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Children seek historical traces of owned objects

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Abstract

An object's mental representation includes not just visible attributes but also its non-visible history. The present studies tested whether preschoolers seek subtle indicators of an object's history, such as a mark acquired during its handling. Five studies with 169 children 3-5 years of

age and 97 college students found that children (like adults) searched for concealed traces of object history, invisible traces of object history, and the absence of traces of object history, to successfully identify an owned object. Controls demonstrated that children (like adults) appropriately limit their search for hidden indicators when an owned object is visibly distinct. Altogether, these results demonstrate that concealed and invisible indicators of history are an important component of preschool children's object concepts.

Children seek historical traces of owned objects

For adults, the mental representation of an object includes not just visible attributes, such as shape, color, or size, but also non-visible attributes, such as function, internal parts, and causal links among features (Keil, 2006; Meyer, Leslie, Gelman, & Stilwell, 2013; Rips, 2011). Among the non-visible attributes that enter into adults' object representations, one of the most pervasive is an object's history, such as who owned it and where it has been. Historical considerations play an important role in how we value and interact with objects. For example, works of art with authentic history are highly valued, collected, and exhibited in museums, whereas forgeries or mass-produced copies of the same works are not (Newman & Bloom, 2012). The role of history extends beyond artwork to a wide range of items with both famous and personal connections (Frazier, Gelman, Wilson, & Hood, 2009; Newman & Bloom, 2014; Newman, Diesendruck, & Bloom, 2011), such as items owned by a celebrity or a beloved family member, as well as items with distinctive origins (e.g., moon rocks) or participation in a meaningful event (e.g., dishes from Pompeii). Moreover, objects with a negative history (such as a sweater handled by an evil person) are viewed as contaminated and to be avoided, even if the negative history leaves no visible trace (Nemeroff & Rozin, 1994).

Young children, too, are sensitive to object history. At the most basic level, children 3-5 years of age use the historical path of an object (that is, its spatiotemporal continuity) to determine its identity (Gutheil, Gelman, Klein, Michos, & Kelaita, 2008; Hall, 1996; Sorrentino, 2001), and consider past states to determine plausible future states (Friedman, 2003; Rosengren, Gelman, Kalish, & McCormick, 1991). Also like adults, preschool children treat objects with special history (e.g., celebrity possessions) as having higher value and being worthy of display in museums (Frazier & Gelman, 2009; Gelman, Frazier, Noles, Manczak, & Stilwell, 2015), and objects with negative history (e.g., contamination) as items to be avoided (Hejmadi, Rozin, & Siegal, 2004; Legare, Wellman, & Gelman, 2009).

Object history is central to concepts of ownership. By 5 years of age, children view historical information (e.g., a girl brought a ball to the beach) but not information about the future (e.g., a boy will leave the beach with the ball) as diagnostic of ownership (Friedman, Van de Vondervoort, Defeyter, & Neary, 2013). Young children prefer their own original attachment objects (e.g., special blanket or soft toy) to exact replicas, which are perceptually identical but lack the significant history (Hood & Bloom, 2008). By 3 years of age, children keep close track of objects designated as belonging to them, thus tracing a continuous historical path through space and time (Gelman, Manczak, & Noles, 2012). Children trace the historical path of owned objects even when such objects are undesirable (e.g., a plain piece of wood) or non-distinctive (e.g., one of three identical toys). Ownership information has special status, as children pay greater attention to the individual identity of objects that are tagged with ownership information ("This is yours") than objects that are tagged with other sorts of information, such as a count-noun label ("This is a sarn") (Gelman, Noles, & Stilwell, 2014).

Even for ordinary objects without a specified owner, object history plays a powerful role. Three- and four-year-old children use object features to make accurate inferences about their history--for example, that an apple that is wet had previously been splashed with water (Gelman, Bullock, & Meck, 1980). In somewhat the reverse process, 22-month-olds (but not 19-month-olds) can use verbally provided historical information to update their representation of a non-visible object ("I spilled water all over Lucy [a toy frog]. Lucy is wet now! She's covered with water."; Ganea, Shutts, Spelke, & DeLoache, 2007). Thus, when historical cues are overt, children add them to their representation of an object, yielding an updated representation that retains the object history. When the object choices are then visible, and one of the choices visibly includes the relevant feature (i.e., wetness), they identify that item as their own.

The current studies examine a related but distinct understanding: that history leaves traces, and that these traces are relevant to ownership judgments. We ask not just whether children retain historical features, but also whether they seek information about object history to differentiate two seemingly identical objects (akin to when an adult might use scuff marks or fingerprints to identify a certain item). We studied children's performance both when the historical cue is hidden yet retrievable (Studies 1, 2, and 5) and when the historical cue is wholly invisible (Studies 3, 4, and 5). Is object history sufficiently central to ownership concepts that children spontaneously and actively search for historical cues, recognizing them as relevant to

ownership judgments? By studying children's sensitivity to object history, we can learn more about how and when children's object concepts extend beyond associations among perceptible features to include theory-like considerations.

The basic task and logic are as follows. On each of a series of trials, the researcher assigns one of two seemingly identical objects to the child. The researcher then marks one of the objects in a hidden location (e.g., on the bottom of the object), either showing the child the mark (Studies 1, 2, and 5) or not (Studies 3, 4, and 5). Objects are then placed on a spinner (with a lid) and spun to defeat spatiotemporal tracking of either object. After the spinner comes to a halt, the lid is lifted and the researcher asks simply: "Can you find which one is yours?" In order for children to succeed on this task, they need to seek a cue that is non-obvious, hidden from view, and not explicitly referenced. Recent research shows that young children represent non-obvious features of objects when reasoning about function (Kemler Nelson, Frankenfield, Morris, & Blair, 2000; Ware & Booth, 2010), causes (Walker, Lombrozo, Legare, & Gopnik, 2014), and internal parts (Setoh, Wu, Baillargeon, & Gelman, 2013; Sobel, Yoachim, Gopnik, Meltzoff, & Blumenthal, 2007). Moreover, ownership has been proposed to be a developmental primitive (Jackendoff, 1992), and the capacity to link visible features to historical processes has also been proposed to be an intuitive cognitive process (Leyton, 1992). We therefore predicted that preschool children would treat object history as central to determinations of ownership, and--without prompting--would look for the concealed "trace" of the object's history by examining the hidden location and select the item that had been designated as their own.

