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Tracking the Actions and Possessions of Agents

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Abstract

We propose that there is a powerful human disposition to track the actions and possessions of agents. In two experiments, 3-year-olds and adults viewed sets of objects, learned a new fact about one of the objects in each set (either that it belonged to the participant, or that it possessed a particular label), and were queried about either the taught fact or an unrelated dimension (preference) immediately after a spatiotemporal transformation, and after a delay. Adults uniformly tracked object identity under all conditions, whereas children tracked identity more when taught ownership versus labeling information, and only regarding the taught fact (not the unrelated dimension). These findings suggest that the special attention that children and adults pay to agents readily extends to include inanimate objects. That young children track an object's history, despite their reliance on surface features on many cognitive tasks, suggests that unobservable historical features are foundational in human cognition.

Keywords: Object tracking; Ownership; Labeling; Children; Artifacts; Concepts; Essentialism

1. Introduction

Imagine an electronic homing chip that can be invisibly implanted. How would you feel about tracking your child? Your cat? Your cell phone? How would you feel if you found out that your neighbor was surreptitiously[1] tracking your child, cat, or cell phone? Intuition suggests that it is permissible for you to track these objects, but it is not permissible for your neighbor to do so. Even for an inanimate object that does not travel with its owner (such as a coffee mug), there is something disturbing about covertly tracking an object that belongs to another person.

These examples illustrate two points. First, moral considerations that arise when tracking individual people also extend to tracking individual artifacts—despite the ontological

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chasm between people and artifacts (regarding mental states, self-determination, personal rights. . .). So, the psychological experience of tracking individual artifacts seems to share at least some important commonalities with the psychological experience of tracking individual people. Second, object ownership appears to be one crucial factor in these judgments: You are responsible for your own possessions and have the right to track your cat or phone, but you are prohibited from tracking items that belong to someone else. So, how we think about tracking an object does not necessarily relate to the material value of that object, but rather in its history and connection to a social world.

Although these scenarios concern moral judgments of fictional scenarios, we propose that analogous considerations are deeply ingrained in everyday, morally neutral object representations. People commonly track individual objects by attending to subtle distinguishing features, and by monitoring spatiotemporal transformations. For example, a party guest might track which of several wine glasses is her own by noting a lipstick smear, or where she last put it down. Adults recruit attentional and perceptual resources to update information regarding the location and identity of artifacts. We posit that these behaviors constitute a powerful, early-emerging, and spontaneous human disposition to track not just agents and their actions (Lyons, Young, & Keil, 2007) but also their possessions.

The organization of this paper is as follows. First, we provide a brief summary of how tracking individual objects reflects an attention to object history, and the foundational role of object history in notions of contamination, contagion, and essentialism. We then review recent research with young children indicating an early capacity to engage in object tracking. Next, we report two experiments that assess children's and adults' tracking of objects that have special links to human agents. Finally, we discuss the implications of these behaviors and speculate as to their origins.

2. Object history and its links to contamination, contagion, and essentialism

Object tracking[2] is an example of how object *history* is a central component of an object's representation. Representing an individual object entails more than perceptual or functional features, to include origins, owner(s), and where it has been (Gutheil, Gelman, Klein, Michos, & Kelaita, 2008). We see this most powerfully with authentic works of art (Bullot & Reber, 2013; Bloom, 1996). The value of a painting rests in large part on its provenance: If two seemingly indistinguishable paintings differ in that one is an original Rembrandt and the other is a reproduction, the original painting has vastly greater value. However, artwork is but a special case of a more general phenomenon.

Contagion and contamination illustrate how object history can literally modify an object, albeit invisibly. Strikingly, even young children understand both contagion and contamination concepts. Preschoolers readily conceptualize invisible particles (Au, Sidle, & Rollins, 1993; Rosen & Rozin, 1993), judge contaminated foods as inedible (Legare, Wellman, & Gelman, 2009; Siegal & Share, 1990), think about germs (Kalish, 1996), and expect illnesses to reflect germ transmission even when it competes with superficial

cues (e.g., a seemingly clean piece of bread with germs on it will lead to illness, whereas a dirty piece without germs will not).

