Who feels more sad? Children reason about sunk costs to infer emotions

Claudia G. Sehl (claudia.sehl@uwaterloo.ca)
Psychology Department, University of Waterloo

Stephanie Denison (stephanie.denison@uwaterloo.ca)
Psychology Department, University of Waterloo

Ori Friedman (friedman@uwaterloo.ca)
Psychology Department, University of Waterloo

Abstract

People expect that others will be biased by sunk costs in their decisions. However, previous work has shown that children do not hold this same expectation. In our work, we examined whether children make other inferences about sunk costs. Specifically, we wondered whether they would anticipate that sunk costs lead others to experience negative emotions, like sadness. In two experiments, we showed children aged five to seven years (N = 168) agents who expended high- or low-costs to obtain objects that were subsequently lost or broken. We found that from around age five, children predicted that an agent will be sadder if they invested greater effort to obtain an object. We show that this expectation is not based on a simple tendency to attribute greater emotions to agents who overcame larger obstacles. Our work shows that children are not entirely insensitive to sunk costs, as previous work may have suggested.

Keywords: emotion; sunk cost bias; theory of mind; cognitive development

Introduction

People are often faced with choices where they consider the time, money, or effort they invested in a project. For example, imagine an art student preparing for an exhibit spent three weeks creating a sculpture. At the end of the last class, a flash of inspiration strikes and in a few minutes she produces another sculpture that she likes even better. Nonetheless, the art student may submit her original project because she is biased by sunk costs—the effort and time she invested in the first project.

The sunk cost bias occurs when people continue to invest in a project because they have already invested resources into it (Arkes, 1996; Arkes & Ayton, 1999; Arkes & Blumer, 1985; Baron et al., 1993; Bornstein & Chapman, 1995; Dijkstra & Hong, 2019; Frisch, 1993; Garland, 1990; Garland & Newport, 1991). According to this bias, the art student only values her original sculpture more than the other because she spent a lot more time and effort creating it. However, this choice is widely considered as irrational (e.g., Arkes & Blumer, 1985; Thaler, 1980). She may feel that choosing her original sculpture will avoid those three weeks of work going to waste. Unfortunately, submitting this sculpture to the exhibit will not recover the work she put into it, and so she should instead submit the sculpture based on her current preference (i.e., the new project), irrespective of sunk costs.

Studies investigating the sunk cost bias in adults often present people with vignettes like the opening example[1]. Participants consider two projects, one that they invested more resources into than the other and then must decide which of the two they will persist with. Adults typically choose the alternative that more resources were invested in (Arkes & Blumer, 1985; Baron et al., 1993; Dijkstra & Hong, 2019; Garland & Newport, 1991; Frisch, 1993; Strough et al., 2008; 2014). Importantly, they also predict that others will be biased by sunk costs (Bornstein & Chapman, 1995), and are even biased by sunk costs when choosing between alternatives that others invested in (Olivola, 2018). For instance, participants in one study imagined that two friends had each gifted them a vacation, but they could only choose one because the trips were booked for the same week. People largely preferred to go on the more expensive vacation, showing that they were sensitive to how much the friends spent on the vacations. Together, this work shows that people are biased by sunk costs in several kinds of scenarios.

Though the bias is pervasive with adults, previous work found that children do not anticipate that others will be biased by sunk costs. In one study, 5-6-year-olds were shown a character who collected a low-cost and high-cost item, such as a flower atop a short hill and an identical one atop a tall hill (Sehl et al., 2021). Children then learned that the character could only keep one item, and predicted which one the character would choose. Adults were biased by sunk costs, such that they predicted that the character would

[1] The sunk cost bias has also been explored in "progress" decisions (distinction highlighted by Moon, 2001; Roth et al., 2015). These scenarios involve continuing to allocate resources towards a failing project, such as investing more money into a failing business venture (e.g., Arkes & Blumer, 1985; Barsky & Zyphur, 2016). For the purposes of our studies, we examine "adoption" decisions (i.e., where people choose between two alternatives they already invested in) to investigate if sunk costs impact children's emotions about objects.

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select the high-cost item, though children chose between the items at chance-level. However, children were not entirely insensitive to costs. In the same study, after the character collected both objects, two new objects appeared, and children predicted which one the character would go get. Consistent with previous work showing that children expect others to minimize the costs of their actions towards goals (e.g., Gönül & Paulus, 2021; Jara-Ettinger et al., 2015; Paulus & Sodian, 2015; see also Gergely et al., 1995), children expected that the character would retrieve the low-cost item.