In contrast, recent findings on preschoolers' object concepts would also support three alternative predictions. First, children might ignore the historical traces in favor of more salient object features (e.g., object shape, size, color, texture, and/or function). The historical features in the present studies were inconspicuous and without functional consequences, and a large body of research demonstrates the salience of shape and function in children's judgments at this age (Kemler Nelson et al., 2000; Landau, Smith, & Jones, 1988). Furthermore, DeJesus, Shutts, and Kinzler (2015) found that it was not until 5.82 years of age that children made use of historical cues in a food-selection task. Below that age, children were insensitive to contamination cues (i.e., an experimenter sneezing into one of two bowls of food), and showed no preference for the clean vs. contaminated food source. Thus, attending to traces of object history may not emerge until about six years of age.

A second alternative possibility is that children might attend preferentially to *spatiotemporal* cues marking ownership. Spatiotemporal cues are argued to be the primary basis of identity judgments by the time children are 4-5 years of age (Gutheil et al., 2008), and by three years of age children skillfully use spatial proximity or spatiotemporal continuity in their ownership judgments (Friedman & Neary, 2008; Friedman et al., 2013; Gelman et al., 2012; Gelman et al., 2014). Thus, when spatiotemporal continuity is disrupted (i.e., when the items in this task are covered up and spun), children may either make use of an item's proximity (selecting the item closest to them), or having insufficient information, randomly guess.

A third alternative possibility is that children could reason that incidental marks are irrelevant to ownership, so that items that differ in slight ways are equivalent. This would be consistent with economic models of how money is treated in financial transactions (see Zelizer, 1997, for review). When playing poker, for example, money or chips are put into a common pot, and then redistributed over the course of the game. It doesn't matter whether one receives the same exact coins or tokens that one initially put into the pot, as long as one receives the right amount in the end. Prior evidence would suggest that owned objects are not wholly fungible for children because, as noted earlier, when given an opportunity to use spatiotemporal continuity to track which objects belong to themselves, young children distinguish their own object from an identical unowned object (Gelman et al., 2014). Nonetheless, spatiotemporal continuity may be a uniquely powerful cue for children, and in its absence, children may be aware of minor featural differences between objects in a set but choose not to seek them out.

We focused on children 3-5 years of age, given that 4- and 5-year-olds have been the focus of prior research arguing for the primacy of children's use of spatiotemporal history over featural cues (Gutheil et al., 2008; Hood & Bloom, 2008), as well as research documenting developmental changes taking place between 3 and 5 years of age in children's appearance/reality contrasts (Deák, Ray, & Brenneman, 2003; Flavell, Flavell, & Green, 1983), use of subtle features indicating function (Kelemen, Widdowson, Posner, Brown, & Casler, 2003), and the kinds of features used on certain categorization and induction tasks (Badger & Shapiro, 2012; Fisher, 2011). Adults were included as a basis of comparison, and provided a developmental endpoint. Studies 1-4 focused on four- and five-year-olds, and Study 5 extended these methods to three-year-old children.

Study 1: Concealed traces of object history

In Study 1, we provided participants with ownership information, varied whether or not the owned object had a distinctive and marked history, and then tested whether participants sought information regarding the object's history before making an ownership judgment. We predicted that even young children would spontaneously search for traces of the owned object's history prior to making ownership judgments, and that they would successfully use this information to determine ownership. A no-history control was included, which was identical to the experimental condition except that no indications of differential histories were made or implied. This tests the baseline rates at which participants examine objects on this task. We predicted that participants would inspect the objects less in the absence of special history.

Method

Participants. Participants included 34 children (age range 4.08-5.43; *M* age 4.74; 15 girls, 19 boys) and 32 adults (age range 17-21; 15 women, 17 men), randomly assigned in equal numbers to either the experimental condition or the no-history control condition. One additional child (age 4.87) was dropped for failure to understand the task. Children were recruited from communities in and around a Midwestern American university town; 88% were White. The adult participants consisted of undergraduates at a large university in the same town; 67% were White. Across the five studies, testing took place from December, 2009 to January, 2015.

Items. Six pairs of identical objects were used in this study (see Table 1). These items were small, ordinary objects and included: miniature notebooks, wooden disks, containers of Play-Doh, wooden stars, cardboard gift boxes, and oval boxes each containing a tiny alien figurine. Several tools were used to alter the objects in some way; these included a pencil, sticky note, small scrap of paper, and paintbrush. The warm-up task used two differently colored but otherwise identical Legos, and two identical paper cups. Additional materials included a spinner with an opaque plastic cover and a small fabric basket.

Insert Table 1 about here

Procedure. Participants were tested individually in a child-friendly, on-campus lab. Each participant sat at a small table, at a 90-degree angle from the researcher, with the spinner and fabric basket in front of them. Participants were first told that they would hear ownership information about a set of objects; furthermore, they were notified that they could pick up or otherwise manipulate the objects in order to help them answer the test questions.

In order to ensure that participants understood the task and felt free to actively search,

they were first given a warm-up trial, in which the object pair consisted of two Legos differing in color. One Lego was assigned to the participant ("This is yours. This is for [participant's name].") but otherwise was not marked by the researcher in any way. The other object was not assigned to anyone, but attention was drawn to it ("See this? Look at this."). Then, the Legos were covered with small paper cups, such that they were obscured from view. The objects were then placed on the spinner, covered, and spun. The research uncovered the spinner and asked, "Can you find which one is yours?" Participants were required to successfully complete the warm-up (i.e., remove the paper cup(s) to find the correct Lego) before advancing to the test trials. Only one child (age 4.08) chose the distracter Lego; for this child, the warm-up was repeated until they selected the correct object.

On test trials, participants saw one item at a time. When showing the first object in each pair, the researcher said, "This is yours. This is for [*participant's name*]." In the experimental condition, the researcher then proceeded to mark the participant's object in a hidden place, either inside or on the underside of the object. The notebook, disk, and gift box had already been marked, in order to feasibly re-use the same objects with different participants, so for these objects the experimenter simply pretended to make the mark during the course of the experiment. The experimenter explicitly mentioned making the mark (e.g., "Let's mark this with a pencil") and showed the mark to the participant after it had been made. After the manipulation, the object was placed on the table in such a way that the distinguishing feature was no longer visible. The no-history control condition was identical, except that no indications of differential histories were made or implied. That is, the researcher did not mark or pretend to mark either object.