Rozin and Nemeroff (1990) show how these literal judgments extend to reasoning about objects that make contact with positive or negative human individuals. Thus, in Rozin's classic example, individuals are averse to wearing a sweater once worn by Hitler in the same way that children avoid contaminated food. There is even a belief (perhaps implicit) that extended contact with a prior owner can have causal effects: Evil seeps into Hitler's sweater and so may make the wearer morally suspect (Rozin & Nemeroff, 1990); a putter once owned by a golf pro may enhance the next user's performance (Lee, Linkenauger, Bakdash, Joy-Gaba, & Profitt, 2011).

A further related notion is psychological essentialism, according to which items have an underlying reality that is responsible for outward behavior. For example, tigers are believed to have an inner essence that causes them to have stripes and the capacity to roar (Gelman, 2003). With essentialism, too, prior history is part of how we represent an item. For example, preschoolers report that animals will develop properties associated with their birth parents, even if raised exclusively by members of another species (Taylor, Rhodes, & Gelman, 2009).

Gelman, Meyer, and Noles (2013) summarize the breadth of attention to object history by noting that "Much of higher-level thought incorporates historical information. . . [including] perception, categorization, economic decision-making, emotional responses, and interpersonal judgments. . .. Interestingly, children share all of the intuitions sketched out above, treating ownership, authenticity, disgust, social relationships, object identity, and object function as rooted in history, not only immediately accessible perceptual cues."

3. Children's early capacity to engage in object tracking

Because tracking objects is crucial for many cognitive tasks, including naming, ownership, and estimating object value, it is unsurprising that adults exhibit extensive tracking behaviors. More impressively, human infants exhibit sophisticated capacities to track the spatiotemporal properties of objects, enabling them to re-identify an object as the same over time by means of its path of motion (Carey, 2009; Spelke, 1995). Likewise, children privilege object history over appearances when tracking an individual (Hall, 1996; Sorrentino, 2001; Xu & Carey, 1996). Object tracking thus appears to be a fundamental and universal bias of broad adaptive significance in navigating a complex and changing environment (Gelman, 2003).

Given this fundamental capacity, an important question is: What are the circumstances that encourage or motivate children to track objects? In other words, even if humans possess a broad, domain-general capacity to track objects, not every object is tracked at every moment, and certain conditions may be particularly likely to capture our attention. Some conditions that foster tracking are likely to pertain to the object itself; for example, attractive or intrinsically valuable objects are likely to evoke tracking. However, we hypothesize that other conditions that promote tracking do not involve inherent properties

of the object, but rather involve how the object participates in intentional patterns of action. Specifically, even a mundane object can become worthy of our attention and the focus of tracking efforts, when it is tagged with ownership information.

Ownership is a special relation as it is inherently social. Even young children understand that only agents can own things, and that inanimate objects cannot be owners (Noles, Keil, Bloom, & Gelman, 2012). The cues to ownership are themselves inherently social, involving possession (Friedman & Neary, 2008), investment of labor (Kanngiesser, Gjersoe, & Hood, 2010), and economic or social exchanges (Blake & Harris, 2009). Although ownership judgments may be guided by information regarding an object's appearance and functional affordances, ultimately object history trumps other cues. Thus, the ownership relation is not inherent in an object, but rather in the network of relations between an object and the agents that interact with it. For these reasons, ownership should particularly prompt object tracking.

Gelman, Manczak, and Noles (2012) conducted a series of experiments in which children ages 2–4 years were shown sets of objects, learned novel ownership information about a subset of these objects, and were tested to see if they had spontaneously tracked the owned objects. By 3 years of age, children tracked individual objects that were designated (by the experimenter) as their own, even when such objects had little value (e.g., a piece of styrofoam) or distinctiveness (e.g., one of three indistinguishable objects). Moreover, children and adults even showed a preference for the owned objects, liking them more than objects that had not been tagged as their own.

