kushnir, & Tomasello, 2024). But almost no work has looked at third person valuations.

On another account, children overlook the sunk cost bias because they do not think future actions can make up for sunk costs. Whereas adults see eating the full-price dinner and keeping the high-cost flower as avoiding a major loss of spent money and effort, children may not share this view. On this account, children may still see incurred costs as causally relevant for emotions—they may anticipate that incurring costs can lead people to feel sad or regretful. Finding that children consider sunk costs as causally relevant for emotions would suggest that children are not entirely insensitive to sunk costs as we may have previously thought.

We tested between these accounts in three experiments. In each experiment, participants saw stories about characters who collected items that were easy and difficult to obtain. In Experiment 1, we first tested whether 4–7-year-olds use sunk costs to infer others' emotions. In Experiment 2, we again tested whether children used sunk costs to infer emotions and also whether they use sunk costs to infer actions. As a point of comparison, we also examined these questions with a sample of adult participants. In Experiment 3, we replicated children's and adults'

emotion predictions with different vignettes and contrasted it with another action prediction.

1. General method

All experiments but Experiment 1 were preregistered. The pre-registrations, materials, data, and code are available online at <https://osf.io/mvf87/>

We tested children in all three experiments. Most children were tested in person (total $N = 226$) but some were tested online (total $N = 94$). In both cases, the experimenter narrated the scenarios and questions about them. For in-person testing, children were shown pictures individually on a laptop at local schools and a museum in Waterloo, Ontario, Canada. Demographic information was not formally collected, but the region is predominantly middle-class, and approximately 79% of residents are White, with Chinese and South Asians as the most visible minorities. For online testing, children were tested individually in a live video call, in the presence of their parent or guardian. Parents were instructed to look down or to turn away from the screen while testing took place. Children answered test questions by identifying the color of clothes the characters were wearing (Experiment 1) or the color box that highlighted the items (Experiments 2 & 3). Before completing the test trials, children were asked two comprehension questions about where it was easy and difficult to obtain the items. We excluded children who failed any of the three comprehension checks three times in a row. In Experiments 1–2, comprehension questions were asked after the initial vignette, and in Experiment 3 they were asked before both test trials.

In Experiments 2 and 3 we also tested adults recruited from CloudResearch (Litman, Robinson, & Abberbock, 2017). They were located throughout the United States and were required to have completed at least 100 HITs with a 95% acceptance rate. They completed the experiments over Qualtrics and so they read the stories and questions. Adults answered post-test attention checks to ensure they read the stories (three questions in Experiment 2, two questions in Experiment 3). We excluded adults who neglected to answer the test trials or failed at least one of the post-test multiple-choice attention checks.

2. Experiment 1

2.1. Method

2.1.1. Participants

We tested 80 four- to seven-year-olds ($M_{age} = 5;11$ [years;months], range = 4;0–7;11, 35 female, 45 male; 20 children per age in years). One additional 4-year-old was excluded for not answering comprehension questions correctly.

2.1.2. Procedure

Children saw pictures of two characters each standing beside a bookshelf and heard a story about the characters collecting toys from them (see Fig. 1). In each trial, one of the toys was lower on a bookshelf and the other was higher on a bookshelf, and characters each collected the toy from their respective bookshelf. The characters then learned that the toys were broken, and children were asked which character was sadder.

In one within-subjects condition, the characters were short, so it was easy to retrieve toys on low shelves and difficult to retrieve toys on high shelves. In the other condition, the characters were tall, so the opposite was true. Children completed a total of four trials; two trials in each condition. Trials within each condition were shown in a fixed order: the short characters first obtained cars (higher one on left), and then boats in the second trial (higher one on right); the tall characters first obtained jack-in-the-boxes (higher one on left), and beach balls in the second trial (higher one on right).



Fig. 1. Sample stimuli and script in Experiment 1.