It is an open question for why adults, but not children, expect others to be biased by sunk costs. One reason for this developmental difference might be that children struggle to predict irrational action. Children anticipate that others will act rationally in light of their preferences, beliefs, and desires (e.g., Cushman, 2020; Gergely & Csibra, 2003). For instance, from as young as 12 months of age, infants expect others to take the most efficient path to a goal (Csibra & Gergley, 2007; Gergely et al., 1995; Gergely & Csibra, 2003; Liu & Spelke, 2017; Scott & Baillargeon, 2013). To our knowledge, only one other study examined whether children predict irrational or suboptimal action (Goldwater et al., 2020). In this study, children learned that an agent developed a habit (e.g., reaching to the left side of the bed to turn on a reading light), but the conditions changed so that the habitual action would no longer be successful (e.g., staying in a different room where the reading light is on the right side of the bed). When predicting agents' actions in this new context, children younger than seven years did not predict that they would act out of habit (i.e., they anticipated that the agent would still reach towards the left side of the bed to turn on the reading light). This finding, along with previous work on sunk costs (Sehl et al., 2021; Webley & Plaisier, 1998), suggest that children younger than seven years may struggle to anticipate that others may not behave rationally or optimally towards their goals.

Sunk Costs and Emotions

Though children may struggle to predict that sunk costs lead to irrational *behavior*, perhaps they can reason about sunk costs in another way. One such inference could be about sunk costs leading to *negative emotions*. Reconsider the opening example with a twist: as the art student inspects her sculptures to decide which to submit to the exhibit, another student trips and falls, knocking over the table. Both sculptures are horribly broken beyond repair. Which sculpture is the student more upset about? This choice also involves considerations about sunk costs: she might be more upset about the sculpture she worked harder on.

This emotion judgment may lead children to consider sunk costs because it may not be irrational to be sad about sunk costs. Feeling disappointment or regret for not being able to recoup sunk costs is a natural emotional response. It might even be functional to feel greater disappointment or regret for greater sunk costs—after all, these emotions might prompt people to be more careful next time. So, children might be more sensitive to the emotions that sunk costs elicit. Discovering how children infer emotions from sunk costs will be informative for their understanding of costs.

We investigated whether children use sunk costs to infer others' emotions in two experiments. Four- to seven-year-olds were told stories about characters collecting objects. One character effortfully obtained an object (e.g., climbed a tall tree for an apple) and the other obtained an object with less effort (e.g., climbed a short tree for an identical apple). In Experiment 1, children predicted which character would be sadder if their objects blew away, or which character would be happier if they successfully obtained their objects. In Experiment 2, children saw similar scenarios about characters collecting toys, but we specifically contrasted situations where the toys took more and less effort to obtain.

Experiment 1

Methods

Participants We tested 88 children: 31 four-year-olds (M_{age} = 4;6 [years;months], range = 4;0 – 4;11, 15 female), 28 five-year-olds (M_{age} = 5;5, range = 5;0 – 5;11, 11 female), 14 six-year-olds (M_{age} = 6;6, range = 6;1 – 6;11, 6 female), and 13 seven-year-olds (M_{age} = 7;7, range = 7;2 – 7;11, 3 female). Children were tested individually online 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.

Materials and Procedure Children completed two trials. In each, they were told a story about two characters each obtaining an object. It was hard for one character to obtain their object (e.g., an apple atop a tall tree; the 'high-cost character') and it was easy for the other character to obtain their object (e.g., an apple atop a short tree; the 'low-cost character'). For example, in one scenario, children were told this story:

> "Here are two boys at the park. And look, there are apples at the top of these trees. The small tree is easy to climb, and the big tree is hard to climb. The boys are going to climb the trees to get the apples. Look! The boys climbed the trees to get the apples."

Children were then asked two comprehension questions, "Which tree was easier to climb? Which tree was harder to climb?". All 88 children passed these comprehension questions. In one between-subjects condition, the characters obtained their objects, and children were asked which character was happier about obtaining their object. For example:

> "Hooray! The boys got up to the apples! Now the boys have their apples. [Test question:] Which boy feels more happy that he got his apple?"

