



Original Articles

Young children infer preferences from a single action, but not if it is constrained[☆]Madison L. Pesowski^{*}, Stephanie Denison, Ori Friedman

University of Waterloo, Canada

ARTICLE INFO

Article history:

Received 24 May 2016

Revised 30 June 2016

Accepted 5 July 2016

Available online 11 July 2016

Keywords:

Preferences

Constraints

Minimal information

Cognitive development

Theory of mind

Conceptual development

ABSTRACT

Inferring others' preferences is socially important and useful. We investigated whether children infer preferences from the minimal information provided by an agent's single action, and whether they avoid inferring preference when the action is constrained. In three experiments, children saw vignettes in which an agent took a worse toy instead of a better one. Experiment 1 shows that this single action influences how young children infer preferences. Children aged three and four were more likely to infer the agent preferred the worse toy when the agent took this toy, compared with when the agent did not take either toy. Experiment 2 then shows that children consider constraints when inferring preferences from a single action. From age 5, children were less likely to avoid inferring a preference for the worse toy when the agent's action was physically constrained. Finally, Experiment 3 provides evidence that children's and adults' sensitivity to constraints, when inferring preferences, is not based on a general notion of constraints, and instead depends on several specific notions. Whereas 5–6-year-olds in this experiment considered physical and socio-moral constraints when inferring preferences, they had difficulty grasping the relevance of epistemic constraints. Adults considered physical and epistemic constraints, but were not influenced by the socio-moral constraint of ownership. Together these findings contribute to a picture of cognitive development in which children are able to infer non-obvious properties on the basis of minimal concrete information, and are also sensitive to subtle changes in this information.

© 2016 Elsevier B.V. All rights reserved.

1. Introduction

You are at a coffee shop with a new co-worker Jamie, and he orders a plain donut. You figure that there is no accounting for taste, and conclude that he prefers plain donuts over the more exciting varieties that the shop carries, like double chocolate with sprinkles. However, you would be less certain about Jamie's preference, if he only had enough change to buy the inexpensive plain donut. If he had more money with him, perhaps he would have ordered the deluxe double chocolate donut. This example illustrates that preferences can often be inferred from a single action, and that this cue is only viable when the action is relatively unconstrained. Seeing Jamie buy one donut allows you to infer which kind of donut he prefers, but only if he was free to buy the other kinds of donuts available.

In the current paper, we examine the development of children's ability to infer preferences from a single action, and their corresponding ability to avoid inferring preferences when the action is constrained. Knowing what others prefer is socially useful (e.g., Fawcett & Markson, 2010b; Liberman, Kinzler, & Woodward, 2014; Mahajan & Wynn, 2012), but preferences are nonobvious mental states that cannot be directly observed. Sometimes inferences about preferences can be based on rich information. For instance, you know your friend Cindy prefers maple bacon donuts because you have seen her buy and devour them many times, and she has repeatedly told you they are her favorite. However, such rich information is not always available. The abilities to infer preferences from a single action, and to avoid such inferences when the action is constrained, could allow children to infer these nonobvious mental states from information that is easily observable. The possibility that young children use such minimal information to infer preferences is broadly consistent with other research showing that children infer non-obvious properties from minimal observable information (e.g., Gelman & Gottfried, 1996; Liu, Gelman, & Wellman, 2007; Schmidt, Rakoczy, & Tomasello, 2011; Weatherhead, White, & Friedman, 2016).

[☆] Research was supported by a NSERC grant awarded to OF, a NSERC grant awarded to SD, and by University of Waterloo Social Sciences and Humanities Research Council of Canada 4A grant awarded to SD & OF.

^{*} Corresponding author at: Department of Psychology, University of Waterloo, 200 University Avenue W, Waterloo, Ontario N2L 3G1, Canada.

E-mail address: mlpesows@uwaterloo.ca (M.L. Pesowski).

Considerable research has investigated how children (including infants) infer others' preferences. However, in most of this research, children had rich information about others' preferences, rather than the minimal information available when you inferred Jamie's preference from a single action. One line of research has examined infants' and toddlers' ability to infer people's preferences from their verbal and emotional reactions towards objects (Fawcett & Markson, 2010a; Repacholi & Gopnik, 1997). For instance, 18-month-olds can infer an agent's preferences from their facial and verbal reactions to eating different foods (Repacholi & Gopnik, 1997). When an agent reacts to eating Goldfish crackers by looking disgusted and saying "Eww! Crackers! Eww! I tasted the crackers! Eww!" and showing the opposite reaction after eating broccoli, 18-month-olds infer she prefers the broccoli, even though they themselves prefer the crackers.

Another line of research has investigated children's ability to infer preferences by integrating agents' choices with information about the distribution of available objects (Diesendruck, Salzer, Kushnir, & Xu, 2015; Hu, Lucas, Griffiths, & Xu, 2015; Kushnir, Xu, & Wellman, 2010; Ma & Xu, 2011; also see Lucas et al., 2014). For instance, when an agent takes a few similar toys from a container, children's inferences about the agent's preference depends on the distribution of toys that was available in the container. They are more likely to infer the agent prefers the chosen kind of toy if the container mostly held many toys of another type, compared with if it only held few or no toys of another type (Kushnir, Xu, & Wellman, 2010; Ma & Xu, 2011). These studies reveal that young children can use subtle cues that indicate whether choices were made intentionally to infer preferences in the absence of affective information, which is critical, because affective information is often unavailable (but see Garvin & Woodward, 2015, which suggests that the information conveyed verbally to children in these studies provided some affective context). Crucially, these studies always featured situations where the agent chose the same object type multiple times in a short session. These repeated choices provide richer information than is available when observing single choice situations.