In both conditions, the researcher then showed the participant the second item of the pair. Participants received no information about the ownership of this second item; instead, it was introduced with, "See this? Look at this." Thus, attention was drawn to both objects in the pair.

The objects were then placed on the spinner, covered, and spun. For the majority of adult participants, the first object was placed under the lid before the second object was presented, in order to thwart a side-by-side visual comparison of the objects that could have allowed the detection of minute perceptible differences. (The first few adult participants did see the objects side-by-side, as did a few further participants for whom the researcher forgot to place the first object under the lid before presenting the second object. However, responses were comparable for those who saw the objects side-by-side and those who did not.) Adult participants were also

asked to close their eyes before the objects were placed and spun, to prevent them from tracking the objects' locations during spinning (based on pilot-testing in which some adults attempted to use this strategy). Children did not demonstrate a tendency to track the spinner's position; thus they were not asked to close their eyes and were instead invited to help the experimenter spin the spinner.

After the spinner had completed spinning, the experimenter uncovered the objects and asked the participants, "Can you find which one is yours?" Once the participant had selected an object, they were instructed to place it inside the fabric basket (this allowed experimenters to later determine which object the child had chosen). After the first set of items, the researcher moved on to the next set. The six item sets were presented in one of two random orders. Test trials were not repeated for any reason.

At the end of the testing session, adult participants received debriefing that explained the purpose of the study, and children were thanked for their participation and received a small gift.

Coding

Choice scoring. After the testing session had ended, participants' object choices were determined by examining the objects placed into the fabric basket. For each of the six test trials, the object choice was scored as 1 if the participant selected the marked, "yours"-designated object and as 0 if the participant selected the distracter object. Thus, participants could obtain a maximum choice accuracy score of 6 and a minimum score of 0. Object choice from the warm-up trial was not included in the overall accuracy score.

Coding for checks. Each videotaped session was coded for participants' checking behaviors. A check was coded each time a participant picked up an object and looked in the location where the mark had been made on the target object (regardless of whether that particular object had actually been marked). If a participant examined both objects in a pair simultaneously, this was coded as two checks. A check was *not* coded if the participant picked up or otherwise examined the object *without* looking specifically in the location of the mark. All checks on a given trial were summed per participant. A second coder also viewed each video recording; when disagreements in coding occurred (which was rare), they were resolved by discussion.

Results

Choices. As noted above, each participant received a score (0-6) for the number of trials on which they correctly selected the owned object. Missing trials (due to child inattention or

experimenter error) were excluded, and scores adjusted (e.g., a child who received only 5 trials had their responses summed and multiplied by 6/5). These scores were entered into a 2-way ANOVA with age group (child, adult) and condition (experimental, no-history control) as between-subjects factors (see Table 2). There was a main effect of condition, $F(1,62) = 44.71$, $p < .001$, $\eta_p^2 = .42$, indicating substantially greater accuracy in the experimental condition than the no-history control condition (*M*s = 5.55, 3.34). There was also a main effect of age group, $F(1,62) = 6.65$, $p = .012$, $\eta_p^2 = .10$, indicating that adults overall were more accurate than children (*M*s = 4.87, 4.02), but no significant interaction. One-way t-tests against the chance value of 3.0 indicate that participants successfully identified the owned object in the experimental condition, $t(32) = 10.93$, $p < .001$, but not in the no-history control condition, $t(32) = 1.30$, $p = .20$.

Insert Table 2 about here

Checks. The total number of checks per participant were entered into a 2-way ANOVA with age group (child, adult) and condition (experimental, no-history control) as between-subjects factors (see Table 3). There was a main effect of condition, $F(1,62) = 40.64$, $p < .001$, $\eta_p^2 = .40$, a main effect of age group, $F(1,62) = 58.95$, $p < .001$, $\eta_p^2 = .49$, and a condition x age group interaction, $F(1,62) = 40.64$, $p < .001$, $\eta_p^2 = .40$. The interaction revealed that children were much more likely to search for traces in the experimental condition than the no-history control condition (*M*s = 8.39, 1.18), $p < .001$, whereas adults searched in both conditions equally (*M*s = 9.13, 9.13), n.s.

Insert Table 3 about here

Discussion

Study 1 demonstrates that preschoolers, like adults, spontaneously seek and make use of cues to object history, when tasked with identifying which of two outwardly identical objects is their own. These cues were hidden inside or underneath the target object, and thus not visible upon outward inspection of the objects--during either initial presentation or test. Additionally, the cues to history were subtle (e.g., a thumbprint; a dot of paint), retained over a delay (during which the objects are hidden under the spinner top, spun, and uncovered), requiring active search (turning an object over or opening it up), and not directly queried (prompted by a query about ownership: "Which is yours?", not a query about history, e.g., "Which did I mark?" or "Which has a thumbprint?"). Not only did four-year-olds use hidden marks of an object's history to

distinguish their own object from one that was not their own, but they also searched for such marks in the absence of any prompting on the part of the experimenter. These results extend beyond prior work, which was focused on children's use of visible, overt cues to object history (such as proximity to the owner). We do not claim that children attended to history *instead of* perceptual cues, but rather that children's object representations and ownership judgments meaningfully included the perceptual cues that *result from* history.

As expected, children were much less likely to search the objects in the no-history control condition (when the objects had been provided with no distinctive history). Surprisingly, however, adults checked the objects just as often in the control condition as in the experimental condition. Perhaps the possibility of differential histories was so salient to adults that they searched for historical cues even when not prompted by the experimental procedure. Alternatively, they may have been searching for features that would distinguish the objects (independent of history). In either case, it is interesting that adults were motivated to inspect the objects closely when given this difficult task, as it is not clear how they would have interpreted such cues, even had they found them.

Study 2: Absence of concealed traces of object history

One possible alternative interpretation of Study 1 is that the children selected the owned object simply because the experimenter interacted with that object more than the contrasting object, thus capturing their attention. Study 2 was designed to test this idea. Specifically, the materials and procedure were nearly identical to those of Study 1, except that in this study, the *unowned* object was marked, and children were again tasked with finding their own object. Thus, in order to succeed on this task, they had to find the object that *lacked* visible traces.