In the other condition, the objects were inadvertently lost, and children were asked which character was sadder that they lost their object. For example:

> "Oh no! The wind blew away the apples! Now the boys don't have their apples. [Test question:] Which boy feels more sad that he lost his apple?"

The characters were identifiable by the color clothes they were wearing. Location of the toys were counterbalanced across trial, and trials were held in a fixed-order.

We predicted that when inferring which character is sadder, children would select the effortful character because of their greater sunk costs. But when inferring happiness, we predicted children would choose between the characters because both characters achieved their goal.

Results

In both experiments, we analyzed the results using generalized estimating equation models (GEE; binary logistic, independent correlation matrix). For this experiment, age in months (mean-centered) was entered as a covariate, with condition as a between-subjects factor and item as a within-subjects factor. For this experiment, children's responses were coded as 0 if they selected the low-cost character, and 1 if they selected the high-cost character.

There was no significant effect of condition, $F(1) = 0.19$, $p = .659$, suggesting that children's responses did not differ when they were asked about sad or happy emotions (see Figure 1). There was a significant effect of age, $F(1) = 16.17$, $p < .001$, as with age, children were more likely to select the high-cost character than the low-cost character. There was no significant interaction between condition and age, $F(1) = 2.11$, $p = .147$.

To determine the age when children's responses differed from chance (i.e., when they chose the high-cost character), we examined when the 95% confidence interval first went above chance. This was at age 5;9 in the sad condition $CI_{95\%}$ [0.51, 0.74]; and age 6;4 in the happy condition $CI_{95\%}$ [0.52, 0.84].

Discussion

Children responded similarly across conditions. They anticipated that the character who incurred greater costs to collect their object would be happier about obtaining it, and sadder if they lost it. Responses in the sadness condition are consistent with the idea that children considered sunk costs because they considered prior effort to infer which character would be sadder.

However, it is unknown whether responses reflect reasoning about sunk costs or reasoning about other considerations. An alternative account is that children may have inferred that the character who overcame the larger obstacle would be sadder and happier about the outcome. That is, they could have reached their judgments without considering sunk costs, and simply have associated stronger emotions with larger obstacles. This may explain why children attributed greater happiness to the high-cost character— they may have been prouder to achieve their goal because they overcame a large obstacle (for related work on children's inferences and understanding of pride, see Harris et al., 1987; Reissland & Harris, 1991; Tracy et al., 2005).

A limitation of this experiment is that we manipulated two factors across the conditions. One factor was the judgment, as children were asked to compare the sadness and happiness of the characters. Another factor was the outcome of the characters' actions. In the sadness condition, the objects blew away, so the characters were unsuccessful in their goal of keeping the objects. But in the happiness condition, the characters were successful in this goal. Since there were two factors manipulated across the scenarios, we cannot be sure of whether children only considered happy or sad emotions across scenarios, or whether they also considered the differing outcomes.

In the next experiment, we used a different approach to examine whether children infer emotions from sunk costs. In this experiment, children saw similar scenarios about characters climbing shelves to collect toys. After the characters collected them, they learned that both toys were broken, and children judged which character was sadder that their toy was broken. In some trials, the characters were short, and so it was more effortful to collect toys from high shelves. In other trials, the characters were tall, and so it was more effortful to collect toys from lower shelves.

If children merely associate greater sadness with physically larger obstacles (i.e., rather than more difficult obstacles), then children would choose the high-cost character in the short trials, but the low-cost character in the tall trials, as both of these characters collected from the tall shelf. However, if children associated greater sadness with greater sunk costs, they should choose the character who invested more in collecting their object, regardless of shelf height.