What is not clear, however, is the scope of this effect. Young children's ease with tracking objects may be facilitated by the special nature of ownership, or it may instead reflect superficial features of the task (that the experimenter provided distinctive information about the objects). An interesting comparison case would be labeling with a count noun (e.g., "This is a sarn"). On the one hand, children are very attentive to nouns and "fast-map" a label to a meaning after hearing the word only one or a few times, and retain that word-meaning mapping over impressive periods of time (Carey & Bartlett, 1978; Markson & Bloom, 1997). Furthermore, children's memory for labels is equivalent to their memory for non-labeling verbal information, including ownership information (that the object was given to the experimenter by her uncle) and historical information (that the object came from a place called Koba). Thus, one motivation for comparing an ownership context to a labeling context is that count nouns are salient in early childhood and at least as powerful as ownership facts in children's attention and memory.

On the other hand, one of the key features of count nouns is that they extend across instances of a kind (e.g., "dog" refers to any member of the category; Waxman & Booth, 2000). Even when a speaker selects a single object as the recipient of a label (e.g., "a koba"), it is less important that the listener track this particular object over time, as the label refers to a kind, not an individual. Markson and Bloom (1997) tested children's ability to map labels versus ownership facts to an object *kind* (not an individual) and, thus, could not examine how labels and ownership information compare with respect to tracking individual objects. Waxman and Booth (2000) and Behrend, Scofield, and Kleinknecht (2001) did examine extension of verbal information to individual instances,

for both labeling and facts. However, because both Waxman and Booth and Behrend et al. gave children the opportunity to select multiple objects as referents of the label or ownership fact, their tasks focused on extension per se, and do not test whether children were tracking the named object.

To summarize, an important unanswered question is whether young children's propensity to track objects varies under conditions of ownership versus labeling, both immediately and after a delay.

4. Experiment 1: Object tracking under conditions of ownership versus labeling

The current experiments examine whether ownership especially encourages object tracking. In Experiment 1, 3-year-olds and adults viewed sets of objects, one at a time, learned a new fact concerning one of the objects in the set (either that it belonged to the participant, or that it possessed a particular label) and were queried about the taught fact after a series of spatiotemporal transformations, as well as after a delay (to assess memory). We predicted that participants would attend more to the link between object and person when the link involves ownership than when the link involves labeling.

The test questions explicitly asked for only one object among a set of objects of the same kind, thereby focusing on object tracking, and neither kind tracking (vs. Markson & Bloom, 1997) nor extension of taught information to multiple instances (vs. Waxman & Booth, 2000 or Behrend et al., 2001). We targeted 3-year-olds, as they were the youngest that consistently tracked owned objects in prior work (Gelman et al., 2012). In each set, objects were either indistinguishable or varied only in color, in order to assess the capacity to track individual objects rather than kinds.

4.1. Methods

4.1.1. Participants

Participants included 48 children and 56 adults. Twenty-four children were randomly assigned to the label condition (14 girls, 10 boys; *M* age = 3.78, *SD* = .42) and 24 to the ownership condition (12 girls, 12 boys; *M* age = 3.63, *SD* = .39). Seven additional children were dropped (4 due to experimenter error; 2 did not complete the task; 1 of wrong age). Twenty-eight adults were randomly assigned to the label condition (23 women, 5 men; *M* age = 19.01, *SD* = .64) and 28 to the ownership condition (18 women, 10 men; *M* age = 19.24, *SD* = .92). Three additional adults were dropped due to experimenter error.

4.1.2. Materials

There were 12 stimulus sets, each containing three novel items. Six of the sets included items that were indistinguishable, and 6 of the sets included items that differed only in color (Fig. 1). Twelve novel words were used in the label condition: eget, frimp, iree, koba, krat, manu, osip, pru, sarn, tanzer, tulver, and zav.

