



Preschoolers use emotional reactions to infer relations: The case of ownership[☆]



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ABSTRACT

In three experiments, we examined whether young children use emotional reactions to infer relations, focusing on their inferences of ownership relations. In Experiment 1, children aged three to five years ($N = 108$) inferred ownership from emotional reactions to a positive event, in which a broken object became fixed. In Experiment 2, children aged three to six years ($N = 138$) inferred ownership from emotional reactions to a negative event in which an object became broken. Finally, in Experiment 3, children aged four and five ($N = 68$) again used sad emotional reactions to a negative event to infer ownership, but they did not use these reactions to infer who likes an object. These findings reveal that children use emotional reactions to infer one kind of relation between people and objects.

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Introduction

From early in development, children use others' emotional reactions to make inferences about ambiguous and non-obvious aspects of the world. Children sometimes use emotional reactions to make inferences about objects in their environments. From 12 months, infants use others' emotional reactions to infer whether novel objects and people are safe to approach, or should instead be avoided (e.g., Hornik, Risenhoover, & Gunnar, 1987; Moses, Baldwin, Rosicky, & Tidball, 2001; for a review see Vaish, Grossmann, & Woodward, 2008). Likewise, children aged three years and older can use others' emotional reactions to infer the events that might have elicited these reactions (e.g., Fabbes, Eisenberg, Nyman, & Michealieu, 1991; Kayyal & Widen, 2015; Russell & Widen, 2002; Strayer, 1986; Widen & Russell, 2004).

Children also use emotional reactions to infer people's mental states, including their perceptions, desires, beliefs, and thoughts. At age two, children use emotional reactions to infer what another person perceives (Wellman, Phillips, Rodriguez, 2000). At age three, children use happy and sad emotional reactions to infer people's desires (Wellman & Banerjee, 1991), and at age four, they use reactions of surprise, curiosity, and fear to infer people's beliefs (Bartsch, Campbell, & Troseth, 2007; Rieffe, Terwogt, & Cowan, 2005; Wellman & Banerjee, 1991; Wellman & Bartsch, 1988). From age three, children also use people's emotional reactions to infer what they are remembering. For instance, they infer that a character is sad during a pleasant interaction with a spotted dog because it reminds her of a dog that previously chased away her pet rabbit (Lagattuta & Wellman, 2001; Lagattuta, Wellman, & Flavell, 1997).

Another way that children may use emotional reactions is to infer *relations*. Suppose a group of people see a car with a smashed window, and one man reacts with surprise and anger. The man's emotional reaction could be used to infer prior

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events in the world (someone else probably broke the window) and to infer the man's mental states (he did not want the car window to be broken). But his emotional reaction also suggests that he may have a specific relation to the car. For instance, he may be especially upset because he *owns* the car. Relations like ownership are similar to mental states because they are nonobvious (Snare, 1972), but such relations are not themselves mental states. For instance, merely believing that something is yours does not make it yours, and you can own an object even if you do not like it, and even young children appear to grasp these facts (Flavell, Mumme, Greene, & Flavell, 1992; Noles & Gelman, 2014). However, no research has investigated whether children use emotional reactions to draw inferences about relations like ownership.

1. Emotional reactions and ownership relations

Ownership is an apt domain for exploring children's ability to infer relations from emotional reactions. Preschoolers have myriad ways of inferring ownership relations (for a review see Nancekivell, Van de Vondervoort, & Friedman, 2013). They infer *whether* objects are owned by considering how they are physically arranged (Rossano, Fiedler, & Tomasello, 2015) and whether they are human-made (Neary, Van de Vondervoort, & Friedman, 2012). Likewise, they judge *who* owns an object by considering factors such as who has possessed or modified it (Blake & Harris, 2009; Friedman & Neary, 2008; Gelman, Manczak, Was, & Noles, 2016; Kanngiesser, Gjersoe, & Hood, 2010; Kanngiesser, Rossano, Tomasello, 2015). Given that young children use many kinds of information to infer ownership relations, they might also base these inferences on emotional reactions. Inferring ownership this way would be useful as it requires minimal information, and does not even require children to know who previously interacted with an object.