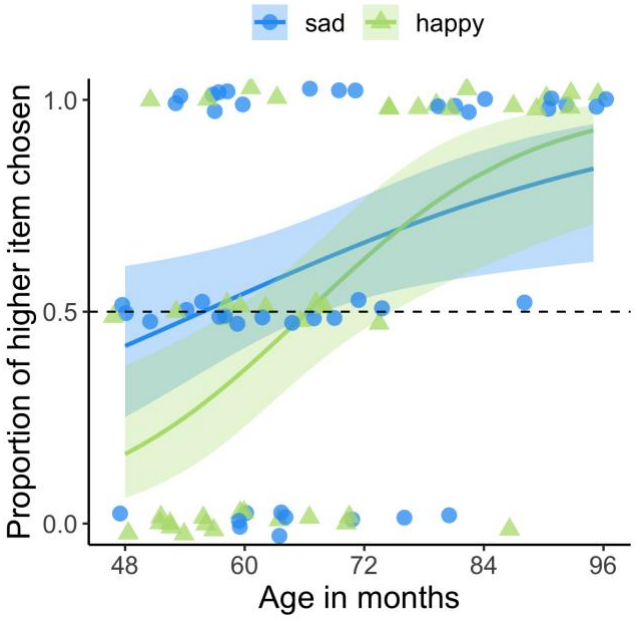

Figure 1. Results from Experiment 1. For both figures, colored bands show 95% confidence intervals. Points are jittered to avoid overplotting.

Experiment 2

Methods

Participants We tested 80 children: 20 four-year-olds (M_{age} = 4;5, range = 4;0 – 4;11, 12 female), 20 five-year-olds (M_{age} = 5;6, range = 5;0 – 5;11, 7 female), 20 six-year-olds (M_{age} = 6;5, range = 6;0 – 6;11, 7 female), and 20 seven-year-olds (M_{age} = 7;5, range = 7;0 – 7;11, 7 female). One additional 4-year-old was excluded for not answering comprehension questions correctly. We tested children online (N = 48), and in-person at local schools (N = 13), and a museum (N = 19). For online testing, we used the same testing protocol as Experiment 1. For in-person testing, children were tested individually in a quiet room at local schools and a museum in the Waterloo Region.

Materials and Procedure Children saw pictures of two characters each standing beside a bookshelf and heard a story about the characters collecting toys from them. 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. For example, in one test trial, children were told:

> "Today there are cars on each shelf. And look, the boys got both of them. But oh no, the wheels don't turn! The boys are sad that the cars are broken, but one of the boys is more sad. [Test question:] Which boy feels more sad?"

Children completed a total of four trials: two trials in each within-subjects condition. In one condition, the characters were short, so it was easy to retrieve toys on low shelves and difficult to retrieve toys on high shelves ('short trial'). In the other condition, the characters were tall, so the opposite was true ('tall trial'). Children were told this (i.e., about the ease and difficulty of the characters obtaining objects from varying shelf heights) before test trials begun. Before completing the two test trials in each condition, children were asked two comprehension questions, asking them to identify where it was easy and hard for characters to collect their toys. Of the 80 children, only three answered one of these comprehension questions incorrectly but provided correct responses after the scenario was described again.

For example, before the short trials, children were told:

> "Here are two boys. Every day, these boys can get toys from the shelves. It's really easy to get toys when they're low down. But it's really hard to get toys when they're up high. [Comprehension questions:] Where is it easy to get toys? And where is it hard to get toys?"

Tall trials used the same script, except it was very easy to get toys from the high shelf and very hard to get toys from the low shelf.

The characters were identifiable by the color clothes they were wearing. Location of the toys was counterbalanced across trials. Trials within each condition were administered in a fixed-order (i.e., the two short trials were in a fixed order, and two tall trials were in a fixed order).

Results

Children's responses were coded as 0 if they selected the character who retrieved the toy from the lower shelf ('low-shelf character'), and 1 if they selected the character who retrieved the toy from the higher shelf ('high-shelf character').

Children were more likely to select high-shelf character when the characters were short than when they were tall, $F(1) = 36.60$, $p < .001$ (see Figure 2). Children's responses did not differ with age, $F(1) = 1.14$, $p = .285$, but there was a significant interaction between trial type and age, $F(1) = 26.32$, $p < .001$. This interaction resulted because in the short trials, children were more likely to select the high-shelf character as they got older, $F(1) = 16.34$, $p < .001$. In the tall trials, children were more likely to select the low-shelf character as they got older, $F(1) = 10.01$, $p = .002$.

To determine the age where responses in the short and tall trials first diverged, we examined when their 95% confidence intervals no longer overlapped. This was at age 5;4; short trial, $CI_{95\%}$ [0.53, 0.71]; tall trial $CI_{95\%}$ [0.34, 0.51]. The confidence intervals also show that responses in the short trials first went above chance (toward the high-shelf character) at 5;3, $CI_{95\%}$ [0.52, 0.69], and responses in the tall trials first fell below chance (toward the low-shelf character) at 5:6, $CI_{95\%}$ [0.32, 0.49].