Also, little research has investigated whether children consider constraints when inferring preferences. To our knowledge, only one study has investigated this (Jara-Ettinger, Gweon, Tenenbaum, & Schulz, 2015, Experiment 1). In this study, 5–6-year-olds saw vignettes in which Ernie (from Sesame Street) could climb either of two boxes to get a watermelon slice or a banana. When the fruits were on boxes that were of equal height, Ernie chose the banana; but when the banana was on top of a taller box (which was harder to climb), he chose the watermelon. Children were sensitive to the constraint on Ernie's choice and inferred that he preferred the banana over the watermelon. However, along with Ernie's actions, children were told about his habitual behavior. For example, they were told, "When both treats are on the short box, Ernie always chooses the banana!" Because children were told such information, it remains unknown whether they consider constraints when inferring preferences from a single action.

Finally, because their study investigated 5–6-year-olds, it is also unknown whether younger children consider constraints when inferring preferences. This could be easy for young children because considerable research shows that they readily consider constraints in understanding others' behavior (e.g., Chernyak, Kushnir, Sullivan, & Wang, 2013; Denison, Trikutam, & Xu, 2014; Denison & Xu, 2010; Kushnir, Gopnik, Chernyak, Seiver, & Wellman, 2015; Schult & Wellman, 1997; Sobel, 2004). For instance, even infants are sensitive to whether actions are physically constrained when they infer and imitate goals (e.g., Gergely, Bekkering, & Király, 2002; Gergely, Nádasdy, Csibra, & Bíró, 1995). Nonetheless, children might have difficulty considering

certain types of constraints. Whereas children consistently consider physical constraints when interpreting actions, findings regarding their sensitivity to epistemic constraints are mixed—some studies find that children successfully consider the consequences of ignorance or false belief (Buttelmann, Carpenter, & Tomasello, 2009; Kushnir, Gopnik, Chernyak, Seiver, & Wellman, 2015; Luo & Baillargeon, 2007; Luo & Johnson, 2009), while other studies find they have difficulty with this (Bradmetz & Schneider, 1999; German & Leslie, 2001; Harris, Johnson, Hutton, Andrews, & Cooke, 1989; Joseph & Tager-Flusberg, 1999; Richert & Lillard, 2002). Investigating whether children show equivalent sensitivity to different kinds of constraints could be informative about whether their inferences of preference depend on a general notion of constraints, or instead on several more specific notions.

1.1. The current approach

We investigated children's abilities to infer preferences from a single action, and to avoid such inferences when the action is constrained. In three experiments, children saw vignettes in which an agent could choose between two toys. One toy was more attractive than the other, and so with no other information, it should be assumed that the agent prefers the better toy. Experiment 1 shows that between ages 3 and 4, children increasingly override this assumption on the basis of a single action. When the agent takes the worse object, they infer it is the one preferred by the agent. Experiment 2 then investigates whether 3- to 6-year-olds avoid inferring preferences when the agent's action is physically constrained. Together these experiments suggest that a sophisticated understanding of the interplay between choices and constraints in preference attribution does not emerge until age 5. Finally, Experiment 3 examines 5–6-year-olds' and adults' sensitivity to different kinds of constraints, and finds that the extent to which different constraints affect preference attributions varies in both age groups.

2. Experiment 1: Inferring preference from a single action

2.1. Method

2.1.1. Participants

We tested 40 three-year-olds (M age = 3;4 [years; months], range = 3;0–3;10, 20 girls) and 40 four-year-olds (M age = 4;5, range = 4;0–4;11, 20 girls).

2.1.2. Materials and procedure

Children listened to two stories narrated by the experimenter, with accompanying pictures shown on a laptop computer; stories were also told this way in the subsequent experiments. In each story, an agent saw two toys on a bookshelf (i.e., a girl and two toy castles in story 1, a boy and two toy cars in story 2). One toy was more attractive than the other toy (i.e., larger and more colorful). Children were randomly assigned to one of two conditions. In the *action condition*, the agent took the worse toy from the shelf, while in the *no-action condition* the agent did not take a toy from the shelf. Children were then shown the two toys on a blank screen and were asked to indicate which one the agent likes more. Here is the script from the version with the castles (also see Fig. 1 for sample slides):

Here is a girl and she is at school. She wants to play with a toy castle. And look! Here are some toy castles. [*action condition only*: Then the girl gets this toy castle.] Now I have a question for you. Here are the toy castles. Can you point to the one the girl likes more?

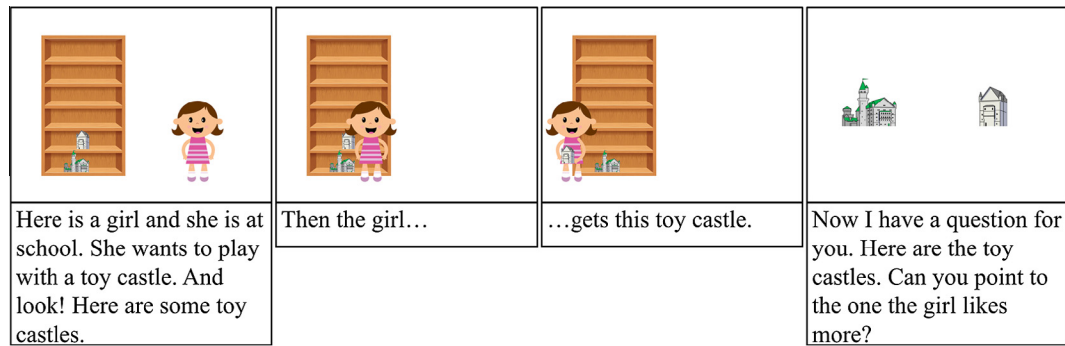


Fig. 1. Experiment 1. All sample slides were shown to children in the action condition. Children in the no-action condition only saw slides 1 and 4. Two factors were counterbalanced across participants. In slides 1, 2, and 3 we counterbalanced which toy was on the lowest shelf, and in slide 4, we counterbalanced which toy appeared on each side.

Some children remained silent when asked the test question ($n = 2$) or provided uninformative responses such as “I don’t know” ($n = 5$). When this happened, the experimenter repeated the question and all children then provided an informative response.

2.2. Results and discussion

If children infer preference from a single action, they should be more likely to indicate the worse toy when the agent takes this toy compared to when the agent does not take a toy. To examine this, children were scored 1 each time they indicated the worse toy, and 0 each time they indicated the better toy (maximum score = 2). Children’s mean scores are shown in Fig. 2.