2.2. Results

In all experiments, we analyzed the results using generalized estimating equation models (GEE; binary logistic, independent correlation matrix). Age in months (mean-centered) was entered as a covariate, with condition as a within-subjects factor. There was a main effect of condition, as children were more likely to select the child who retrieved the toy from the higher shelf in the short character trials than the tall character trials, $F(1) = 30.56, p < .001$, see Fig. 2. There was no main effect of age, $F(1) = 0.62, p = .432$, but there was a significant interaction between trial type and age, $F(1) = 20.12, p < .001$. This interaction resulted because for the short character trials, children were more likely to select the character who retrieved the toy from the higher shelf as they got older, $p < .001$. For the tall character trials, children were more likely to select the character who retrieved the toy from the lower shelf as they got older, $p = .015$.

To pinpoint the age where responses in the short character and tall character trials first diverged, we examined when their 95% confidence

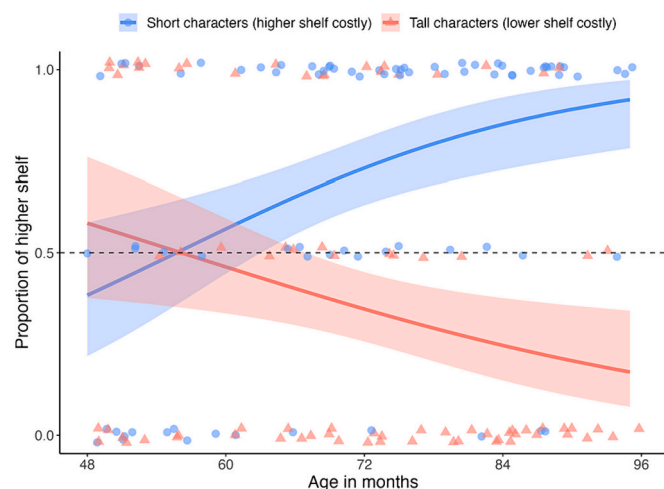


Fig. 2. Results of Experiment 1, showing the proportion of children's selection of the character with the higher shelf as a function of trial type and age. In all graphs, colored bands and error bars show 95% confidence intervals, and points are jittered to avoid overplotting.

intervals no longer overlapped.² This was at age 5;5; short character judgment, $CI_{95\%}$ [0.53, 0.73]; tall character judgment $CI_{95\%}$ [0.34, 0.51]. The confidence intervals also show that responses in the short character trials first went above chance (toward the tall shelf) at 5;4, $CI_{95\%}$ [0.52, 0.72], and responses in the tall character trials first fell below chance (toward the low shelf) at 5;8, $CI_{95\%}$ [0.29, 0.49].

2.3. Discussion

We found that around age five, children considered others' sunk costs to infer emotion. They judged that the character who exerted more effort toward a failed goal would be sadder than a character who exerted less effort. Children inferred this for short and tall trials, suggesting that they did not simply associate greater sadness with a character who obtained their toy from a larger shelf—that is, their responses did not reflect “more-is-more” reasoning (see Stavy, Tsamir, & Tirosh, 2002). Instead, children predicted that the character who exerted greater effort toward collecting their toy would be sadder.

These findings suggest that while children do not use sunk costs to predict actions (e.g., Sehl et al., 2021), they can use sunk costs to predict emotions. If so, this would support the account which predicts that children consider sunk costs as causal. However, this finding is inconsistent with the account claiming that children see costs as non-causal, and as incapable of affecting both emotions and actions. To be more certain about this conclusion, though, in the next experiment we compared predictions of emotions and actions in a single experiment. As an extra precaution, the next experiment also included a sample of adults. For reasons discussed below, we wanted to be sure they would predict that actions would be biased by sunk costs.

One concern with the present experiment is that children might have identified the high-cost character as sadder, without thinking that incurring greater costs caused the character to be sadder. Instead, children may have inferred the value each character placed on their toy. They could have assumed that the character who worked harder would

² This approach provides a conservative estimate for the age in which responses in each condition differ and when responses differ from chance (for use of this approach, see Blake et al., 2015; see also Corbit, 2020; Lee & Warneken, 2020). This approach is considered conservative because it is possible to have significant p -values when CIs do not overlap (Greenland et al., 2016).