Method

Participants. Participants included 16 children (7 female, 9 male; age range 4.03 – 4.98; *M* age 4.54). One additional child was dropped for failing to understand the task (the child consistently selected both items during the test trials). Children were recruited from communities in and around a Midwestern university town; 81% were White.

Materials. The same materials from Study 1 were used.

Procedure. The procedure was the same as in the experimental condition of Study 1, except that the distracter object was marked instead of the “yours” (participant's) object. As in Study 1, participants first received a warm-up trial; four children (*M* age = 4.47) had to repeat the

warm-up before moving on to the test trials. Subsequently, for each test trial the experimenter showed the participant an object and told them "This is yours. This is for [*participant's name*]." The object was then placed facedown in front of the experimenter. The second item was then introduced as "See this?" and marked in the same way as the "yours" objects in Study 1. As in Study 1, the experimenter also told the participant that the mark was being made (e.g., "Let's mark this with a pencil") and showed it to the participant. Finally, as in Study 1, participants were asked to find their object after both items were spun.

Coding

Choice scoring. Participants' object choices were determined by the same method as Study 1; however, since the distracter object was marked in this study, the object choice was scored as 1 if the participant selected the *unmarked*, "yours"-designated object and as 0 if the participant selected the marked distracter object. Again, participants could obtain a maximum choice accuracy score of 6 and a minimum score of 0.

Coding for checks. Checking behavior was coded as in Study 1.

Results

Choices. Children selected the owned object (i.e., the one without the mark) correctly a mean of 5.00 out of 6 trials, which is significantly greater than chance, $t(15) = 4.70$, $p < .001$. This is also significantly greater than in the no-history control condition of Study 1, $t(31) = 3.78$, $p = .001$, and equivalent to the experimental condition of Study 1, $t(31) = -0.24$, $p = .81$.

Checks. Children checked the objects an average of 8.63 times, which is significantly greater than in the no-history control condition of Study 1, $t(31) = 11.45$, $p < .001$, and equivalent to the experimental condition of Study 1, $t(31) = 0.33$, $p = .75$.

Discussion

Study 2 replicates the primary finding of Study 1, that preschool children seek and make use of hidden historical cues to identify object identity. Moreover, because Study 2 required that children select the unmarked object (rather than the marked object, as in Study 1), it demonstrates that these results cannot simply be attributed to greater attention to or interest in the object that had received more attention from the researcher.

Study 3: Invisible traces of object history

An alternative explanation for the results of Studies 1 and 2 is that participants were not looking for traces of history per se, but rather for distinguishing features. By placing a pencil

mark in the notebook, for example, the owned notebook becomes materially different from the unowned notebook, much like a red notebook is different from a blue notebook. Perhaps participants were not searching for historical traces but rather simply noting that the objects possess different (albeit hidden) features. Note, however, that attending to differential features in this task would still have required children to update their object representations based on the items' history, to hold that updated representation in mind even when the distinguishing features were no longer visible, and to consider them important when making an ownership decision. That preschool children search for a feature as seemingly insignificant as a dot of paint (which is neither salient nor functionally relevant) speaks to the centrality of historical events in their ownership representations.

Nonetheless, we wished to test whether participants search for historical traces even when such traces are never shown--and in fact, when the differential history leaves no visible trace. In Study 3, for each trial, the owned object underwent a special history in which a mark was implied but not made.

In addition, we included a new control condition that asked for liking judgments, designed to assess whether participants are selective in their checking. Do they check for historical traces only when the question requires it (ownership question: "Which is yours?"), or do they do so even when it is not required (liking question: "Which one do you like best?")? The no-history control condition of Study 1 demonstrated that the task per se does not demand checking, because in the absence of differential history, child participants rarely checked the objects. However, that did not address the question of the conditions under which participants check differential history when it is available. Thus this additional control asked about liking rather than ownership, and yields two competing hypotheses. On the one hand, participants may selectively make use of historical information only in response to the ownership question, given the special status of ownership concepts early in development (Friedman & Neary, 2008). On the other hand, the special status of owned objects in economic judgments ("mere ownership effect", Beggan, 1992; "endowment effect", Kahneman, Knetsch, & Thaler, 1990) might suggest that participants would care about object history even when the question does not ask specifically about identity. If this is the case, then we may find participants using the historical information when they are asked about liking as well as ownership.

Method

Participants. Participants included 32 children (4.09-5.35, *M* age 4.65; 11 girls, 21 boys) and 33 adults (18-21 years of age, *M* age 19; 21 women, 12 men). Two additional children were tested but dropped (one was unable to complete the task, and the other was ineligible for inclusion due to prior participation in a similar study). Children were recruited from communities in and around a Midwestern university town; 84% were White. The adult participants consisted of undergraduates at a large university in the same town; 79% were White. Within each age group, participants were randomly assigned to either the experimental or the like-best control condition.

Items. The items were identical to the no-history control items used in Study 1. However, a pencil was the only tool used. Although it appeared to be a normal, functioning pencil, it had been altered so that it could not write.

Procedure. As in the prior two studies, participants first received a warm-up trial with differently colored Legos. Only one child (age 4.2) had to repeat the warm-up. The procedure for the experimental condition was identical that of Study 1, except that the experimenter only *pretended* to mark the test objects designated as belonging to the participant, and for each test item the marking involved a pencil. Participants were neither shown where the implied mark had been made, nor explicitly told that a mark was being made. However, the researcher's actions suggested that these implied marks were in the same locations as the actual traces from Studies 1 and 2 (e.g., on the bottom of a wooden disk; inside the mini blank book). For the like-best control condition, the procedure was identical to the experimental condition (including conveying ownership, pretending to mark the owned object, spinning both objects under the cover), except that the test question on each trial was, "Can you find which one you like best?"

Coding

Choice scoring. Because the pairs of objects remained identical throughout the study (neither the “yours” or distracter object were marked), the method for calculating accuracy differed slightly from the scoring scheme used in Study 1. After the testing session was complete, accuracy was determined by examining the chosen objects for minute, extremely subtle indicators of the objects’ identity that had been placed on the key object in each pair before the study began. These indicators included a tiny pencil mark between the cover and “folder” section of the notebook; a faint eraser mark on one edge of the disc; a pinprick on one edge of the star; a marker dot on the bottom of the Play-Doh; a pen mark on the bottom of the cardboard

box; and a pen mark on the bottom of the oval. These indicators were barely visible and never shown to the participants. Even if a participant were to come across these indicators during the testing session, they would have been unable to distinguish which object they signified.