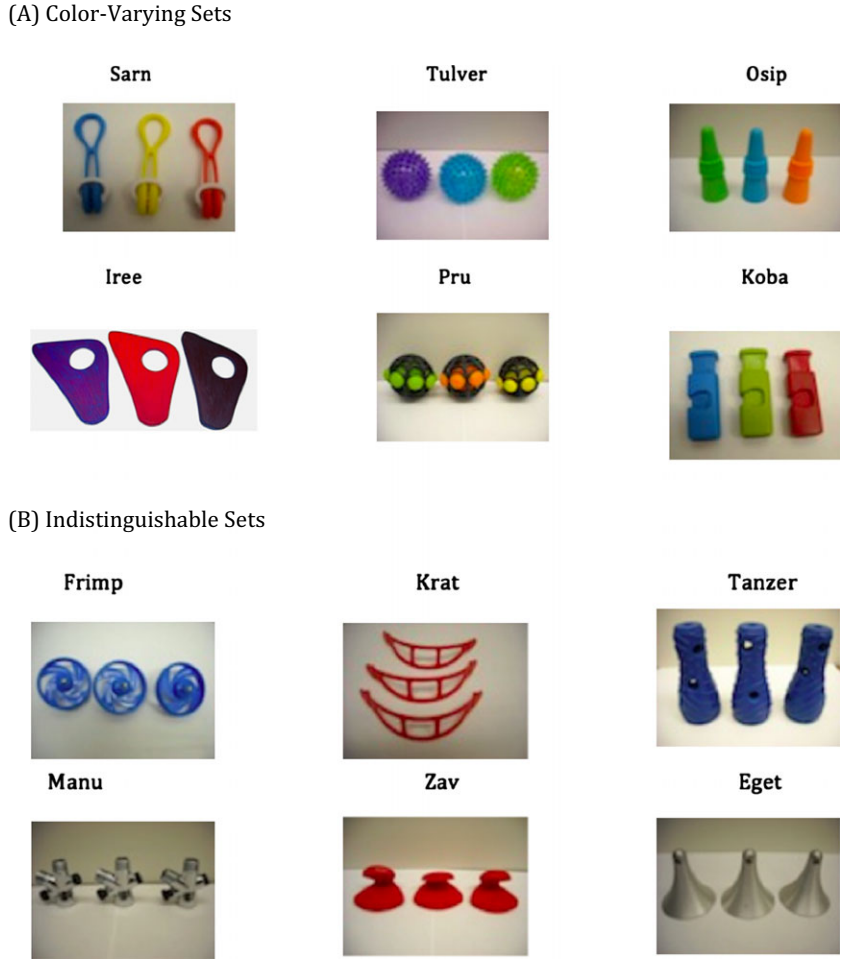

Fig. 1. Item sets in Experiments 1 and 2, with novel labels, including (A) color-varying sets and (B) indistinguishable sets.

4.1.3. Design

Condition (ownership vs. label information) and age group (children vs. adults) were between-subjects factors; similarity within a set (indistinguishable vs. color-varying) was a within-subjects factor. The items were presented in blocks (indistinguishable vs. color-varying), with the order of the blocks counterbalanced. For each set, the target item in each set (e.g., the red, yellow, or blue "sarn"), the order in which the target was presented (first, second, or third), and the final position of each target item at test (left, right, or middle) was counterbalanced. For each set, the order in which the objects were initially presented determined the final position in which objects were presented at test (Fig. 2). For each participant, the order in which the target was presented was counterbalanced across trials.