Discussion

Children showed opposite response patterns across the short and tall trials. When judging the sadness of characters in the short trials, they predicted that the character who collected their object from the tall shelf would be sadder when their toy broke. Conversely in the tall trials, children predicted that the character who collected their toy from the shorter shelf would be sadder. Though children selected different characters across these trials (i.e., high-shelf character; low-shelf character), both characters had greater sunk costs: they put in greater effort to obtain their objects.

This finding suggests that children consider sunk costs when inferring sadness. It also clarifies the concern raised in Experiment 1 that children may have only inferred emotions based on physically larger obstacles. If this were true, then children would have always selected the character who overcame the larger obstacles. In the short trials, the character who overcame the larger obstacle expended greater effort to obtain their toy. But in the tall trials, the character who overcame the larger obstacle expended less effort. So, choices for the physically larger obstacles would have led children to attribute emotions to high- and low-cost characters at chance-level.

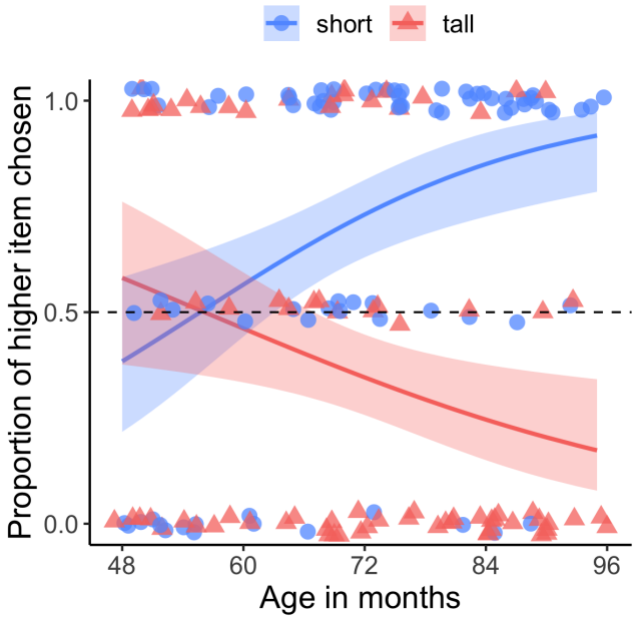

Figure 2. Results from Experiment 2.

General Discussion

Across two experiments, children anticipated that sunk costs led to negative emotions. Children inferred that a character who worked harder to obtain an object would be more upset about a bad outcome (e.g., object is lost or broken) than another character who worked less to obtain an identical object. However, children did not merely associate greater emotions with a physically larger obstacle. In conditions where effort was inversely related to obstacle size, children inferred negative emotions based on sunk costs.

This work extends findings about children's inferences about behaviors based on sunk costs. Previous work showed that children fail to anticipate that someone will select items associated with greater sunk costs (Sehl et al., 2021; Webley & Plaisier, 1998). This lack of a sunk cost effect in children is in stark contrast to findings that adults show the sunk cost bias in a variety of scenarios: in first-person vignettes (i.e., when making their own judgments about imagined sunk costs; Arkes & Blumer, 1985; Baron et al., 1993; Garland & Newport, 1991); in third-person vignettes (i.e., when predicting others' decisions; Arkes & Blumer, 1985; Bornstein & Chapman, 1995); and when making first-person judgments about others' sunk costs (Olivola, 2018). The present work found that children considered agents' past investments of effort to infer their emotion about a negative outcome, suggesting that children are not entirely insensitive to sunk costs.

In light of previous work on the sunk cost bias in children (Sehl et al., 2021; see also Webley & Plaisier, 1998), the present findings suggest that when reasoning about sunk costs, children can predict others' negative emotions before they can predict others' actions about sunk costs. Children's ability to infer emotions before actions may be consistent with previous work following the same broader pattern. One example is with ownership— three-year-olds infer that someone would be sadder if their property went missing than if another person's property went missing (Pesowski & Friedman, 2015), and even two-year-olds expect someone will be sadder if someone uses their property without permission (as opposed to another person's property; Pesowski & Friedman, 2015). However, it is only by four- to five-years do children predict agents' actions based on ownership (Pesowski & Friedman, 2018; see also Pietraszewski & Shaw, 2015). Indeed, children's ability to infer others' emotions emerges from a young age (e.g., Barden et al., 1980; Borke, 1971; Doan et al., 2020; Harris et al., 1987). However, the reverse pattern has been documented in children's understanding of false beliefs. Specifically, children predict actions based on false beliefs before they correctly attribute emotions based on them (e.g., Bradmetz & Schneider, 1999; see also, Ronfard & Harris, 2014).