A 2 (condition: action, no-action) \times 2 (age: 3, 4) ANOVA revealed a main effect of condition, $F(1,76) = 47.88$, $p < 0.001$, $\eta_p^2 = 0.39$, an age by condition interaction, $F(1,76) = 5.32$, $p = 0.024$, $\eta_p^2 = 0.07$, and no effect of age, $F(1,76) = 0.98$, $p = 0.326$. The main effect of condition resulted because children were more likely to indicate the worse toy when the agent took this toy than when the agent did not take a toy from the shelf.

Follow-up analyses indicated that the difference between the conditions emerged in both age groups: 3-year-olds, $t(38) = 2.82$, $p = 0.008$, $d = 0.91$; 4-year-olds, $t(38) = 8.05$, $p < 0.001$, $d = 2.61$. These analyses also revealed that the interaction between age and condition resulted from children at both ages indicating the worse toy at similar rates in the no-action condition, $t(38) = 1.08$, $p = 0.288$, but 4-year-olds indicating it more than 3-year-olds in the action condition, $t(38) = -2.08$, $p = 0.044$, $d = 0.67$.

These findings suggest that young children use a single action to infer an agent’s preference. Three- and four-year-olds inferred that a person prefers an object they selected, even though the object

was less attractive than the other available option. However, the findings also revealed developmental changes, as 4-year-olds were more likely than 3-year-olds to judge that the agent preferred the toy they took. With development, children may place increasing weight on a single action when inferring preferences.

Although a single action can indicate an agent’s preference, this is diminished if the action is constrained. In the next experiment, we investigated whether children are less likely to infer preferences for an action that is constrained. To constrain the agent’s action, we showed children a modified version of our vignette in which the better toy was physically inaccessible—it was on a high shelf, out of the agent’s reach. Because we were uncertain of whether children aged 3 and 4 would be sensitive to this constraint, we also tested children aged 5 and 6.

3. Experiment 2: Constrained versus unconstrained action

3.1. Method

3.1.1. Participants

We tested 40 three-year-olds (M age = 3;6, range = 3;0–3;11, 16 girls), 40 four-year-olds (M age = 4;5, range = 4;0–4;11, 18 girls), 40 five-year-olds (M age = 5;6, range = 5;0–5;11, 23 girls), and 40 six-year-olds (M age = 6;5, range = 6;0–6;11, 19 girls).

3.1.2. Materials and procedure

Children again listened to two stories about an agent who saw two toys on a bookshelf (i.e., a girl and two toy castles in story 1, a boy and two toy cars in story 2). The worse toy was always on the lowest shelf, but the location of the better toy depended on the condition to which children were randomly assigned. In one condition, the better toy was on the second lowest shelf, and so it was accessible to the agent (*no-constraint condition*); in the other condition, the better toy was on a high shelf that the agent could not reach (*constraint condition*). Children in both conditions were explicitly told about whether the agent could reach the better toy. In both conditions, the agent took the worse toy from the shelf. Children were then shown the two toys on a blank screen and were asked to indicate which one the agent likes more. This task is similar to that used by Jara-Ettinger et al. (2015, Experiment 1); the most important difference is that children in the present experiment were only informed about a single action, and not about what the agent does habitually.

Here is the script from the story version with the castles; see Fig. 3 for the accompanying slides. Text that varied between the conditions is shown in brackets, with text from the no-constraint condition shown first, and text from the constraint condition shown second.

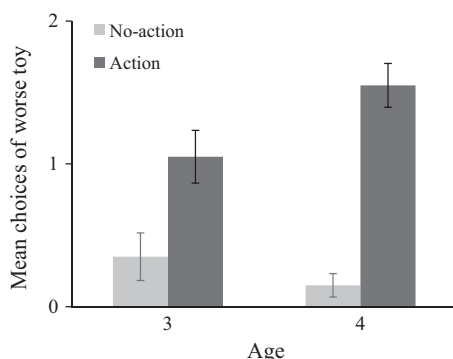


Fig. 2. Experiment 1. Mean times children indicated the worse toy when asked which object the agent prefers. Error bars show ± 1 standard error of the mean.

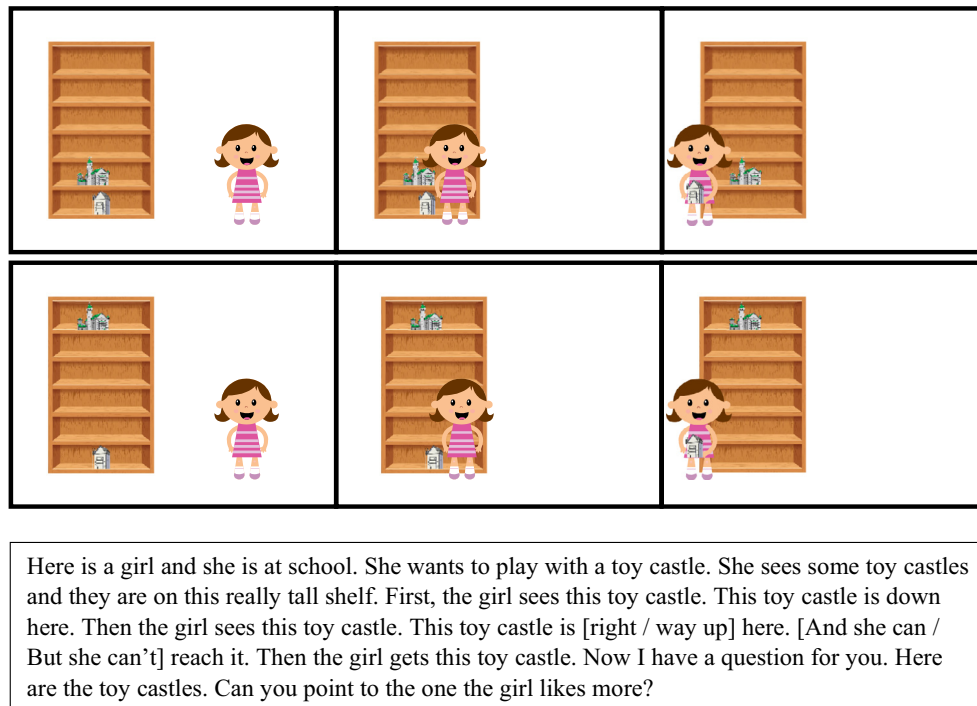


Fig. 3. Experiment 2. Sample slides from the no-constraint condition (top panel), and the constraint condition (bottom panel); text varying between conditions appears in brackets.