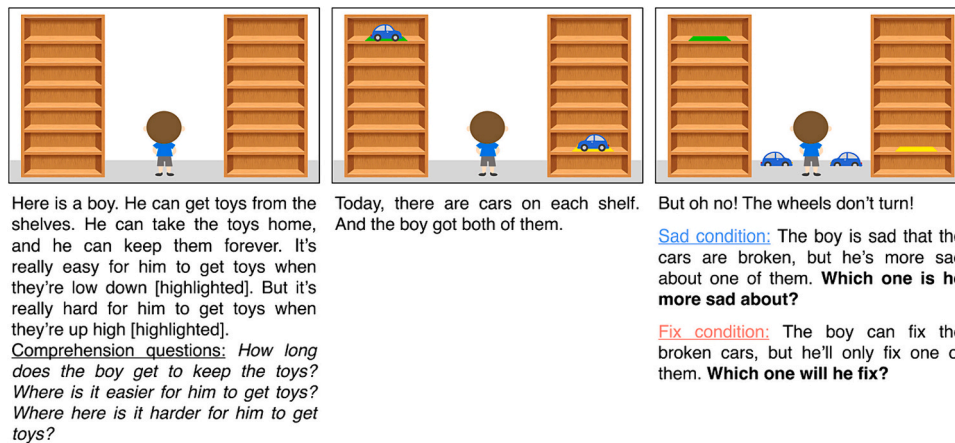


Fig. 3. Sample stimuli and script for Experiment 2.

like their toy more and thus be sadder if it broke. To address this concern, the next experiment used stories where one character collected identical objects, instead of two separate characters each collecting an object. This design avoids this alternative explanation because it is unlikely that a character would initially value one toy over an identical one.

3. Experiment 2

In this experiment, participants watched a boy collect two toys that he later discovered were broken. Participants were either asked about his emotions ("Which [toy] is the boy more sad about?") or his actions ("Which [toy] will the boy fix?"). We asked about fixing the broken toy because this action fits with the idea that sinking costs in a goal increases people's tendency to pursue it (e.g., Arkes & Blumer, 1985; Bornstein & Chapman, 1995). However, because we do not know of previous experiments to use this measure, we included an adult sample to be sure this action judgment would produce sunk cost predictions.

3.1. Method

3.1.1. Participants

We tested 120 five- to seven-year-olds ($M_{age} = 6;5$, range = 5;0–7;11, 73 female, 47 male; 40 children per age in years) and 217 adults ($M_{age} = 39.22$, range = 22–76, 76 female, 137 male, 4 other/unspecified). An additional 14 children and 22 adults were tested but excluded due to our preregistered exclusion criteria.³

3.1.2. Procedure

Participants saw pictures of a boy standing beside two bookshelves and heard a story about him collecting toys from them (see Fig. 3). The boy retrieved a toy from up high on one bookshelf, and one low down on the other bookshelf. The boy was short so it was easier to retrieve toys from lower shelves. In each of four trials, participants saw that the boy collected both toys, and were either asked which toy the boy was sadder about, or which toy the boy would fix (between-subjects).

Before completing test trials, participants were informed that the boy could take the toys home and keep them forever. After, children were

asked an additional comprehension question about how long the boy could keep the toys. The test trials were shown in a fixed-order: cars (higher one on left), boats (higher one on right), jack-in-the-boxes (higher one on right), beach balls (higher one on left).

To explore whether asking about the boy's sadness impacts children's response to the fix judgment, we asked children which toy the boy would fix after the last trial in the sadness condition. We discuss the results in the Supplemental Materials.

3.2. Results

Figure 4 shows children's and adults' sad and fix judgments. We first ran separate analyses on children and adults, but also report an exploratory analysis comparing their responses.

3.2.1. Children

There was a main effect of condition, as children were more likely to select the high-cost toy when judging which toy the boy was sadder about than which one the boy would fix, $F(1) = 44.74$, $p < .001$. There was also a main effect of age, as children were more likely to select the high-cost toy with age, $F(1) = 4.12$, $p = .043$. There was a significant interaction between condition and age, $F(1) = 6.18$, $p = .013$.