Coding for checks. Checking behavior was coded as in Study 1.

Results

In the analyses, we included as a baseline the no-history control data from Study 1, in which no history was provided or shown, to determine the extent to which presence versus absence of a history affects performance (in both cases, when there is no visible distinction between the objects in a pair).

Choices. Participant scores were entered into a 2-way ANOVA with age group (child, adult) and condition (experimental, like-best control, no-history control) as between-subjects factors (Table 2). There was a significant effect for age group, $F(1,92) = 7.70$, $p = .025$, $\eta_p^2 = .054$, indicating that adults performed better than children (*M*s = 3.71, 3.15), with adults' scores slightly but significantly above chance, $t(48) = 4.07$, $p < .001$, but children's scores at chance, $t(48) = 0.85$, $p = .40$. There were no differences as a function of condition, indicating that participants had difficulty identifying the owned object in the absence of an identifying mark.

Checks. Checks were entered into a 2-way ANOVA with age group (child, adult) and condition (experimental, like-best control, no-history control) as between-subjects factors (see Table 3). We obtained a main effect of condition, $F(2,92) = 8.58$, $p < .001$, $\eta_p^2 = .16$, a main effect of age group, $F(1,92) = 59.21$, $p < .001$, $\eta_p^2 = .39$, and a trend toward a condition x age group interaction, $F(2,92) = 2.86$, $p = .062$, $\eta_p^2 = .059$. Collapsing over age group, we found that participants were more likely to search for traces in both the experimental and the like-best control conditions than in the no-history control condition from Study 1 (*M*s = 8.75, 7.31, 5.15), both *p*s < .05, and that the invisible and like-best control conditions did not significantly differ, $p = .32$. However, this effect was carried wholly by the children (*M*s = 6.56, 5.19, 1.18), as adults showed no significant differences across conditions (*M*s = 10.94, 9.44, 9.12, *p*s > .40).

Discussion

Study 3 again demonstrates that children, like adults, seek traces of object history. This evidence is stronger than that of Studies 1 and 2, in three respects. First, both children and adults searched for historical traces that were not just hidden but invisible -- that is, no marks were shown, nor were there any marks corresponding to the observed history for a participant to detect.

Second, in contrast to Studies 1 and 2, the experimenter never verbally highlighted or narrated the historical event that differentiated the two objects in each set. Third, both children and adults searched for historical traces on a task in which identifying the owned object was not strictly necessary. That is, both children and adults searched for cues to object history on the like-best control task, when they were not asked about object identity ("Can you find which one is yours?"), but rather when asked about object liking ("Can you find which one you like best?"). This result is consistent with a "mere ownership" effect, whereby merely owning an object leads one to like it more (Beggan, 1992). In order to test this idea directly, however, it would be necessary to compare an ownership condition with a non-ownership condition. If children were provided no ownership information but still searched for the marking when asked to find the one they like better, this would suggest that rather than stemming from the mere ownership effect, children might look for the marking whenever asked to distinguish between two otherwise identical-looking objects. However, this test is outside of the scope of the present report.

Although adults selected the owned objects much less often in Study 3 (62%) than in the Experimental condition of Study 1 when distinguishing features were concealed rather than invisible (100%), a surprising result was that they were non-random in their choices. We do not know how adults achieved above-chance performance, given that the historical features were non-visible. However, it may be that they occasionally detected minute variations in the items that were unrelated to object history (e.g., slight dents or imperfections), thus occasionally permitting them to successfully guess which item in each pair had been assigned as their own.

The finding that both preschool children and adults searched for history cues even on the "like-best" task also raises the question of whether participants will always use object history on any task in which it has been provided (or implied), or whether instead they show appropriate selectivity, refraining from using object history when other cues are sufficient. Study 4 is designed to test this question.

Study 4: Invisible traces in visibly distinct objects

Study 4 was identical to Study 3, with one exception: namely, the two objects on each trial were overtly and visibly distinct from one another (different colors or patterns). We predicted that when observable features distinguish the object choices, neither children nor adults would look for traces of their history. This finding, if obtained, would rule out a response bias interpretation of Study 3, and support claims that children behave in accordance with a

rationality principle, in which they pursue goals efficiently (Csibra, Gergely, Bíró, Koós, & Brockbank, 1999; Rose & Baillargeon, 2013).

Because the objects in each set were visibly distinct, it was important to rule out the possibility that the object assigned to the participant was more desirable (and thus was selected as the owned object on that basis). We therefore again included liking judgments as a control.

Method

Participants. Participants included 32 children (age range 4.00-5.37 years, *M* age 4.63; 14 girls, 18 boys) and 32 adults (18-23 years of age, *M* age 20; 25 women, 7 men). Four additional children were tested but dropped (one did not complete the task, one was ineligible for inclusion because of participation in a similar study previously, for one we did not have the child's birth-date, and for one there was equipment malfunction). Children were recruited from communities in and around a Midwestern university town; 78% were White. The adult participants consisted of undergraduates at a large university in the same town; 56% were White. Within each age group, participants were randomly assigned to either the experimental or the like-best control condition.

Items. The items were identical to the items used in Study 3, except that the two items in each pair could be readily distinguished by their outward appearance, either different colors and/or different patterns (e.g., one wooden star was yellow, the other was orange; one mini-notebook had a yellow flower on the cover, the other had a purple flower on the cover).

Procedure. The procedures used in the experimental and like-best control conditions of Study 4 were identical to those used in Study 3.

Coding

Choice scoring. Choice accuracy was determined as in Study 3.

Coding for checks. Checking behavior was coded as in Study 1.

Results

In addition to the key comparison between the experimental condition and the like-best control condition, we again included the Study 1 no-history control condition as a "low" baseline of how often children selected the owned object and engaged in checking behaviors when there was no differential history and no outwardly differentiating features between the two objects in each pair.