Here is a girl and she is at school. She wants to play with a toy castle. She sees some toy castles and they are on this really tall shelf. First, the girl sees this toy castle. This toy castle is down here. Then the girl sees this toy castle. This toy castle is [right/way up] here. [And she can/But she can't] reach it. Then the girl gets this toy castle. Now I have a question for you. Here are the toy castles. Can you point to the one the girl likes more?

Two 3-year-olds did not initially provide an informative response to the test question, but did provide an informative response when the experimenter repeated the test question.

3.2. Results and discussion

If children consider constraints when inferring preferences, they should be more likely to judge that the agent prefers the worse toy when they could take either toy, compared with when they could not take the better toy. To examine this, children were scored 1 each time they indicated the worse toy, and 0 each time

they indicated the better toy (maximum score = 2). Children's mean scores are shown in Fig. 4.

Scores were entered into a 2 (condition: no-constraint, constraint) \times 4 (age: 3, 4, 5, 6) ANOVA. The analysis yielded a main effect of condition, $F(1,152) = 17.94$, $p < 0.01$, $\eta_p^2 = 0.11$, with children more likely to indicate the worse toy when both toys were accessible to the agent than when only the worse toy was accessible. There was no effect of age, $F(3,152) = 0.62$, $p = 0.607$; and no age by condition interaction, $F(3,152) = 1.11$, $p = 0.346$. However, because age is a continuous variable, we also analysed children's scores using a linear regression with the predictors: condition, age-in-months, and the interaction between condition and age-in-months. The model was significant, $R^2 = 0.13$, $F(3,156) = 7.57$, $p < 0.001$, with children's scores predicted by condition, $\beta = -0.32$, $t = -4.31$, $p < 0.001$, and marginally predicted by the interaction between condition and age-in-months, $\beta = -0.14$, $t = -1.85$, $p = 0.067$.

To explore these developmental differences, we used linear contrasts to examine whether responses in each condition varied with age. These tests revealed a developmental increase in children's scores in the no-constraint condition, $F(1,76) = 4.51$, $p = 0.037$, but no effect of age in the constraint condition, $F(1,76) = 0.05$, $p = 0.830$. With age, children increasingly inferred preference from a single unconstrained action. However, children's interpretation of constrained actions does not vary with age.

We also explored these developmental differences by separately examining each age group. At ages 3 and 4, responses did not significantly vary by condition, $t(38) = 0.89$, $p = 0.38$ and $t(38) = 1.53$, $p = 0.135$, while 5- and 6-year-olds were more likely to indicate the worse toy when both toys were accessible than when the better toy was inaccessible, $t(38) = 3.42$, $p = 0.002$, $d = 1.11$, and $t(38) = 2.80$, $p = 0.008$, $d = 0.91$.

These findings suggest that by age 5, children differentially infer preferences from a single action, depending on whether it was constrained. Importantly, the developmental effects we observed hinged on children's responses in the condition where the agent's

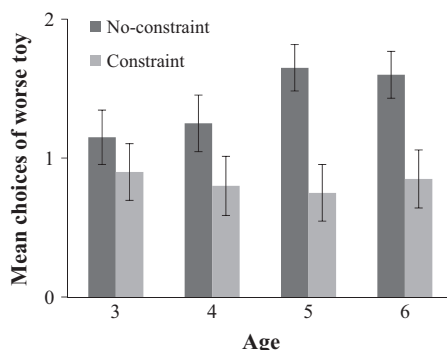


Fig. 4. Experiment 2. Mean times children indicated the worse toy. Error bars show ± 1 standard error of the mean.

action was not constrained. This suggests that what may change with age is children's ability to infer preferences from a single action, rather than children's sensitivity to constraints. We consider this further in Section 5.

One limitation of this experiment, however, is that it only examined children's sensitivity to one type of constraint, a physical one. Considerable research shows that children are also sensitive to other kinds of constraints, but that they also sometimes fail to consider them (e.g., [Buttelmann et al., 2009](#); [Chernyak, Kushnir, Sullivan, & Wang, 2013](#); [Harris et al., 1989](#); [Joseph & Tager-Flusberg, 1999](#); [Josephs, Kushnir, Gräfenhain, & Rakoczy, 2016](#); [Luo & Baillargeon, 2007](#); [Luo & Johnson, 2009](#); [Richert & Lillard, 2002](#)). The final experiment examined whether children also consider other kinds of constraints when inferring preferences. This experiment again examined whether children consider physical constraints when inferring preferences, but also looked at whether they consider epistemic and socio-moral constraints. The experiment focussed on children aged 5–6 because they showed the most robust ability to differentiate between constrained and unconstrained actions. We also tested adults to see whether any differences in children's sensitivity to constraints would be consistent across the lifespan. Also, to more closely match stimuli across conditions, participants saw the same pictures in all conditions; the conditions only differed in the information mentioned in the accompanying script.

4. Experiment 3: Physical, socio-moral, and epistemic constraints

4.1. Method

4.1.1. Participants

We tested 122 children aged 5–6 (M age = 5;5, range = 5;0–6;11, 65 girls) and 161 adults (M age = 35 years, range = 18–75, 64 female). Adult participants were recruited and tested online using Amazon Mechanical Turk and Qualtrics, and were all located in the United States.