To follow-up on this interaction, we separately examined responses in each condition. In the sad condition, there was no effect of age, $p = .727$, with children mostly predicting the boy would be sadder about the high-cost toy, $CI_{95\%} [0.61, 0.76]$. By contrast, in the fix condition, older children were more likely than younger ones to predict the boy will fix the low-cost toy, $p = .003$, and responses first fell below chance (toward the low-cost toy) at 5;8, $CI_{95\%} [0.31, 0.48]$. Responses in the sad and fix conditions first diverged at age 5;5; sad judgment, $CI_{95\%} [0.57, 0.76]$; fix judgment $CI_{95\%} [0.34, 0.54]$.

3.2.2. Adults

There was a main effect of condition, as adults were more likely to select the high-cost toy in the sad condition than the fix condition, $F(1) = 38.18$, $p < .001$, see Fig. 5. Adults mostly predicted the boy would be sadder about the high-cost toy, $p < .001$, $CI_{95\%} [0.79, 0.91]$, but only indicated it at chance when predicting which toy he would fix, $p = .641$, $CI_{95\%} [0.39, 0.57]$.

3.2.3. Exploratory analysis

We compared children's and adults' responses using a binary logistic GEE with age (child, adult) and condition (sad, fix) as predictors. There was a main effect of condition, as participants were more likely to select the high-cost toy in the sad condition than the fix condition, $F(1) = 82.17$, $p < .001$. There was also a main effect of age, as adults were more likely to select the high-cost toy than children, $F(1) = 21.76$, $p < .001$.

³ All excluded children passed our second and third questions, but failed the first one, "How long does the boy get to keep the toys". The correct answer was "forever" (though we also accepted variations of this, e.g., "a long time", "100 days", etc.) but many children failed with answers like "a few minutes" or "for the day". Regardless, when data from the excluded children are retained in the analysis, the results come out the same (see Supplemental Materials for the analysis and plot).

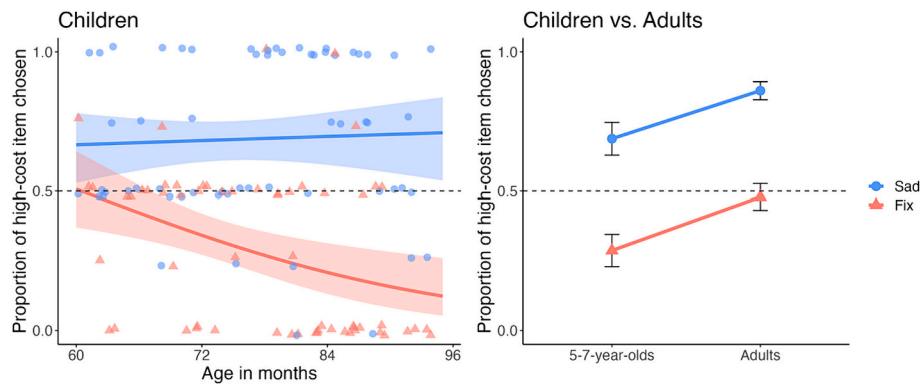


Fig. 4. Results for Experiment 2. The left graph shows children's responses in the sad and fix conditions by age. The right graph provides a comparison between children's and adults' responses across conditions.

There was no interaction between condition and age, $F(1) = 0.27$, $p = .602$.

3.3. Discussion

Children at all ages and adults predicted that characters would be sadder about high-cost toys than low-cost ones. These findings again suggest that children use sunk costs to predict emotions. Further, these results suggest that children's sadness judgments in Experiment 1 were not merely driven by the inference that the high-cost character initially valued their toy more than the low-cost character.

However, neither children nor adults inferred that the character would fix the high-cost toy. These findings raise the question of whether adults saw the scenario as involving sunk costs. If they did not, this might explain why adults didn't expect the boy to honor sunk costs when deciding which toy to fix. To address this question, we showed adults the same scenarios (plus versions where the toys were not broken) and asked them which toy the boy would keep and which he would play with (see Supplemental Material). Adults predicted the boy would choose the high-cost objects, $p < .001$. This finding shows that adults *did* see the situation as involving sunk costs, and likewise suggests that fix judgments are less susceptible to sunk cost effects. An explanation for this comes from work showing that adults are less likely to predict others will be biased by sunk costs when the future investment is greater than the sunk costs (Thames, 1996; see also Arkes and Blumer, 1985; Garland, 1990; Olivola, 2018). That is, adults may have thought that fixing the toys would require greater effort compared to acquiring them initially, making the (sunk) costs of obtaining the toys appear trivial in comparison to the future cost of repairing them.