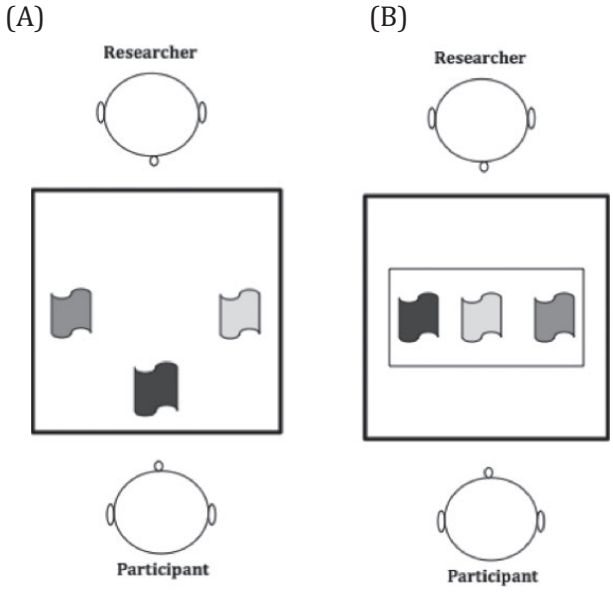

Fig. 2. Experiments 1 and 2, placement of objects in one-sample item set, from a bird's-eye-view: (A) during initial training, and (B) after spatiotemporal transformation.

4.1.4. Procedure

The experimenter and participant were seated across a table from one another. For each of 12 trials, the researcher first presented three objects, one at a time. In the Ownership condition, the experimenter provided ownership information (for one object) or simply drew the participant's attention to the object (for the other two objects). For example, one object was placed in front of the participant and the experimenter said, "This is yours," then the other two objects were placed on either side of the experimenter (one on the right, one on the left), and the experimenter said for each, "Look at this." Then, the items were placed on a small tray, in scrambled position, as the participant watched. Immediately following, the participant was asked, "Now show me by pointing: Which one is yours?" No feedback was provided, and the toys in one set were removed before continuing to the next set.

Following all 12 trials, participants received a delayed recall task in which they were presented with the color-varying object sets, one at a time, and asked to indicate which object was theirs, using the same wording as earlier. The indistinguishable object sets were not included, as it would be impossible to identify the target object given the disruption in spatiotemporal cues. At the end of the session, children were asked to select one of three small containers of Play-Doh, as a gift.

The Label condition was identical to that of the Ownership condition except for the verbal prompts provided during training and testing. Specifically, for each set, as the objects were placed on the table, one object was highlighted with a label (e.g., "This is a sarn"), and the experimenter simply drew the participant's attention to the other two

objects ("Look at this"). In the Label condition, the test question both in immediate test and delayed recall asked about the label: "Now show me by pointing: which one is a sarn?"

4.2. Results

Each participant received three scores, indicating the number of trials (out of 6) on which they selected the target item exclusively, for the indistinguishable trials (immediate test), the color-varying trials (immediate test), and the color-varying trials (delayed test).

We first analyzed responses to the immediate test questions ("Which is yours?", "Which is a sarn?"), with a 2 (age group: preschoolers, adults) × 2 (condition: ownership, labeling) × 2 (set type: indistinguishable, color-varying) repeated-measures ANOVA. As predicted, selection of the target object was higher in the ownership condition than the labeling condition (Ms = 5.23 and 4.28, respectively), $F(1,96) = 14.50$, $p < .001$, $\eta_p^2 = .13$. However, this effect was carried exclusively by the children, as indicated by a significant age group x condition interaction, $F(1,96) = 8.70$, $p < .01$, $\eta_p^2 = .08$. The ownership advantage was significant for the children ($M_{ownership} = 4.50$, $M_{label} = 2.81$, $p < .001$) but not for the adults ($M_{ownership} = 5.96$, $M_{label} = 5.75$, $p = .53$). Not surprisingly, we also found that adults performed better than children overall, $F(1,96) = 77.70$, $p < .001$, $\eta_p^2 = .44$. Finally, there was a main effect for set type, $F(1,100) = 4.30$, $p < .05$, $\eta_p^2 = .04$, and a set type x age group interaction, $F(1,100) = 4.30$, $p < .05$, $\eta_p^2 = .04$, indicating that children performed better on the color-varying sets than the indistinguishable sets (Ms = 3.90 and 3.42, respectively, $p < .01$), but adults' performance did not differ by set type (Ms = 5.86 for both, $p = 1.0$).