4.1.2. Materials and procedure

Children saw a vignette about a boy and two boxes. One box contained a better toy car, the other box contained a worse toy car, and the boy wanted to play with a toy car. Children were randomly assigned to one of four conditions. In three of the conditions, the boy could take the worse car, but could not take the better car because of a constraint, which was physical, epistemic, or socio-moral. In the remaining condition, the boy's action was

unconstrained. In each condition, children first heard information about the worse car, and then information about the better one. In the constraint conditions, the information implied that the boy could take the worse car, but could not take the better one. In the physical condition, children were told “The boy has a key to open this box. But he doesn't have a key to open this box”; in the epistemic condition, they were told “The boy knows there's a car in this box. But the boy doesn't know there's a car in this box”; and in the socio-moral condition, they were told “The car in this box belongs to the boy. But the car in this box doesn't belong to the boy.” To match the structure of these conditions, in the no-constraint condition, children were told “The car in this box is noisy. But the car in this box isn't noisy.”

In all conditions, the boy took the worse car. Children were then shown the two cars on a blank screen and were asked which one the boy liked more (“Here are the cars. Can you point to the one the boy likes more?”). After children indicated one of the cars, they were asked whether he liked it “a little bit more” or “a lot more” than the other car. These responses were coded onto a scale ranging from 1 (Likes the better car a lot more) to 4 (Likes the worse car a lot more). See [Fig. 5](#) for the story images and scripts. The location of the toy cars (i.e., left/right of the boy, and left/right on the blank screen) and the order of options in the rating question (i.e., a little bit more, a lot more) were counterbalanced across participants.

One 5-year-old said “I don't know” when asked which car the boy liked more, but then provided an informative response after the experimenter repeated the story and question. The same 5-year-old and two 6-year-olds responded “I don't know” to the follow-up question, where children chose between “a little bit more” and “a lot more”. Two of these children provided informative responses after a further prompt. The third child still did not provide an informative response; the preference rating for this child was coded as “a little bit more”, as this coding is most conservative. The task also included a comprehension question (see [Fig. 5](#)). Four children initially responded to this question incorrectly, but provided correct responses after the experimenter repeated the information and question.

Adults. Adults were also randomly assigned to one of the four conditions and saw the same scenarios with some minor adjustments. Because adults completed the experiment online, they read the testing script and questions (rather than having these narrated to them). Adults saw the same slides that were shown to children (see [Fig. 5](#)), using versions where the worse car was on the left and the better car was on the right. Because there was no experimenter to point at the cars and boxes, the letter “A” appeared below pictures of the worse car and its box, and the letter “B” appeared below pictures of the better car and its box. The script was changed

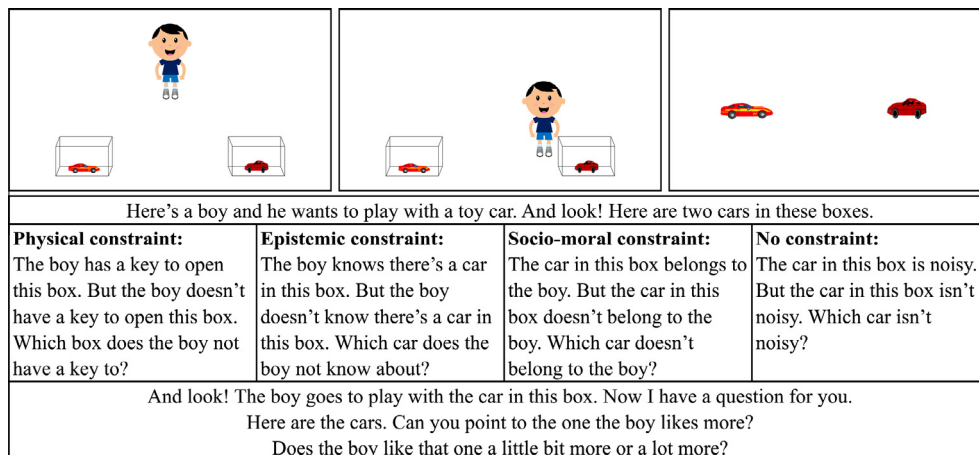


Fig. 5. Experiment 3. Sample image and story scripts used with children.

accordingly. For instance, in the physical constraint condition, adults read: “The boy has a key to open box A. But the boy doesn’t have a key to open box B.”

We also used a more sensitive test question with adults (which would have been difficult to use with children). Specifically, adults were asked “How does the boy feel about the cars?” and responded using a 7 point Likert scale. The mid-point was labelled “likes them equally” and the other points were labelled “[strongly/moderately/mildly] prefers [A/B]”. These responses were coded onto a scale ranging from 1 (Strongly prefers the better car) to 7 (Strongly prefers the worse car).

After responding to the test question, adults answered brief demographic questions about their age and gender, and also answered a multiple-choice comprehension question, asking which of four statements, pertaining to each of the four conditions, appeared in their story. Because performance on this question was very strong, and findings are equivalent when including and excluding participants who failed it, we included all participants’ data. We omitted the mid-task comprehension question that children were asked (e.g., “Which box does the boy not have a key to?”), as it seemed inappropriate for adults, because they had just read the relevant information.

4.2. Results and discussion

If children consider constraints when inferring preferences, they should be more likely to judge that the boy prefers the worse car in the no-constraint condition than in the constraint conditions. See Fig. 6 for their mean scores in each conditions.

We first entered children’s scores into a 1×4 (condition: physical, epistemic, socio-moral, no-constraint) ANOVA, which revealed a main effect of condition, $F(3, 118) = 4.59$, $p = 0.004$, $\eta_p^2 = 0.10$. Independent samples t -tests then tested whether responses in the no-constraint condition differed from those in each of the constraint conditions. Children inferred greater preference for the

worse toy in the no-constraint condition than in the physical constraint condition, $t(59) = 3.83$, $p < 0.001$, $d = 1.00$, and in the socio-moral constraint condition, $t(60) = 2.37$, $p = 0.021$, $d = 0.61$. However, their responses in the no-constraint and epistemic constraint conditions did not significantly differ, $t(59) = 1.30$, $p = 0.198$. These findings suggest that children not only consider physical constraints, but also socio-moral ones when inferring preferences. At the same time, they suggest children may have difficulty considering epistemic constraints, though it is possible that this sensitivity would be revealed with other methods. For example, children might have found it easier to consider epistemic constraints if the boxes had looked opaque rather than transparent.