Returning to children, what do the findings tell us about how they see sunk costs? Again, the findings suggest children use sunk costs to predict emotions. But given the adult findings, we cannot conclude much from their fix judgments. It's also difficult to understand why younger children chose between the toys at chance whereas older children predicted the character would fix the low-cost toy. One explanation is that this effect was driven by children's experiences with fixing broken things. Whereas younger children likely have little experience with this, older children might recognize that fixing takes time and effort and might have preferred to invest further effort into the toy that had seen less prior investment (i.e., a kind of reverse sunk cost effect). Admittedly, this explanation is speculative and entirely post hoc (i.e., we never would have predicted the developmental trend) and it also does not explain why adults' fix judgments more closely resemble those of the younger children.

4. Experiment 3

In the final experiment, we again compared how children and adults

use sunk costs to infer emotion and action. But rather than asking about fixing items, we instead asked participants to judge which of two items a character would keep, since this measure has been used in previous work on adults' sunk cost predictions (Arkes & Blumer, 1985; Baron et al., 1993; Sehl et al., 2021).

4.1. Method

4.1.1. Participants

We tested 120 five- to seven-year-olds ($M_{age} = 6;6$, range = 5;0–7;11, 62 female, 58 male; 40 children per age in years) and 212 adults ($M_{age} = 41.29$, range = 21–72, 102 female, 109 male, 1 other/unspecified). All children answered the comprehension questions correctly, so none were excluded. Data were excluded from an additional 23 adults who failed the first post-test multiple-choice comprehension check.⁴

4.1.2. Procedure

Participants saw two stories about a character who collected two identical items (see Fig. 5). One was easy for them to obtain (e.g., a flower from a short hill) and the other was difficult for them to obtain (e.g., a flower from a tall hill). After the character collected both items, they learned that they were not allowed to keep both of them. In one between-subjects condition, participants were asked which item the character was sadder about; for example, "the girl is sad that she can't keep both of the flowers, but she's more sad about one of them. Which one is she more sad about?". In the other condition, participants were asked which item the character would keep; for example, "the girl cannot keep both flowers, but she can keep one of them. Which one will she keep?". The location of the high-cost item was on the right in the first story, and on the left in the second story.

4.2. Results

Figure 6 shows children's and adults' sad and keep judgments. As before, we first ran separate analyses on children and adults, and then ran an exploratory analysis comparing their responses.

4.2.1. Children

There was a main effect of condition, as children were more likely to select the high-cost item in the sad condition than the keep condition, $F(1) = 18.99$, $p < .001$. There was no main effect of age, $F(1) = 1.81$, $p =$

⁴ We also preregistered that we would exclude participants if they failed the second comprehension check. However, this question had a response option that was easily confused with the correct answer. Using this exclusion criterion would remove an additional 58 participants, so we included their responses in our analyses. However, excluding responses from these participants does not impact the results.

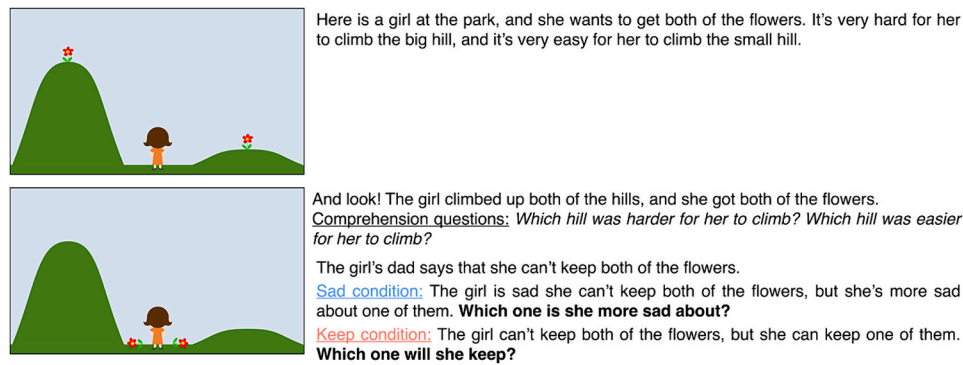


Fig. 5. Sample stimuli and script for Experiment 3.