It is especially plausible that children might use people's emotional reactions to infer ownership because toddlers and preschoolers appear to understand that ownership can impact emotions (Pesowski & Friedman, 2015). For instance, they predict that owners will react negatively when others use their property without permission. Preschoolers also sometimes refer to ownership when explaining emotions (e.g., "He's mad because she took his toy"; Fabes et al., 1991; Widen & Russell, 2004), though it is unknown how often they give such explanations. Children's understanding of how ownership influences emotions suggests that they have the causal knowledge necessary to draw inferences in the opposite direction, and to use emotional reaction to infer ownership.

However, such inferences could be challenging for young children. The ability to draw inferences in one direction does not always guarantee the ability to draw inferences in the reverse direction (Gelman, Collman, & Maccoby, 1986; Legare, Wellman, & Gelman, 2009; Legare, Zhu, & Wellman, 2013). For instance, whereas 3–4-year-olds readily explain that one of two agents became sick because the agent ate contaminated food, they fail to use information about contamination to predict which of two agents will become ill (Legare et al., 2009, 2013). Previous research on ownership suggests similar asymmetries. Whereas 3-year-olds use information about ownership to make judgments about how objects should be used or who should control them (e.g. McEwan, Pesowski, & Friedman, 2016; Neary & Friedman, 2012; Rossano, Rakoczy, & Tomasello, 2011; Schmidt, Rakoczy, & Tomasello, 2013), they sometimes have difficulty inferring ownership from these consequences (Nancekivell & Friedman, in press; Neary, Friedman, & Burnstein, 2009).

One plausible reason that young children could have difficulty inferring ownership from its consequences (including emotional reactions) is that other potential explanations for these consequences might occur more readily to them. For instance, suppose an agent becomes upset when a toy breaks. Although the agent might be sad because she owns the toy, it is also possible that she is sad because she wanted to play with it. Younger children readily make desire-based inferences (e.g., Wellman & Banerjee, 1991; Wellman & Woolley, 1990), and this could prevent them from seeing that emotional reactions stem from ownership. As such, it is uncertain whether young children infer ownership from emotional reactions.

We explored whether children infer ownership from emotional reactions in three experiments. In the first two experiments, children watched vignettes in which two characters stood beside an object. Then something happened to the object, and one of the characters reacted emotionally to this event, while the other did not. We examined whether children chose the character who responded emotionally as the owner of the object. We anticipated that if children infer ownership from emotional reactions, they should be more likely to choose this character if their emotional reaction is appropriate for an owner, compared with if it is inappropriate. To examine whether children's inferences from emotion show specificity to ownership, the third experiment features a similar design, but compares their inferences of ownership with their inferences of liking.

2. Experiment 1: emotional reactions to positive events

This experiment examined whether children infer ownership from emotional reactions to positive events involving objects. To discover whether there are developmental changes in children's ability to infer ownership from emotional reactions, we tested children age three to five.

2.1. Methods

2.1.1. Participants

The participants were 36 three-year-olds ($M = 3;7$, range = 3;1–3;11, 13 females), 36 four-year-olds ($M = 4;5$, range = 4;0–4;11, 15 females), 36 five-year-olds ($M = 5;5$, range = 5;0–5;11, 17 females). In all experiments, participants were tested in

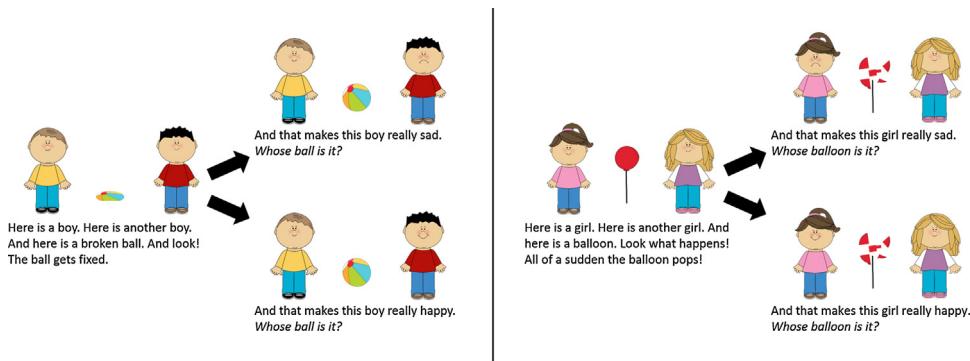


Fig. 1. Sample slides and scripts from Experiment 1 (left panel) and Experiment 2 (right panel).

childcare settings (preschoolers, daycares, and schools). Although demographic information was not formally collected, most children were Caucasian and from middle-class families.