Adults. Adults’ scores are also shown in Fig. 6. A 1×4 ANOVA (condition: physical, epistemic, socio-moral, no-constraint) revealed that their responses varied by condition, $F(3, 157) = 4.46$, $p = 0.005$, $\eta_p^2 = 0.08$. Adults inferred greater preferences for the worse toy in the no-constraint condition than in the physical constraint condition, $t(67.79) = 3.41$, $p < 0.001$, $d = 0.83$, and in the epistemic condition, $t(68.99) = 2.75$, $p = 0.008$, $d = 0.66$. However, their responses in the no-constraint condition did not significantly differ from those in the socio-moral constraint condition, $t(71.49) = 0.91$, $p = 0.365$. These findings reveal a different pattern than observed with children—whereas adults were sensitive to epistemic constraints, they did not show significant sensitivity to the socio-moral constraint of ownership.

5. General discussion

The findings of three experiments reveal that children infer preferences from a single action, and limit such inferences when the action is constrained. At the same time, there were developmental differences in how children inferred preferences, and in their responses (and likewise in adults’ responses) to different kinds of constraints. We consider these findings in turn.

5.1. Inferring preferences from a single action

Our findings show that preschool-age children are able to infer people’s preferences from a single action. In each experiment, children saw scenarios where an agent was free to take either a better or worse toy. When the agent did not act (Experiment 1), children recognized that the agent should prefer the better toy. But when the agent simply took the worse toy, children often judged that it was the one the agent preferred (all experiments). This finding shows that children are able to infer preferences on the basis of minimal information. In previous studies examining how children infer preferences, they either had rich or explicit information about others’ preferences (Fawcett & Markson, 2010a; Repacholi & Gopnik, 1997), or information about the agent’s repeated (e.g., Kushnir et al., 2010) or habitual (Jara-Ettinger et al., 2015) actions. To our knowledge, the present findings are the first to show that children infer preferences from the minimal information provided by an agent’s single action.

We also observed developmental differences in how children infer preferences from a single action. In Experiment 1, children aged 4 were more likely than those aged 3 to judge that the agent preferred the worse toy when it was selected. Likewise, in Experiment 2, these inferences increased with age in the condition where the agent’s action was not constrained. What might explain this developmental difference? One possibility is that younger children reject the idea that someone could prefer an inferior item over a better alternative. However, this possibility can be effectively ruled out because considerable previous research shows that even toddlers can grasp that an agent prefers a boring toy over a more interesting one (Fawcett & Markson, 2010b; Ma & Xu, 2011).

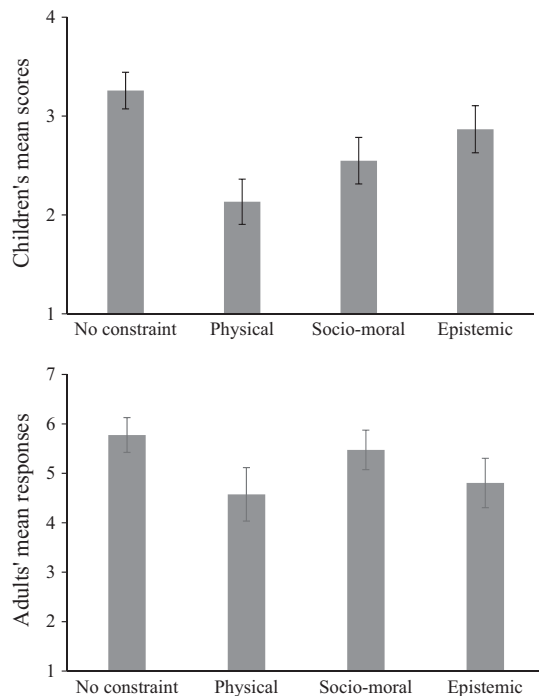


Fig. 6. Experiment 3. Children’s (top) and adults’ (bottom) mean ratings of the agent’s preference. Children’s ratings ranged from 1 (likes the better car a lot more) to 4 (liking the worse car a lot more); adults’ ratings ranged from 1 (strongly prefers better car) to 7 (strongly prefers worse car). Error bars show ± 1 standard error of the mean.

A more viable explanation is that there are developmental changes in how much evidence children need to overturn the assumption that a superior item is preferred. Younger children might typically require more information (or richer information) than older children to overturn their assumptions, such as information about an agent's repeated actions or emotional reactions to an object. In this regard, it is important to note that our design, which requires that children attribute a preference for an inferior item, makes our test quite stringent. If the agent instead chose between equivalent items, a single action might similarly influence the inferences of younger and older children.

5.2. Children's sensitivity to constraints

Our findings also show that children are sensitive to physical and socio-moral constraints on action when inferring preferences. In constraint conditions, the agent took the worse of two toys, but was prevented from taking the better one. In these conditions, children were generally less likely to judge that the agent preferred the worse toy, compared with conditions where the agent's action was not constrained. Children's sensitivity to visible, physical constraints is consistent with much previous work. More impressive are the findings showing that children's use of constraints is not just limited to observable physical constraints, such as a toy being out of reach on a high shelf. In the final experiment, the constraints could not be seen; children learned about them from the experimenter's description. Moreover, in the socio-moral constraint condition, children were sensitive to information about ownership, which is abstract and strictly non-observable (e.g., Kalish & Anderson, 2011; Snare, 1972). This is noteworthy because most studies that examine epistemic or psychological constraints display these constraints in a visual format (e.g., Luo, 2011; Luo & Baillargeon, 2007).