.179, and no interaction between condition and age, $F(1) = 0.02$, $p = .896$. Single-sample tests against chance revealed that children mostly chose the high-cost item in the sad condition, $p < .001$, $CI_{95\%}$ [0.73, 0.89], but children's responses did not differ from chance in the keep condition, $p > .999$, $CI_{95\%}$ [0.40, 0.60].

4.2.2. Adults

There was a main effect of condition, as adults were more likely to select the high-cost item in the sad condition than the keep condition, $F(1) = 3.91$, $p = .048$. However, in both conditions, adults mostly indicated the high-cost item; sad condition, $p < .001$, $CI_{95\%}$ [0.92, 0.99], keep condition, $p < .001$, $CI_{95\%}$ [0.84, 0.95].

4.2.3. Exploratory analysis

There was a main effect of condition, as participants were more likely to select the high-cost item in the sad condition than the keep condition, $F(1) = 18.26$, $p < .001$. There was also a main effect of age, as adults were more likely to select the high-cost item than children, $F(1) = 42.46$, $p < .001$. There was an interaction between condition and age, $F(1) = 4.04$, $p = .044$. This interaction resulted because there was a greater effect of age in the keep condition than the sad condition; keep $M_{diff} = 0.38$, $p < .001$; sad $M_{diff} = 0.11$, $p = .004$.

4.3. Discussion

We found further evidence that as early as age 5, children use sunk costs to infer emotions. However, while adults predicted that the character would keep the high-cost item, 5–7-year-olds chose between objects at chance.

5. General discussion

Young children and adults used sunk costs to infer others' emotions. They expected that characters would be more upset about broken toys that were harder to get, and more upset about leaving behind items they worked harder to collect. However, only adults used sunk costs to infer action (an exception is Experiment 2, which we discuss below). While adults expected characters would keep high-cost items, children chose between high-cost and low-cost items at chance. Overall, these results suggest a developmental lag. While children understand how sunk costs can affect emotions, it is only later that people think others will honor sunk costs.⁵

⁵ The second experiment also included an anomalous finding: Adults did not predict characters would honor sunk costs when deciding which toy to fix. As discussed above, this likely resulted because of considerations specific to the question about fixing, given further findings that adults expected sunk costs to be honored in decisions about which object to play with and keep (see Supplemental Materials).

Our findings show that incurred costs are also integrated into children's and adults' theory of emotions (e.g., Harris, 2008; Ong, Zaki, & Goodman, 2015; Saxe & Houlihan, 2017; Walle & Lopez, 2020; Wellman & Banerjee, 1991). Some prior work hinted that adults link emotions with sunk costs (e.g., Dijkstra & Hong, 2019; Wong & Kwong, 2007; Zeelenberg & Van Dijk, 1997). For example, one study found that people often discuss negative emotion when justifying why they think others will be biased by sunk costs (Arkes, 1996). But none of this work directly showed that adults expect sunk costs to cause negative emotions. Also, while developmental work has investigated if children and adolescents use sunk costs to predict actions, this work did not look at emotion predictions (e.g., Baron et al., 1993; Morsanyi & Handley, 2008; Sehl et al., 2021; Webley & Plaisier, 1998). The connection between costs and emotions was also not explored in work examining how children infer emotions (e.g., Hadwin & Perner, 1991; Harris, Johnson, Hutton, Andrews, & Cooke, 1989; Lagattuta, 2005) and reason about costs (e.g., Jara-Ettinger et al., 2016; Powell, 2022).