Choice. Choice scores were entered into a 2-way ANOVA with age group (child, adult)

and condition (experimental, like-best control, no-history control) as between-subjects factors (see Table 2). We obtained a main effect of condition, $F(2,92) = 49.68$, $p < .001$, $\eta_p^2 = .52$, indicating that the experimental condition yielded more accurate selections of the owned object than either the like-best or no-history control conditions (*M*s = 5.87, 3.28, 3.39), *p*s < .001. The two latter conditions did not differ from one another. *T*-tests against chance (3.0) indicated that participants selected the owned object significantly above chance in the experimental condition, $t(31) = 2.87$, $p < .001$, but not in the like-best control condition, $t(32) = 1.05$, $p = .30$. We also obtained a main effect for age group, $F(1,92) = 5.71$, $p = .019$, $\eta_p^2 = .06$, indicating more accurate selections by adults than children (*M*s = 4.45, 3.88).

Checks. Checking scores were entered into a 2-way ANOVA with age group (child, adult) and condition (experimental, like-best control, no-history control) as between-subjects factors (see Table 3). We obtained a main effect of condition, $F(2,91) = 29.86$, $p < .001$, $\eta_p^2 = .40$, a main effect of age group, $F(1,91) = 10.84$, $p = .001$, $\eta_p^2 = .11$, and a condition x age group interaction, $F(2,91) = 61.13$, $p < .001$, $\eta_p^2 = .57$. Adults searched for traces significantly more often in the no-history condition from Experiment 1 than either of the two conditions in which the objects were visibly distinct (*M*s = 9.12, 0.44, 1.06), *p*s < .001, and the latter two conditions did not differ significantly from one another, $p = 1.00$. In contrast, children searched for traces of history significantly more in the experimental condition than the no-history control condition, $p = .027$, with the like-best control condition in the middle and not significantly different from either of the other two conditions (*M*s = 3.12, 1.18, 2.12, *p*s > .50).

Discussion

Study 4 demonstrates that children, like adults, are selective in their use of historical cues tied to ownership. When these cues are redundant due to visible differences between items, both age groups were much less likely to search for hidden traces of an object's historical path. However, children were more likely to search for cues in this redundant condition than were adults, suggesting that children were not as skilled as adults in efficiently directing their actions only when needed.

Another benefit of this study is that it provides an additional control for Study 3. Study 4 was procedurally identical to Study 3, and thus presented identical task demands, including the extent to which attention was drawn to one of the objects and the intentionality of the experimenter's actions. Nonetheless, in Study 4 neither children nor adults engaged in searching

the objects for historical traces, thereby demonstrating further that task demands are insufficient to result in the searching behaviors we recorded in the previous studies.

Study 5: Three-year-olds' search for traces of object history

Given the success of four-year-olds on this task, it is of particular interest to examine the performance of younger children. As noted in the Introduction, prior work has found developmental changes between 3 and 5 years of age in children's appearance/reality contrasts (Deák et al., 2003; Flavell et al., 1983), use of subtle features indicating function (Kelemen et al., 2003), and use of conceptual vs. more obvious features on certain categorization and induction tasks (Badger & Shapiro, 2012; Fisher, 2011). Moreover, Nancekivell and Friedman (2014) found that 3-year-olds did not infer differential histories to explain why a character owns certain objects, in contrast to 4- and 5-year-olds. These prior results suggest that the tendency to attend to object history and connect it to present features may undergo important developmental changes in the preschool years, and that when presented with our task, 3-year-olds may be unable to link ownership to object history. On the other hand, if ownership is a developmental primitive (Jackendoff, 1992), and if the capacity to link visible features to historical processes is an immediate cognitive process (Leyton, 1992), then even 3-year-olds may link ownership to object history.

We included three key conditions from the earlier studies: the concealed trace condition (from Study 1), the invisible trace condition (from Study 3), and the no-history control condition (from Study 1).

Method

Participants. Participants were 55 three-year-olds, assigned to one of three conditions: concealed trace (n=22, *M* age 3.36, range 3.07 to 3.86; 11 girls, 11 boys), invisible trace (n=17, *M* age 3.50, range 3.08 to 3.97; 10 girls, 7 boys), and no-history control (n=16, *M* age 3.29, range 3.02 to 3.57; 10 girls, 6 boys). Five additional children were tested but dropped for repeatedly failing the warm-up or not completing the task. Children were recruited from communities in and around a Midwestern university town, and were primarily White.

Items. The items in the concealed trace and no-history control conditions were identical to those from Study 1; items in the invisible trace condition were identical to those from Study 3.

Procedure. The procedure was identical to those of the relevant conditions in Studies 1 and 3. Two children (ages 3.13, 3.19) had to repeat the warm-up.

Coding

Coding of choices and checking behavior were identical to those of Study 1.

Results

Choices. Participant scores were entered into a univariate ANOVA with condition (concealed trace, invisible trace, no-history control) as a between-subjects factor (see Table 4). Three-year-olds identified the owned object more accurately in the concealed trace condition (M = 4.13) than in the invisible trace and no-history control conditions (Ms = 3.18, 3.04), $F(2,52)$ = 4.04, p = .023, η_p^2 = .13. Performance was significantly above chance (of 3.0) in the concealed trace condition, $t(21)$ = 3.49, p = .002, but at chance in the invisible trace and no-history control conditions, ps > .59.

Insert Table 4 about here

Checks. Checks were entered into a univariate ANOVA with condition (concealed trace, invisible trace, no-history control) as between-subjects factors (see Table 4). Three-year-olds were more likely to search for traces in both the concealed and invisible trace conditions (Ms = 5.90, 4.82) than in the no-history control condition (M = 1.82), $F(2,52)$ = 8.47, p = .001, η_p^2 = .25. Post-hoc tests revealed no significant difference between the concealed and invisible trace conditions, p > .27.

Correlations. In order to determine the effects of age on performance across the full child age range (i.e., from 3-5 years), we combined the child data from Studies 1 and 3 with those of Study 5, and conducted a series of six bivariate Pearson correlations: three for the choices in each of the concealed trace, invisible trace, and no-history control conditions, and three for the checks in each of the same three conditions. The data appear in Table 5. As can be seen, age significantly predicted choices in the concealed trace condition, indicating that older children more readily made use of subtle historical cues to identify the object assigned to them. Not surprisingly, age did not predict choices in either the invisible trace or the no-history control conditions, given that the lack of distinguishing features meant that participants of all ages were forced to guess. In contrast, for participants' checking behavior, age significantly predicted performance in both the concealed trace and invisible trace conditions, demonstrating that older children were more apt to search for cues to object history than younger children, regardless of whether those cues were detectable. In contrast, age did not predict checking behavior in the no-history control condition.