At the same time, we found some evidence for developmental differences in children's sensitivity to constraints. In examining physical constraints in Experiment 2, only children aged 5 and 6 responded differently between the conditions where the agent was constrained or not constrained; those aged 3 and 4, in contrast, responded similarly across these conditions. Although this could indicate a developmental increase in children's ability to consider constraints when inferring preferences, this is unlikely: The developmental differences only occurred in the condition where the agent's action was *not* constrained. In contrast, children at all ages responded similarly in the constraint condition. So rather than suggesting increased sensitivity to constraints, we believe it is more likely that the developmental differences reside mostly in children's ability to use a single action to infer a preference for an inferior item.

5.3. Differences between constraints

We also found differences in how children and adults reasoned about different kinds of constraints. In the final experiment, children showed sensitivity to physical and social constraints, but they had difficulty grasping the relevance of the epistemic constraint, in which the agent did not know about the better toy. This difficulty with the epistemic constraint may be surprising given that infants and children can determine whether others are knowledgeable or ignorant (e.g., Pratt & Bryant, 1990; Woolley & Wellman, 1993), and that young children consider epistemic constraints in their judgments about actions (e.g., Kushnir et al., 2015). However, many studies have found that children (including 5- and 6-year-olds) often have difficulty appreciating epistemic constraints—even after they correctly acknowledge ignorance, they fail to grasp its consequences (e.g., Bradmetz & Schneider, 1999; German & Leslie, 2001; Harris et al., 1989; Joseph & Tager-Flusberg, 1999;

Richert & Lillard, 2002; Yuill & Perner, 1988). Children have difficulty grasping how ignorance limits what people can pretend, draw, think, and intentionally do, and have difficulty recognizing that people should not be blamed for their harmful actions, when they did not know or foresee that these would cause harm.

Adults showed a different pattern of sensitivities. They were sensitive to both epistemic and physical constraints, but their responses were not influenced by the socio-moral constraint of ownership. Specifically, they responded as though the agent was as free to play with the toy that was not theirs. There is some precedent for this finding as both experimental (Neary & Friedman, 2014) and observational (Ross, 1996) research has found that adults may give less weight to ownership rights than do young children, at least when the ownership rights are held by children over relatively low value toys. So, it is possible that adults would be more sensitive to ownership as a constraint in a situation involving an adult agent, and more valuable goods.

Regardless, the variation in children's and adults' sensitivity to different kinds of constraints suggests that in inferring preferences, people do not draw on a general representation of constraints. If a general representation were used, we would expect equivalent findings for all constraints, especially given that all were conveyed using the same visual materials, and that the narration was similarly structured for all three constraints. Instead, it appears that people rely on representations of constraints that are more specific. Drawing on specific representations might be functional because constraints differ in the extent to which they limit actions. For instance, some constraints are absolute and render actions impossible, whereas others only impose difficulty and costs. It was impossible for the boy in Experiment 3 to access the better toy when it was locked up; but it was possible (though perhaps immoral) for him to take it in the condition where it was not his. Given such differences, the strength of a constraint may be relevant when inferring preferences, and indeed our adult findings are consistent with this. We leave it for future research to examine whether children are sensitive to the strength of constraints.

5.4. Broader implications

Although our findings are primarily informative about children's abilities to infer preferences from a single action, and to avoid such inferences when the action is constrained, they also have broader significance. Considerable research in cognitive development has examined how young children are able to make inferences about abstract concepts and about non-obvious properties of things. In many instances, this research has found that young children make these inferences using minimal information that is concrete and observable. For instance, they use information about who has physically possessed an object to infer who owns it (e.g., Blake, Ganea, & Harris, 2012; Friedman & Neary, 2008); they use a speaker's accent to infer their background (Kinzler & DeJesus, 2013; Weatherhead et al., 2016); they use a single behavior to infer enduring personality traits (Boseovski & Lee, 2006; Liu et al., 2007); and they use a single observed use of an object to infer its function and how it should be used (Phillips, Seston, & Kelemen, 2012; Schmidt, Rakoczy, & Tomasello, 2011). Our findings provide another example of this, and also show how subtle changes in context lead children to avoid making an inference.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.cognition.2016.07.004>.