Our findings are informative about why children fail to anticipate that sunk costs bias actions. One explanation we considered is that children see sunk costs as effects, but not as causes. But contrary to this account, we found that children recognize that incurring costs does affect people's emotions. A related account is that children overlook sunk costs because they do not tag objects with the effort invested to obtain them. Again, children's emotion inferences speak against this. Children must have tracked which flower was high-cost and low-cost in order to infer that the girl would be sadder about the flower from the tall hill. So, children tag objects with their costs, just as they tag them with other aspects of their histories (Gelman & Echelbarger, 2019; Pesowski et al., 2022).

A more promising explanation relates to potential differences between how mental accounting works in children and adults. In mental accounting, adults see actions as existing on an internal balance sheet (Thaler, 1985, 1999). For example, getting a reward with little effort is profitable, whereas spending a lot of effort on a meager reward may only count as breaking even or as a loss. Adults also often see these transactions as occurring in separate accounts—instead of looking at the net balance across all actions, they look at them in isolation. So, when the girl learns she can keep only one flower, adults see her as faced with either a small loss for the low-cost flower or a greater loss for the high-cost one. To minimize losses, adults predict she will choose the high-cost flower.

Children may complete some but not all aspects of mental accounting. Children's emotion inferences suggest that they treated actions as existing in separate accounts (c.f., Baron, 2008; Krouse, 1986; Thaler, 1999; Webley & Plaisier, 1998). After all, if children did not do this (i.e., if they had not separately tagged objects with the effort required to obtain them), they should have viewed the girl as equally sad about them. However, children may not retrospectively calculate the balance of each account by considering sunk costs relative to rewards. So although children recognize that the flower from the tall hill represents a

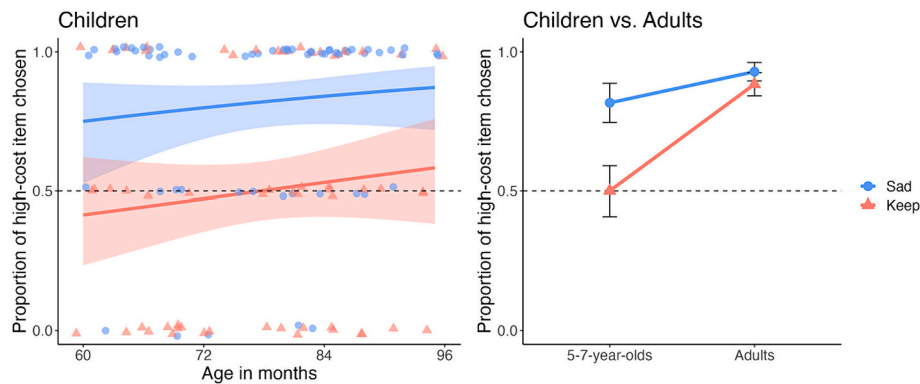


Fig. 6. Results for Experiment 3. The left graph shows children's responses in the sad and keep conditions by age. The right graph provides a comparison between children's and adults' responses across conditions.

greater loss, they do not see keeping that flower as offsetting this loss. Put another way, whereas adults see sunk costs as recoupable, children do not.⁶

We consider one further account. In adults, sunk cost predictions could hinge on avoiding negative emotional reactions. For example, adults might reason about the flower scenario as follows: 1) The girl feels sadder about the prospect of not keeping the flower from the tall hill; 2) The girl wants to avoid sadness; 3) So she will keep the flower from the tall hill. This account relates to other claims that emotions are central to the sunk cost bias (Arkes & Blumer, 1985; Dijkstra & Hong, 2019) and on this kind of view honoring sunk costs is not necessarily irrational—on the contrary, it is emotionally healthy. But on this account, children's judgments are surprising: Children recognized how sinking costs can lead to negative emotions. So why didn't they predict that characters would act to minimize these emotions?

One answer is that children do not *spontaneously* consider emotions when thinking about sunk cost scenarios—they only infer emotions if explicitly asked about them. So, perhaps children didn't expect the girl to minimize sadness because the children who predicted which flower the girl would keep were not prompted to consider how she felt. A second answer is that children (and adults) might not see sunk costs in our scenarios as producing *strong* emotions. That is, although participants might recognize the girl feels sad about losing the flowers, they might not think she feels much sadder about losing the one from the big hill, and the difference in sadness might not be enough to drive action predictions.