Insert Table 5 about here

We also conducted a correlation between checking and choices, within each of these conditions. As shown in Table 5, in the concealed trace condition, those children who engaged in more checking behavior more successfully identified their owned objects, indicating that preschool children can coordinate searching behavior with identifying and interpreting historical traces. In contrast, no significant correlations were obtained in the invisible trace or no-history control conditions, where checking behavior could not result in successful object choices, given the lack of visible cues.

Discussion

Study 5 extends the prior studies to three-year-old children who were over a full year younger than the four- and five-year-olds in Studies 1-4. These data show remarkably similar patterns to the previous studies, with children seeking concealed and invisible traces of objects in the context of an ownership task. Importantly, when cues were hidden but visible, children successfully used this information to identify which of two identical items in each pair was their own. A baseline control condition verified that this behavior did not emerge when the objects did not differ in history.

Although participants throughout the age range of 3 to 5 years linked history to objects and used hidden traces to identify their property, children's tendencies to do so increased over time. These developmental patterns suggest that children are consolidating these skills during the preschool period.

GENERAL DISCUSSION

Altogether, this set of five studies demonstrates that children as young as three years of age actively search for traces of object history when making ownership judgments. These traces were perceptually subtle (either hidden or altogether invisible), functionally insignificant, and not directly queried (e.g., the experimenter did not ask, "Which did I mark?"). Nonetheless, children actively attended to the differential histories of the items and spontaneously determined that they were relevant to ownership. Although prior research demonstrated that children make use of spatiotemporal cues to history in their ownership decisions (e.g., current possession, spatiotemporal continuity), the present studies are the first to find that preschool children (a) expect history to leave a visible trace on objects, and (b) seek such traces to determine ownership. These data thus provide the first empirical demonstration of a key feature of children's early

object concepts, one that is often overlooked in theoretical debates in the literature, and that opens up a variety of important questions for the future. Whereas spatiotemporal history is often conceptualized and operationalized as being in competition with featural cues, as if the two are in opposition, these studies demonstrate that linking features cues to an object's history is an important aspect of human cognition.

Because the task in these studies entails searching for material differences between objects, it rests on a causal analysis of what sorts of properties can be transmitted as a result of the historical event (Leyton, 1992; White, 2009). Whereas some historical events are likely to leave traces (e.g., a plastic spoon falling onto muddy ground), others are less likely to do so (e.g., a plastic spoon falling onto a clean carpet). Although one can minimize the cues that result from object history and make them more subtle and non-obvious, ultimately one cannot remove the possibility of them altogether while still maintaining the logic of this task, as participants should not search for cues to object history if they believe them to be invisible. Therefore, when children succeeded on the task, we cannot determine whether they were actively thinking about object history, as they may instead have been consulting their updated representations of the objects. However, we do know that this updating process required incorporating historical events into their object representations. In this sense, there is an important distinction between item sets for which consideration of the historical information is superfluous (e.g., when indications of history are continuously visible and obvious, as in the differently-colored Lego blocks in the warm-up task) versus item sets for which updating a mental representation *requires* integrating a historical event. The latter is the focus of the research reported in this manuscript.

Controls were included that allow us to rule out various alternative interpretations of these results. First, children rarely checked the objects when historical evidence was not implied, demonstrating that their inspection of objects was not the result of task demands (Study 1 control). Second, children successfully used the *absence* of object history to identify owned objects that lacked historical traces, demonstrating that they did not simply allocate more attention to objects handled by the researcher (Study 2). Third, children were significantly less likely to check objects in the presence of redundant, visual cues that differentiated the items in a pair, indicating that they did not indiscriminately search for historical evidence (Study 4). This result also demonstrates that the results of Studies 1 and 3 are not solely due to procedural factors, such as the experimenter's drawing attention to one object, or the intentionality of her

actions.

These controls demonstrate some of the important boundary conditions under which children do and do not consult cues to object history, but more questions remain. For example, the intentionality of the researcher's actions may have encouraged a causal analysis of the events (see Butler & Markman, 2014), and it would be interesting in future research to determine if children would still attend to historical features when the researcher's actions are instead accidental. We also do not wish to claim that history is unique in directing children's attention to non-obvious cues. Preschool children seek non-obvious, albeit non-historical cues in their exploratory play (Schulz, Standing, & Bonawitz, 2008) and when reasoning about causes (see also Butler & Markman, 2014; Sobel et al., 2007; Walker et al., 2014) and object functions (Kelemen et al., 2003).

Although in many respects children's responses were comparable to those of adults, there were some differences as well. First, whereas children searched the objects only when a differential history was implied, adults did so even in the absence of such a distinction (Study 1 control). Adults may hold a broad expectation that objects inevitably carry traces of their history, such that they look for such cues even when the experimental procedure provides no evidence that the two objects in each set had different histories. In contrast, young children may require evidence of an overt historical cue with known causal effects, in order to make these links. Second, in Study 3, when the historical traces were invisible, adults more persistently searched for these cues than did children, suggesting that children may find it more difficult to persist in their search when they do not have a concrete memory of what the historical trace looks like. Third, in Study 4, when redundant visible cues were present, children were much more likely than adults to continue to check the objects for traces of their history. This finding suggests that children may not be as efficient as adults in using available cues to guide and limit their search. Fourth, the correlations with age in Study 5 indicated developmental changes over the period of 3 to 5 years of age, with increased searching for historical traces as well as increased success in identifying the owned object.

An important question that remains unresolved from this series of studies is the conceptual role of ownership per se, and the extent to which it encourages participants to attend to historical cues. In all the conditions, the two objects contrasted in the ownership information provided (one object was said to belong to the participant; for the other, no ownership was

mentioned). Prior research indicates that ownership may especially draw attention to object history (e.g., children are more likely to track which of several similar or identical objects is which, after hearing ownership information than after hearing a common-noun label; Gelman et al., 2014). Would children focus on object history whenever they are asked to make a choice among objects (e.g., when provided with a category label rather than ownership information), or does ownership especially draw children's attention to this dimension? We speculate that children may be particularly attentive to history when it involves objects that they themselves own (Cunningham, Vergunst, Macrae, & Turk, 2013), when it involves agents for whom they have a strong emotional response (either positive or negative; e.g., Gelman et al., 2015), or when it involves causal processes that are believed to have powerful effects, such as contaminants (e.g., Legare et al., 2009). These open questions would be interesting to examine in future studies.