One potential worry with the current experiments is that children in our tasks may not have considered sunk costs at all. Instead, children may have inferred that characters who worked harder to obtain objects value their objects more than others who worked less. On this account, rather than inferring that the expenditure of greater costs led one character to be sadder than the other, children inferred the character was sadder because they valued the toy more. This is a real concern, but one reason to doubt it is that children did not have clear evidence that the characters differed in their willingness to work for the toys. For example, in the second experiment characters appeared across pairs of trials, and each character always pursued toys from the same shelving unit regardless of whether the toys were on high or low shelves. Moreover, in subsequent research we have replicated the findings in one-character scenarios.

Another concern for why our experiments may not involve sunk costs is because children made emotion judgments, and sunk costs are typically associated with behavior judgments. However, considerations about sunk costs may not be limited to judgments about behavior. Sunk costs are past investments in a project that cannot be recovered, and so people may consider them when evaluating the objects and predicting future behavior. This consideration of sunk costs may therefore include people's feelings towards objects.

Future Directions

Although our findings taken together with previous work (Sehl et al., 2021; Webley & Plaisier, 1998) suggest a developmental lag in children's use of sunk cost to predict emotions and actions, this conclusion is indirect—it requires drawing comparisons across entirely separate experiments (i.e., from different papers and using different stimuli). Moreover, previous work did not determine the age when children first use sunk costs to predict actions—the oldest children tested were oblivious to sunk costs in this context (i.e., 6-year-olds in Sehl et al., 2021 and 12-year-olds in

Webley & Plaisier, 1998). This leaves two goals for future research. First, future work could directly compare children's judgments about emotions to their predictions of actions in response to sunk costs. One outcome of this comparison might be that children may infer can infer emotions based on sunk costs from around five years of age, but they may not predict actions based on sunk costs until later in development. Understanding when children make inferences about emotions and actions about sunk costs may advance knowledge on how children reason about costs and how people reason about sunk costs more generally. Second, future work will need to determine the age at which children do start using sunk costs to infer actions.

Another area for future research is to examine children's emotions about their own sunk costs. Most sunk cost studies with adults uses first-person scenarios, where adults make their own decisions about hypothetical sunk costs (e.g., Arkes, 1996; Arkes & Blumer, 1985; Garland & Newport, 1991; Strough et al., 2008). Previous work showed that children themselves are not biased by sunk costs in hypothetical first-person judgments (Sehl et al., 2021; Webley & Plaisier, 1998), though, children may have an emotional response to sunk costs in similar first-person judgments. This work could help us understand how children reason about their own sunk costs and whether they feel negative emotions about sunk costs.

One final future direction is to investigate whether children consider sunk costs to infer emotions other than sadness. Sunk costs may lead people to feel sad because they invested high costs into a failed project. However, there may be other relevant emotions in response to sunk costs, like frustration, regret, or relief. Returning to the opening example, after the art student's sculptures were broken, she may feel regret for having worked on the first project for so long because all her effort went to waste. The art student may also feel relieved if the low-cost sculpture broke but not the high-cost one. However, not all emotions may be elicited by sunk costs. One example is surprise—the art student may not feel more surprised if one of the sculptures broke instead of the other, based on her sunk costs. Future work could identify whether children differentiate between emotions that may and may not be elicited by sunk costs. This work would also be informative about the age that children can use sunk costs to reason about different emotions because inferences about complex emotions like regret, relief, and surprise may only emerge later in development (e.g., Johnston et al., 2022; Thompson, 1987; Weisberg & Beck, 2010; see also McCormack & Feeney, 2014).

Conclusions

In sum, we found evidence that from around age five, children consider sunk costs when reasoning about others' emotions. These findings show that children are not entirely insensitive to sunk costs, as previous work may have suggested.

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