2.1.2. Materials and procedure

Children listened to two brief stories, with accompanying pictures shown on a laptop computer; stories were also told this way in the subsequent experiments. Fig. 1 shows a sample story and script. Each story was about two children and an object (two girls and a bicycle in story 1, two boys and a ball in story 2). The object was broken at the beginning of the story, and the two characters stood on either side of it with light smiles on their faces. The object then became fixed, and one character reacted emotionally to this change (character on left in story 1, character on right in story 2), while the other character did not react. Depending on the condition to which children were randomly assigned, the character who reacted either became happy or sad. These emotional reactions were conveyed by showing the character's expression change to a big smile or a big frown. Children were then asked which character owns the object (e.g., "Whose bike is it?").

Children sometimes responded to the test question without indicating one of the characters. For example, children sometimes said "I don't know" or remained silent. When this happened, the experimenter began the scenario anew and asked the question again. Children's response to this was used in the analysis, even if the response was still uninformative. Children also sometimes gave ambiguous responses (e.g., "the girl", "his"). When this happened, the experimenter prompted them to be more specific, by asking "Which one?" Also, in a few rare cases, children responded by pointing to the object. When this happened, the experimenter said, "That's the [object] and who does it belong to?" These procedures were also used for uninformative responses in the subsequent experiments.

2.2. Results and discussion

In both conditions, children could choose between the character who reacted when the object became fixed, and the character who did not react. If children use emotional reactions to infer ownership, they should be more likely to choose the character who reacts when this character becomes happy (an appropriate reaction for an owner), compared with when this character becomes sad (an inappropriate reaction). However, if children do not infer ownership by considering emotional reactions, their responses should not vary across the conditions (e.g., they might choose the character who reacts regardless of whether the reaction is happy or sad).

To examine whether children infer ownership from emotional reactions, children received a score of 1 each time they chose the character who reacted emotionally, and they received a score of 0 each time they chose the other character, and for all other responses (i.e., saying "I don't know", remaining silent). Scores ranged between 0 and 2; children's responses were also scored this way in the subsequent experiments.

Children's mean scores are shown in Fig. 2. A 2(condition: happy, sad) \times 3(age-in-years: 3, 4, 5) ANOVA yielded a main effect of condition, $F(1|102) = 35.90, p < 0.001, \eta_p^2 = 0.26$, but no main effect of age, $F(2|102) = 0.852, p = 0.429$, and no condition by age interaction, $F(2|102) = 1.45, p = 0.239$. The main effect of condition resulted because children were more likely to choose the character who reacted when this character became happy, compared with when this character became sad. When the character became happy, children chose this character at rates exceeding chance (i.e., their scores were greater than the chance score of 1), $t(53) = 3.37, p = 0.001$. When the character became sad, children chose this character less than expected by chance, $t(53) = -5.125, p < 0.001$.¹

Although we did not observe any effects of age, we nonetheless conducted further analyses to better characterize children's performance at each age. Children at each age were more likely to choose the character who reacted when this

¹ Using a chance score of 1 out of 2 is conservative because children did not just choose between the two characters. As noted, some children said "I don't know" or remained silent.