References

- Blake, P. R., Ganea, P. A., & Harris, P. L. (2012). Possession is not always the law: With age, preschoolers increasingly use verbal information to identify who owns what. *Journal of Experimental Child Psychology*, 113, 259–272.
- Boseovski, J. J., & Lee, K. (2006). Children's use of frequency information for trait categorization and behavioral prediction. *Developmental Psychology*, 42, 500–513.
- Bradmetz, J., & Schneider, R. (1999). Is Little Red Riding Hood afraid of her grandmother? Cognitive vs. emotional response to a false belief. *British Journal of Developmental Psychology*, 17, 501–514.
- Buttelmann, D., Carpenter, M., & Tomasello, M. (2009). Eighteen-month-old infants show false belief understanding in an active helping paradigm. *Cognition*, 112, 337–342.
- Chernyak, N., Kushnir, T., Sullivan, K. M., & Wang, Q. (2013). A comparison of American and Nepalese children's concepts of freedom of choice and social constraint. *Cognitive Science*, 37(7), 1343–1355.
- Denison, S., Trikutam, P., & Xu, F. (2014). Probability versus representativeness in infancy: Can infants use naïve physics to adjust population base rates in probabilistic inference? *Developmental Psychology*, 50, 2009–2019.
- Denison, S., & Xu, F. (2010). Integrating physical constraints in statistical inference by 11-Month-Old Infants. *Cognitive Science*, 34, 885–908.
- Diesendruck, G., Salzer, S., Kushnir, T., & Xu, F. (2015). When choices are not personal: The effect of statistical and social cues on children's inferences about the scope of preferences. *Journal of Cognition and Development*, 16, 370–380.
- Fawcett, C. A., & Markson, L. (2010a). Children reason about shared preferences. *Developmental Psychology*, 46, 299–309.
- Fawcett, C. A., & Markson, L. (2010b). Similarity predicts liking in 3-year-old children. *Journal of Experimental Child Psychology*, 105, 345–358.
- Friedman, O., & Neary, K. R. (2008). Determining who owns what: Do children infer ownership from first possession? *Cognition*, 107, 829–849.
- Garvin, L. E., & Woodward, A. L. (2015). Verbal framing of statistical evidence drives children's preference inferences. *Cognition*, 138, 35–48.
- Gelman, S. A., & Gottfried, G. M. (1996). Children's causal explanations of animate and inanimate motion. *Child Development*, 67, 1970–1987.
- Gergely, G., Bekkering, H., & Király, I. (2002). Rational imitation in preverbal infants. *Nature*, 415, 755.
- Gergely, G., Nádasdy, Z., Csibra, G., & Bíró, S. (1995). Taking the intentional stance at 12 months of age. *Cognition*, 56, 165–193.
- German, T. P., & Leslie, A. M. (2001). Children's inferences from 'knowing' to 'pretending' and 'believing'. *British Journal of Developmental Psychology*, 19, 59–83.
- Harris, P. L., Johnson, C. N., Hutton, D., Andrews, G., & Cooke, T. (1989). Young children's theory of mind and emotion. *Cognition and Emotion*, 3, 379–400.
- Hu, J., Lucas, C. G., Griffiths, T. L., & Xu, F. (2015). Preschoolers' understanding of graded preferences. *Cognitive Development*, 36, 93–102.
- Jara-Ettinger, J., Gweon, H., Tenenbaum, J. B., & Schulz, L. E. (2015). Children's understanding of the costs and rewards underlying rational action. *Cognition*, 140, 14–23.
- Joseph, R. M., & Tager-Flusberg, H. (1999). Preschool children's understanding of the desire and knowledge constraints on intended action. *British Journal of Developmental Psychology*, 17, 221–243.
- Josephs, M., Kushnir, T., Gräfenhain, M., & Rakoczy, H. (2016). Children protest moral and conventional violations more when they believe actions are freely chosen. *Journal of Experimental Child Psychology*, 141, 247–255.
- Kalish, C. W., & Anderson, C. D. (2011). Ownership as a social status. *New Directions for Child and Adolescent Development*, 132, 65–77.
- Kinzler, K. D., & DeJesus, J. M. (2013). Children's sociolinguistic evaluations of nice foreigners and mean Americans. *Developmental Psychology*, 49, 655–664.
- Kushnir, T., Gopnik, A., Chernyak, N., Seiver, E., & Wellman, H. M. (2015). Developing intuitions about free will between ages four and six. *Cognition*, 138, 79–101.
- Kushnir, T., Xu, F., & Wellman, H. M. (2010). Young children use statistical sampling to infer the preferences of other people. *Psychological Science*, 21, 1134–1140.
- Liberman, Z., Kinzler, K. D., & Woodward, A. L. (2014). Friends or foes: Infants use shared evaluations to infer others' social relationships. *Journal of Experimental Psychology: General*, 143, 966–971.
- Liu, D., Gelman, S. A., & Wellman, H. M. (2007). Components of young children's trait understanding: Behavior-to-trait inferences and trait-to-behavior predictions. *Child Development*, 78, 1543–1558.
- Lucas, C. G., Griffiths, T. L., Xu, F., Fawcett, C., Gopnik, A., Kushnir, T., Markson, L., & Hu, J. (2014). The child as econometrician: A rational model of preference understanding in children. *PLoS One*, 9, e92160.
- Luo, Y. (2011). Do 10-month-old infants understand others' false beliefs? *Cognition*, 121, 289–298.
- Luo, Y., & Baillargeon, R. (2007). Do 12.5-month-old infants consider what objects others can see when interpreting their actions? *Cognition*, 105, 489–512.
- Luo, Y., & Johnson, S. C. (2009). Recognizing the role of perception in action at 6 months. *Developmental Science*, 12, 142–149.
- Ma, L., & Xu, F. (2011). Young children's use of statistical sampling evidence to infer the subjectivity of preferences. *Cognition*, 120, 403–411.
- Mahajan, N., & Wynn, K. (2012). Origins of "us" versus "them": Prelinguistic infants prefer similar others. *Cognition*, 124, 227–233.
- Neary, K. R., & Friedman, O. (2014). Young children give priority to ownership when judging who should use an object. *Child Development*, 85, 326–337.
- Phillips, B., Seston, R., & Kelemen, D. (2012). Learning about tool categories via eavesdropping. *Child Development*, 83, 2057–2072.
- Pratt, C., & Bryant, P. (1990). Young children understand that looking leads to knowing (so long as they are looking into a single barrel). *Child Development*, 61, 973–982.
- Repacholi, B. M., & Gopnik, A. (1997). Early reasoning about desires: Evidence from 14- and 18-month-olds. *Developmental Psychology*, 33, 12–21.
- Richert, R. A., & Lillard, A. S. (2002). Children's understanding of the knowledge prerequisites of drawing and pretending. *Developmental Psychology*, 38, 1004–1015.
- Ross, H. S. (1996). Negotiating principles of entitlement in sibling property disputes. *Developmental Psychology*, 32, 90–101.
- Schmidt, M. F., Rakoczy, H., & Tomasello, M. (2011). Young children attribute normativity to novel actions without pedagogy or normative language. *Developmental Science*, 14, 530–539.
- Schult, C. A., & Wellman, H. M. (1997). Explaining human movements and actions: Children's understanding of the limits of psychological explanation. *Cognition*, 62, 291–324.
- Snare, F. (1972). The concept of property. *American Philosophical Quarterly*, 9, 200–206.
- Sobel, D. M. (2004). Exploring the coherence of young children's explanatory abilities: Evidence from generating counterfactuals. *British Journal of Developmental Psychology*, 22, 37–58.
- Weatherhead, D., White, K. S., & Friedman, O. (2016). Where are you from? Preschoolers infer background from accent. *Journal of Experimental Child Psychology*, 143, 171–178.
- Woolley, J. D., & Wellman, H. M. (1993). Origin and truth: Young children's understanding of imaginary mental representations. *Child Development*, 64, 1–17.
- Yuill, N., & Perner, J. (1988). Intentionality and knowledge in children's judgments of actor's responsibility and recipient's emotional reaction. *Developmental Psychology*, 24, 358–365.