Ownership information in the current studies was presented explicitly ("This is yours; this is for [child's name]"; "Which one is yours?"), and prior work on ownership using similar procedures found effects indicating a special relation between owner and object (Cunningham et al., 2013; Coventry, Griffiths, & Hamilton, 2014; Gelman et al., 2012; Gelman et al., 2014). Nonetheless, because ownership information was only verbally stated, participants may have viewed this relation as temporary, and future research could examine whether children would respond differently if ownership information were either enhanced (e.g., by letting the child take the object home for a period of time, before testing) or diminished (e.g., if ownership were assigned to an unknown third party rather than to the participant himself or herself).

Conclusions and implications

The present findings have implications for the perennial question in developmental psychology concerning when and to what extent children's concepts are based on salient surface appearances versus theory-based considerations. It is well-known that children are easily seduced by outward perceptual features on many categorization, word-learning, and inference tasks, and that their tendency to do so decreases over time (Piaget, 1970; Rakison & Oakes, 2003; Sloutsky, Kloos, & Fisher, 2007). Nonetheless, the present studies demonstrate an important way in which children's object concepts include theory-like considerations: Children privilege features based on a causal analysis of how history results in perceptible traces. These findings are notable given that the traces were subtle (either non-obvious or invisible), that children maintained this ability throughout the age range of 3-5 years, and that history trumped other possible outcomes (e.g.,

children could instead have privileged features such as shape, function, or spatiotemporal continuity). The findings are consistent with an extensive and growing body of evidence (reviewed earlier) that children consider non-obvious features of objects when reasoning about their function, causal consequences, and identity.

It would be misleading, however, to place too stark a contrast between appearance and object history. Although in certain contexts and on certain tasks these factors can be pitted against one another, there are important and lawful relations between the two. The key conclusion from this series of studies is not that children consider history *instead of* perceptible features (although in some contexts they can do so), but rather that children consider causal links between history and perceptible features. This work supports the broader conclusion that the process of linking perceptual and conceptual features occurs early in childhood for a range of conceptual tasks (not only in thinking about ownership, but also in thinking about functions and causes).

An important empirical direction for the future is to chart the development of children's capacity to build these links between historical processes and perceptual transformations. For example, when does attention to historical traces emerge in development? Furthermore, when and how do children make the reverse inference (inferring historical events from perceptible features)? Certainly adults can infer historical processes from featural differences (e.g., a dented car invites inferences regarding the history that yielded those features--a process that Leyton, 1992, calls a "history-recovery" process). Preschool children are able to form at least rudimentary inferences of this sort as well (Gelman et al., 1980; Rosengren et al., 1991). However, little is known regarding the scope of such inferences in childhood, and whether (and if so, when) they emerge unprompted.

More generally, the process of attempting to *link* perceptual and conceptual may be an important engine of cognitive development (Wellman & Gelman, 1998). An appeal to underlying, internal, or historical causal properties engages children in the important interplay between data and theory that leads to conceptual change. This approach aligns with that of Waxman and Gelman (2009, p. 263), who propose that at all ages children rely on both perceptual and conceptual information, that is, both statistical regularities in the environment and theory: "As infants and young children build a repertoire of concepts and acquire words to describe them, they take advantage of both perceptual and conceptual information, and rely upon both the

rudimentary theories that they hold and the statistics that they witness."

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Table 1. Test materials in Studies 1-5.

Test objects	**Concealed trace (Studies 1, 2, & 5)**	**Invisible trace (Studies 3, 4, & 5)**	**Location of trace**
Mini notebooks	Pencil mark	Pencil mark	Inside

Play-Doh containers	Thumb print	Pencil mark	Inside
Boxes w/ figurines	Changed position	Pencil mark	Inside
Wooden disks	Spot of paint	Pencil mark	Under
Wooden stars	Sticky note	Pencil mark	Under
Cardboard boxes	Paper stuck to bottom	Pencil mark	Under

Table 2. Studies 1-4, mean number of choices of owned object, as a function of study, condition, and age group (SDs in parentheses). Scores can range from 0-6.

	4-YEAR-OLDS	ADULTS
STUDY 1 (Concealed traces)		
Experimental	5.09 (1.77)	6.00 (0.00)
No-history control	2.94 (1.39)	3.74 (1.43)
STUDY 2 (Absence of traces)		
Experimental	4.95 (1.66)	--
STUDY 3 (Invisible traces)		
Experimental	3.19 (1.22)	3.82 (1.18)
Like-best control	3.31 (0.87)	3.56 (1.09)
STUDY 4 (Visibly distinct objects; invisible traces)		
Experimental	5.75 (0.45)	6.00 (0.00)
Like-best control	2.94 (1.43)	3.62 (1.50)

Table 3. Studies 1-4, mean number of checks, as a function of study, condition, and age group (SDs in parentheses).

	4-YEAR-OLDS	ADULTS
STUDY 1 (Concealed traces)		
Experimental	8.39 (1.92)	9.13 (1.75)
No-history control	1.18 (1.42)	9.13 (3.56)
STUDY 2 (Absence of traces)		

Experimental	8.63 (2.25)	--
STUDY 3 (Invisible traces)		
Experimental	6.56 (2.34)	10.94 (5.18)
Like-best control	5.19 (3.37)	9.44 (4.15)
STUDY 4 (Visibly distinct objects; invisible traces)		
Experimental	3.12 (1.59)	0.44 (0.89)
Like-best control	2.12 (1.96)	1.06 (2.14)

Table 4. Study 5, three-year-olds' mean number of choices and checks, as a function of condition (*SD*s in parentheses).

	CHOICES	CHECKS
Concealed traces	4.13 (1.52)	5.90 (3.13)
Invisible traces	3.18 (1.33)	4.82 (3.94)
No-history control	3.04 (0.91)	1.82 (1.46)

Table 5. Correlational analyses involving children across Studies 1, 3, and 5. Note: * $p < .05$, ** $p < .01$, *** $p < .001$

	Concealed Traces (N = 39)	Invisible Traces (N = 33)	No-History Control (N = 33)
Choices with Age	.32*	.07	.07
Checks with Age	.46**	.35*	-.19
Choices with Checks	.61***	.03	-.07