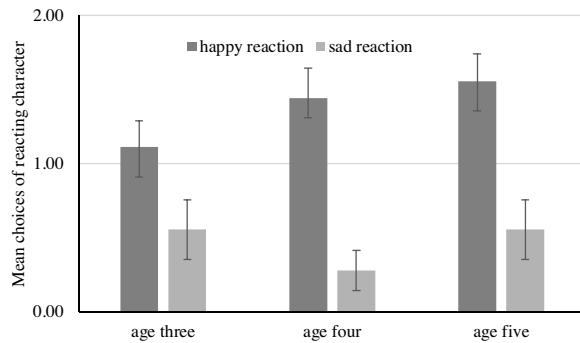


Fig. 2. Experiment 1. Mean times children chose the character who reacted emotionally; vertical lines depict ± 1 standard error of the mean.

character became happy rather than sad: 3-year-olds, $t(34) = 2.06, p = 0.047$; 4-year-olds, $t(34) = 4.80, p < 0.001$; 5-year-olds, $t(34) = 3.66, p = 0.001$. When the character became happy, 4- and 5-year-olds chose this character at rates exceeding chance, single-sample t -tests, $p \leq 0.042$, but 3-year-olds did not, $p = 0.542$. When the character became sad, children at all ages chose this character less than expected by chance, $p \leq 0.042$.

These findings show that young children consider emotional reactions when inferring ownership relations. From age four, they infer that an object is owned by a person who becomes happy when something good happens to it; and from age three, they infer it is not owned by someone who becomes sad in this circumstance. Because this experiment only looked at emotional reactions to positive events, the next experiment examined whether children also infer ownership from *negative* events involving objects.

3. Experiment 2: emotional reactions to negative events

Inferring ownership from emotional reactions to negative events may be more challenging than inferring ownership from positive events. When something negative happens to property, the owner should have a negative emotional reaction (e.g., become sad). Children might have difficulty inferring ownership from negative reactions because it may be associated with positive feelings towards property—for instance, children more readily judge that the recipient of a gift owns it, if the gift is something the recipient finds desirable rather than undesirable (Noles & Gelman, 2014). Also, in an attempt to better capture development in children's inferences of ownership from emotional reactions, we included 6-year-olds in this experiment.

3.1. Methods

3.1.1. Participants

The participants were 36 three-year-olds ($M = 3;5$, range = 3;0–3;11; 12 males, 24 females), 34 four-year-olds ($M = 4;5$, range = 4;0–4;11, 16 females), 34 five-year-olds ($M = 5;7$, range = 5;0–5;11, 18 females), and 34 six-year-olds ($M = 6;5$, range = 6;0–6;10, 23 females).

3.1.2. Materials and procedure

Children again listened to two brief stories about two children and an object (two girls and a balloon in story 1, two boys and a rocking horse in story 2). In each story, the object suddenly breaks. One character reacts emotionally to this event (character on left in story 1, character on right in story 2), while the other character does not react. Depending on the condition to which children were randomly assigned, the character who reacted either became sad or happy. As in Experiment 1, children were then asked which character owns the object (e.g., "Whose balloon is it?"). See Fig. 1 for a sample story and script.

3.2. Results and discussion

If children use emotional reactions to infer ownership, they should be more likely to choose the character who reacts emotionally when this character becomes sad than when the character becomes happy. Children's mean scores are shown in Fig. 3. A 2(condition: happy, sad) \times 4(age-in-years: 3, 4, 5, 6) ANOVA yielded a main effect of condition, $F(1,130) = 60.66, p < 0.001, \eta_p^2 = 0.32$, no main effect of age, $F(3,130) = 0.16, p = 0.924$, and an interaction of age by condition, $F(3,130) = 2.98, p = 0.034, \eta_p^2 = 0.06$. The main effect of condition occurred because children chose the character who reacted more when this character became sad than when this character became happy. As can be seen in Fig. 3, the interaction between age and condition resulted because the effect of condition was greater in 5- and 6-year-olds than in 3- and 4-year-olds. Nonetheless, this difference between conditions emerged at each age, though it was only marginally

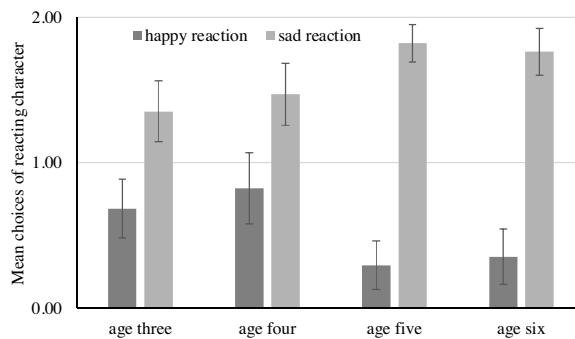


Fig. 3. Experiment 2. Mean times children chose the character who reacted emotionally; vertical lines depict ± 1 standard error of the mean.