A series of one-sample t-tests comparing performance to chance (2 of 6) indicated that both children and adults selected the target object significantly above chance in every cell of the design (both indistinguishable and color-varying objects sets in both the label and ownership conditions), ps < .05.[3]

Participants occasionally selected more than one object on a trial (2% of adults' responses; 7% of children's responses). We, therefore, reanalyzed the data focusing exclusively on those trials in which participants chose a single object (dividing the number of target choices by the number of single-item-choice trials, and multiplying by 6 in order to weight all participants equally), and again obtained a significant main effect for condition and significant condition x age group interaction.

We next analyzed responses in the delay task. We conducted a 2 (age group: preschoolers, adults) × 2 (condition: ownership, label) univariate ANOVA. As predicted, selection of the target object was higher in the ownership condition than the label condition (Ms = 4.14 and 3.28, respectively), $F(1,100) = 8.01$, $p < .01$, $\eta_p^2 = .07$, but did not interact with age group. Not surprisingly, we also found that adults performed better than children overall, $F(1,100) = 37.94$, $p < .001$, $\eta_p^2 = .27$. These significant effects were upheld when we reanalyzed the data focusing exclusively on those trials in which participants chose a single object.

When comparing performance to chance (2 of 6) via a series of one-sample *t*-tests, adults were above chance on the delay task in both conditions, *p*s < .001, whereas children were above chance on the delay task in the ownership condition only, $p < .01$.

4.3. Discussion

Participants were presented with a deceptively simple task that required tracking individual objects over space and time, given indistinguishable or highly similar distracters. It would be easy to lose track of the target object, particularly at 3 years of age. However, as in Gelman et al. (2012), both young children and adults effectively tracked individual objects. When an object was tagged with ownership information, 3-year-olds as well as adults readily tracked individual objects, both immediately and after a delay. Furthermore, adults showed identical performance when the information provided was a label. In contrast, for 3-year-olds, object tracking was superior when given ownership information versus a label. This holds both for color-varying sets (which can be tracked using features and/or object history) and for indistinguishable sets (which require object history information). The ownership advantage was also maintained for both immediate and delayed recall.

Minimally, these data show that hearing distinctive information is insufficient to evoke object tracking. In both the ownership and label conditions, the researcher provided distinctive information about the target (with structurally identical wording). This still leaves open the question of why performance was superior in the ownership condition. The interpretation we favor is that ownership information is special and encourages object tracking. Alternatively, it is possible that participants in the label condition tracked the target items just as well as those in the ownership condition, but assumed that they did not need to indicate the original object during testing, because all objects of the same kind can receive the same label. This is unlikely, because the condition effects were maintained even when we conducted post-hoc analyses focused exclusively on trials in which participants selected just a single object. However, in future research, this alternative interpretation could be examined more directly, by providing the same information (ownership or label) during initial training, but then at test asking participants which object the experimenter had pointed to. If participants once again show greater performance on the ownership condition than the label condition, then this would argue that ownership especially fosters object tracking.

Although the ownership condition apparently elicited more tracking than the label condition, the source of this effect remains unclear. Did ownership encourage object tracking, or did label information suppress object tracking (by signaling that individual differences could be ignored), or both? Whatever the cause, children are selectively engaging in tracking behaviors, and dedicating more cognitive resources to object and action tracking, when objects are linked to an agent via ownership than when they are linked to a verbally supplied label. These findings suggest that attending to object history is not an automatically triggered process but requires tagging an object or link as special in some way.

However, once this link is established, the special attention that children and adults pay to agents is readily extended to include inanimate objects.

5. Experiment 2: Evaluative judgments under conditions of ownership versus labeling

The purpose of Experiment 2 is to examine whether participants engage in tracking even when the task does not explicitly request that they do so. As in Experiment 1, in each item set, a target object was "tagged" with either ownership ("This is yours") or labeling information ("This is a sarn"). Once again, there was a delay task with the color-varying sets, in which participants were asked to indicate the object in each set that matches the instruction given initially. The only difference in the procedure of Experiment 2 was that the immediate test questions made no mention of the taught information. Instead, participants were simply asked which object they liked best, which only required an evaluation and not object tracking.