The present work also speaks to children's reasoning about rational and irrational action in general. Much previous research has suggested that expectations of rationality underlie children's social judgments. Young children anticipate that others act intentionally to fulfil their desires and goals (e.g., Gergely & Csibra, 2003; Jara-Ettinger et al., 2015; for overviews see Rakoczy, 2017, 2022). However, extant research has suggested that children struggle to predict irrational action (e.g., Goldwater et al., 2020; Sehl et al., 2021). For instance, before age 7, children fail to anticipate that a character who repeatedly reaches for a lamp at one location may continue to reach for it there (i.e., out of habit) even after it has been moved (Goldwater et al., 2020). Our findings offer more evidence that children do not predict irrational action as they did not predict that others would (irrationally) honor sunk costs. While children did understand that sunk costs affect emotions, these emotions are not in themselves irrational (Baron, 1985; Zeelenberg,

1999).

One explanation for children's difficulty predicting irrationality is that they are more rational than adults (in some respects at least). On this view, biases that contribute to irrationality (e.g., over-extending a waste-not rule) are learned (e.g., Gualtieri & Denison, 2018; Lucas, Bridgers, Griffiths, & Gopnik, 2014; Seiver, Gopnik, & Goodman, 2013; for a review, see Buchsbaum, Seiver, Bridgers, & Gopnik, 2012; Gualtieri & Finn, 2022). This possibility conflicts with long-standing views of preschool children as pre-logical (Piaget, 1954) and may also struggle to explain why children engage in seemingly irrational actions like over-imitation (Lyons, Young, & Keil, 2007; c.f., Buchsbaum, Gopnik, Griffiths, & Shafto, 2011; Keupp, Behne, & Rakoczy, 2018). As we have seen, children's neglect of the sunk cost bias may reflect incomplete mental accounting. This could be viewed as indicative of early rationality, since some aspects of mental accounting do produce irrational biases, such as the sunk cost effect itself. More likely, though, incomplete mental accounting should be viewed as mere immaturity, since the procedures needed for full-fledged mental accounting (e.g., weighing costs and benefits retrospectively) may help save time and effort when making decisions, and might also help guide future actions by avoiding waste before it happens (e.g., Thaler, 1999).

6. Future directions

Given that children succeeded in recognizing how sunk costs can impact emotions, it might seem that changing testing methods might likewise reveal that children recognize how sunk costs impact actions. One potential change would be to have children imagine that they are the ones collecting the objects. However, previous work has already used this approach and found otherwise (Baron et al., 1993; Sehl et al., 2021). Another change might be to use scenarios where the choice between items is more consequential. In our tasks, children might have felt the choice didn't matter much. For example, even though the girl could only keep one flower, children probably anticipated that many other flowers would be readily available to her in the future.

Further methodological changes might also tell us more about how children see the relation between sunk costs and emotions. One potential change would be to use continuous measures that include a midpoint. This could reveal the degree to which children think the character will be sadder about losing one item rather than the other. It might also be informative to examine judgments about interpersonal sunk cost scenarios (Olivola, 2018), where costs are incurred by people besides the main character. An example would be if the girl's friends collected the flowers for her and she had to choose which to keep and which to discard. With these scenarios, the girl might not feel sadder about giving up the costlier flower, but the choice might prompt other emotions—perhaps guilt.

⁶ This conclusion could be too strong — children might think sunk costs can be recouped in *some* circumstances. For example, suppose that after learning she cannot keep both flowers, the girl is offered a windfall of many other flowers. Perhaps children would see this as a large gain for the girl (i.e., rather than seeing it as a large gain accompanied by a small loss).

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CRedit authorship contribution statement

Claudia G. Sehl: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing, Funding acquisition. **Ori Friedman:** Conceptualization, Funding acquisition, Writing – review & editing. **Stephanie Denison:** Conceptualization, Funding acquisition, Writing – review & editing.

Data availability

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/mvf87/>

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.cognition.2024.105774>.

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