significant in 4-year-olds: 3-year-olds, $t(34)=2.29$, $p=0.028$; 4-year-olds, $t(32)=1.99$, $p=0.055$; 5-year-olds, $t(32)=7.28$, $p<0.001$; 6-year-olds, $t(32)=5.66$, $p<0.001$.

Further analyses examined whether children at each age chose the character who reacted emotionally at rates departing from chance. When the character became sad, 4- to 6-year-olds chose this character at rates exceeding chance, single-sample t -tests, $ps \leq 0.041$, but 3-year-olds did not, $p=0.111$. When the character became happy, 5- and 6-year-olds chose this character less than expected by chance, $ps \leq 0.004$, while 3- and 4-year-olds chose this character at chance, $ps > 0.13$.

These findings suggest that children also use emotional reactions to negative events to infer ownership. Children aged 4–6 inferred that an object belonged to a person who became sad after it broke. Moreover, children at all ages showed appropriate sensitivity to emotion in inferring ownership because they were more likely to choose the character who reacted emotionally when this character became sad that the object broke, compared with when this made the character happy.

4. Experiment 3: ruling out a low-level response strategy

One concern with our findings so far is that children might have succeeded using a low-level response strategy. Instead of considering ownership, children could have adopted a response-rule of choosing characters who became sad when asked about negative events and characters who became happy when asked about positive events (see Lagattuta, 2008; Amsterlaw, Lagattuta, & Meltzoff, 2009). If children responded this way, they could have succeeded without considering ownership. We conducted Experiment 3 to rule out this possibility.

To rule out the possibility of children succeeding without considering ownership, we asked them to either infer who owns an object, or who likes it. If children respond differently when inferring ownership and liking, this will show that they are not simply following a low-level response strategy, and are in fact considering the question they are asked (i.e., whether they are being asked about ownership or liking).

The expectation that ownership and liking judgments should differ might seem surprising because owners prefer their own property over similar items that belong to others (e.g., Beggan, 1992). On this basis, one might expect that if children judge that a certain character is the owner, they should also infer that this character likes it more. However, we did not think children would reason this way because although preschoolers do show such preferences for their own property, they do not regularly attribute this to others (Gelman, Manczak, & Noles, 2012). Gelman et al. showed participants sets of three objects where one object was assigned to the participants, and another was assigned to the experimenter. Later, 3-year-olds indicated their object when asked about which was theirs and when asked about which one they liked best. But, they only indicated the experimenter's object when asked about ownership, and not when asked about which one the experimenter liked best. Also, other studies have found differences in children's inferences about ownership and liking (Malcolm, Defeyter, & Friedman, 2014; Nancekivell & Friedman, 2014; Neary et al., 2012; Verkuyten, Siersma, & Martinovic, 2015; Verkuyten, Siersma, & Thijs, 2015). For instance, some of these studies show that factors like first possession and occupancy strongly influence children's judgments about who owns a resource, but have no effect on their judgments of liking.

Given these past findings, we anticipated that whereas children would use emotional reactions to infer who owns an object, they might not use these reactions when inferring who likes it more. To examine this prediction, we focussed on children aged four and five. We did not include 3-year-olds because their responses in Experiment 2 were inconsistent with a low-level strategy (i.e., they often chose between the characters at chance); we also did not include 6-year-olds because in Experiment 2 they performed similarly to 5-year-olds.

4.1. Methods

4.1.1. Participants

The participants were 34 four-year-olds ($M=4;6$, range = 4;0–4;11, 17 females) and 34 five-year-olds ($M=5;6$, range = 5;0–5;11, 24 females).