The immediate testing task provided a test of the "reach" of object history in people's object representations. Prior research demonstrates that ownership information leads to a mere-ownership effect, whereby individuals prefer the object they were given (Beggan, 1992), as well as an endowment effect, whereby they are reluctant to swap an owned object with another object of a different type (Kahneman, Knetsch, & Thaler, 1990). Although most of this research has focused on adults (but see Harbaugh, Krause, & Vesterlund, 2001), there is evidence that preschool children also indicate a preference for objects tagged as belonging to them (Gelman et al., 2012). Thus, in the current experiment, we test whether tagging an object with ownership information preferentially leads to greater liking.

The delayed testing task addresses a slightly different question. It provides a stronger test of the persistence of object history in participants' object representations. Because the immediate test questions made no reference to object history, they serve effectively as a distracter task prior to delayed recall. Thus, the question here is whether participants (especially young children) can retain the information regarding object history despite having their attention drawn to non-historical information. Any evidence for continued object tracking on this delayed task indicates the spontaneous nature of object tracking, even in the absence of direct instructions to do so.

5.1. Methods

5.1.1. Participants

Participants included 48 children and 48 adults. Twenty-four children were randomly assigned to the label condition (13 girls, 11 boys; *M* age = 3.77, *SD* = .41) and 24 to the ownership condition (14 girls, 10 boys; *M* age = 3.49, *SD* = .28). No children were dropped. Twenty-four adults were randomly assigned to the label condition (15 women, 9 men; *M* age = 19.16, *SD* = .85) and 24 to the ownership condition (15 women, 9 men; *M* age = 19.60, *SD* = 1.40). One additional adult was dropped due to experimenter error.

5.1.2. Materials

Materials were identical to those of Experiment 1.

5.1.3. Procedure

The procedure was identical to that of Experiment 1, except that during immediate testing, participants were asked, "Can you show me by pointing: Which one do you like best?" In the delayed testing task, the questions were identical to those of Experiment 1 (Ownership condition: "Which is yours?"; Label condition: "Which is a [novel word, e.g., sarn]?").

5.2. Results

As in Experiment 1, each participant received three scores, indicating the number of trials (out of 6) on which he or she selected the target item exclusively, for the indistinguishable trials (immediate test), the color-varying trials (immediate test), and the color-varying trials (delayed test). We first analyzed responses to the immediate test questions ("Which one do you like best?"), with a 2 (age group: preschoolers, adults) × 2 (condition: ownership, label) × 2 (set type: indistinguishable, color-varying) repeated-measures ANOVA. In contrast to Experiment 1, there were no significant effects involving condition. There was a significant effect of age group, with adults selecting the target object more often than children (*M*s = 5.86 and 3.66, respectively), $F(1,92) = 39.15$, $p < .001$, $\eta_p^2 = .30$. There was also a main effect of item type, $F(1,92) = 33.13$, $p < .001$, $\eta_p^2 = .26$, with more selection of the target object for indistinguishable sets ($M = 3.11$) than color-varying sets ($M = 2.08$). However, the effect of item type interacted with age group, $F(1,92) = 9.84$, $p < .01$, $\eta_p^2 = .10$, indicating that the effect of item type was larger for adults (*M*s = 4.21 and 2.60, respectively, $p < .001$) than for children (*M*s = 2.02 and 1.55, respectively, $p = .067$).

Adults selected the target object in the similar sets significantly above chance (2 of 6) in three of the four cells (the color-varying objects sets in both the label and ownership conditions, and the indistinguishable object sets in the label condition, *p*s < .05), and marginally above chance in the fourth cell (owning condition, color-varying sets, $p = .10$). In contrast, children selected the target object in the similar sets at chance levels in three of the four conditions (ownership and label, indistinguishable sets; ownership, color-varying sets), but selected the target object in the color-varying sets significantly *below* chance in the label condition, $p < .01$.