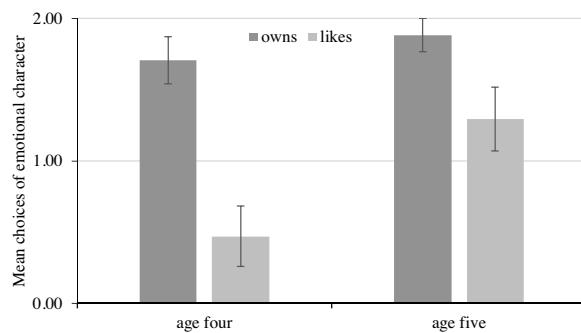


Fig. 4. Experiment 3. Mean times children chose the character who reacted emotionally; vertical lines depict ± 1 standard error of the mean.

4.1.2. Materials and procedure

Children saw the stories from Experiment 2 in which the object became broken and one character reacted by becoming sad. Children were either asked which character owns the object (e.g., "Whose balloon is it?") or which character likes it more (e.g., "Who likes the balloon more?").

4.2. Results

We expected that when asked about ownership, children would mostly say that the object belongs to the character who becomes sad when it breaks, as in Experiment 2. If children respond similarly when asked which character likes the object more, then this could indicate that children do not consider the nature of the relation they were asked to infer. However, this concern would be ruled out if children instead respond differently when asked about liking.

Children's means scores are shown in Fig. 4. A 2(condition: ownership, likes) \times 2(age-in-years: 4, 5) ANOVA yielded a main effect of condition, $F(1, 64) = 24.41, p < 0.001, \eta_p^2 = 0.28$; children were more likely to choose the sad character when judging who owns the object, compared with when judging who likes it more. There was also a main effect of age, $F(1, 64) = 7.34, p = 0.009, \eta_p^2 = 0.10$, and a marginally significant interaction of age by condition, $F(1, 64) = 3.07, p = 0.084, \eta_p^2 = 0.05$: 5-year-olds' scores were higher than those of 4-year-olds, but this difference was predominantly driven by their responses to the liking question. Children's scores did not vary with age when they made ownership judgments, $t(32) = 0.87, p = 0.393$, but they increased with age when children made liking judgments, $t(32) = 2.68, p = 0.012$.

Further analyses examined whether children at each age chose the character who became sad at rates departing from chance. When judging who owns the object, children at both ages chose this character at rates exceeding chance, $p \leq 0.001$. In contrast, when judging which character likes the object more, 4-year-olds chose the sad character less than would be expected by chance, $p = 0.024$, and 5-year-olds chose this character at chance rates, $p = 0.206$.

Children's different responses for the ownership and liking questions suggest that they *did* consider the nature of the relation they were asked to infer (i.e., ownership or liking), and that they did not rely on a response strategy that could have allowed them to bypass thinking about ownership. As such, the findings suggest that children use emotional reactions to infer ownership.

5. General discussion

Our findings show that young children use emotional reactions to infer ownership relations. When a broken object became fixed, children often inferred it belonged to a character who reacted with happiness (Experiment 1). Likewise, when an object became broken, they often inferred it belonged to a character who reacted with sadness (Experiment 2). This pattern of findings cannot be explained by children responding using low-level heuristics. Children did not simply respond by choosing whichever character reacted emotionally—indeed, children sometimes chose this character less than would be expected by chance. And children did not assume that the owner was whichever character had the more positive emotional reaction (i.e., as might be expected if they had solely based responses on associations between owners and positive feelings for property). Children's inferences likewise showed specificity to ownership: Whereas children used sad emotional reactions to a negative event to infer ownership, they did not use these reactions to infer who likes an object (Experiment 3). These differences between responses to questions about ownership and liking show that children actually considered the relation they were asked to infer.

Our findings advance knowledge of the inferences children make from emotional reactions. Previous studies showed that children use emotional reactions to make inferences about objects and events (e.g., [Fabes et al., 1991](#); [Russell & Widen, 2002](#); [Widen & Russell, 2004](#)) and to make inferences about people's mental states ([Bartsch et al., 2007](#); [Lagattuta & Wellman, 2001](#); [Lagattuta et al., 1997](#); [Rieffe et al., 2005](#); [Wellman & Banerjee, 1991](#)). The present findings reveal that young preschoolers also use emotional reactions to infer one kind of relation between objects and people—ownership. We expected that preschoolers might be able to use emotional reactions to infer ownership relations because they grasp how ownership influences people's

emotions (Pesowski & Friedman, 2015) and because preschoolers have many other ways of inferring ownership relations. However, inferring ownership from emotional reactions is distinctive and important because it allows children to infer who owns an object on the basis of minimal information, and without knowledge of who previously used it.

The findings from our third experiment also advance knowledge about differences between children's thinking about ownership and preferences. Several previous studies have found that young children understand that ownership and liking have different causes (Nancekivell & Friedman, 2014; Verkuyten, Sierksma, & Martinovic, 2015; Verkuyten, Sierksma, & Thijs, 2015). However, in our third experiment, children considered ownership and liking as potential causal factors, and had to judge whether they could have caused the emotional reactions. Because we found differences in children's ownership and liking judgments, our findings provide preliminary evidence that children not only differentiate ownership and liking when thinking about their causes, but also when thinking about their consequences. This said, future research could more directly investigate such differences by providing children with information about ownership and liking (rather than having children infer this), and then directly asking children about their consequences.

6. Developmental findings

In all experiments, children at all ages showed sensitivity to emotional reactions—they responded differently depending on whether the character reacted with happiness or sadness. Nonetheless, we also observed development: Whereas children aged three often chose between the characters at chance, this never happened by the time children were aged five. What might explain this age-related improvement in children's ability to infer ownership from emotional reactions?

One possible explanation is that younger children do not understand the causal connections between ownership and emotions. For instance, if 3-year-olds were unaware that breaking a person's property will make them sad, then they would lack the knowledge necessary to infer that a person who becomes sad when an object breaks is likely to be the owner. However, this cannot explain younger children's performance because even toddlers grasp such causal relations between ownership and emotions (Pesowski & Friedman, 2015).

A more plausible explanation is that younger children's difficulty might arise because they are especially prone to viewing emotional reactions as stemming from the fulfillment and frustration of desires (Wellman & Banerjee, 1991; Wellman & Woolley, 1990). When younger children see that a girl becomes sad when an object breaks, they may quickly conclude that she wanted to play with it, and is upset because this desire can no longer be fulfilled. Drawing this conclusion could prevent children from considering other possible explanations for emotional reactions, and might therefore prevent them from realizing that these reactions could also stem from ownership. Older children, in contrast, may consider multiple causes when trying to understand emotional reactions, and this could make the connection between ownership and emotional reactions more apparent for them.

7. Further questions

Although we only examined children's ability to infer ownership relations, emotional reactions can also be used to infer other kinds of relations. If an adult is proud when a child wins a race, or is very upset if the child fares poorly, we might infer that they are the child's parent. Similarly, if someone shows pride in the accomplishments of a country, or becomes upset when someone mildly criticizes it, we may infer that they have some relation to the country—perhaps they live there, or have family there. And if someone is openly angry with someone they work with, this might lead us to suspect that they have authority over the other person (or, at least, that the other person does not have authority over them). It is an open question, though, whether preschoolers can infer these other kinds of relations and relationships (i.e., kinship, nationality, authority) from emotional reactions, and whether these are inferred as readily as ownership.

Another open question is whether children can use more complicated emotional input when inferring relations. In our scenarios, children drew inferences from very simple emotional reactions—in each scenario, one character showed an emotional reaction in response to changes in the state of an object. But when inferring relations from emotional reactions, it may sometimes be informative to consider emotional reactions which are themselves responses to emotions. For instance, in the workplace example, our judgments might be influenced not only by the anger expressed but also by the reaction of the person who is the target of this anger. If the person responds with fear, this may increase our confidence that they are a subordinate. But if they reciprocate with anger, this may cast doubt on this interpretation.

Although the current findings raise these (and other) new questions, they also reveal a novel way in which children use emotional reactions. They show that children use these reactions to infer a kind of nonobvious relation between people and objects—children use them to infer ownership. These inferences allow children to understand their social environments, and this may help them ensure that they behave in socially appropriate ways.

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