As in Experiment 1, participants occasionally selected more than one object on a trial (1% of adults' responses; 9% of children's responses). When we reanalyzed the data focusing exclusively on those trials in which participants chose a single object, as in Experiment 1, we again obtained the same patterns of significant and non-significant effects.

We next analyzed responses in the delay task. Recall that here, the test questions were identical to those of Experiment 1: "Which is yours?" (Ownership condition) and "Which is a [label; e.g., sarn]?" (Label condition). We conducted a 2 (age group: preschoolers,

adults) × 2 (condition: ownership, label) univariate ANOVA. As found in Experiment 1, selection of the target object was higher in the ownership condition than the label condition (*M*s = 3.52 and 2.80, respectively), $F(1,91) = 5.40$, $p < .05$, $\eta_p^2 = .06$. The age group x condition interaction was non-significant, $F(1,91) = 0.96$, $p = .33$, $\eta_p^2 = .01$. Not surprisingly, we also found that adults performed better than children overall, $F(1,91) = 8.99$, $p < .01$, $\eta_p^2 = .09$. These significant effects were upheld when we reanalyzed the data focusing exclusively on those trials in which participants chose a single object.

As in Experiment 1, adults were above chance on the delay task in both conditions, *p*s < .001, whereas children were above chance on the delay task in the ownership condition only, $p < .01$. Their performance in the label condition did not significantly differ from chance, $p > .8$.

5.3. Discussion

Experiment 2 tested two separate though related issues: whether object tracking extends to judgments of liking (mere-ownership effect), and whether object tracking persists after a distracter task and delay. When participants were asked which toy they like, adults in the ownership condition selected the target toy above chance, which is consistent with a mere-ownership effect. Surprisingly, however, adults were also above chance in the label condition. This result could be interpreted as showing that preference for the owned object does not constitute a mere-ownership effect at all, but perhaps a response bias. On the other hand, the label condition may have been interpreted by adults as an implicit ownership task, given that the object was first placed in front of the participant, thus indicating a possible ownership relation (Friedman & Neary, 2008).

In contrast, children's preferences for the target objects were not above chance, in either condition. Thus, in contrast to Gelman et al. (2012), we obtained no evidence that objects tagged as belonging to the child were preferred. However, two key methodological differences may have contributed to the different results. First, each trial included a single owner (participant) rather than two contrasting owners (participant vs. experimenter), thus potentially diminishing the dimension of contrast. Second, in this study, when the objects were distinguishable, they varied in only color, whereas in Gelman et al., they varied in kind as well as appearance.

Although we obtained no significant effect of condition on immediate recall, we did find consistently higher rates of target selection on the indistinguishable versus color-varying sets. This result is puzzling, given that object tracking should be more difficult in the indistinguishable sets. However, responses on the color-varying sets may have been influenced by participants' actual preferences (e.g., liking blue more than yellow), shifting their attention away from the labeled target. It was also surprising that children's preferences for the target objects were actually below chance in one cell of the design (labeling of color-varying objects). This may be explained if the experimenter's act of labeling implied that she had ownership rights over the target object (see Kim & Kalish, 2009).

Although we obtained no condition effects on the main task, at either age group, an important result was that children (though not adults) showed a consistent ownership

boost in the memory task at the end. Even though participants received 12 trials in a row in which they were not asked about either ownership or liking, children nonetheless showed better memory for which object was owned than which object was labeled, replicating the main results of Experiment 1 and demonstrating that they persist even in the face of a distracter task.

6. General discussion

The present experiments yielded two major results. First, 3-year-olds track individual objects over space and time, even under relatively taxing conditions: (a) when the objects were subtly different instances of the same kind (thus identifiable by only a single perceptual cue), (b) when the objects were indistinguishable (requiring attention to spatiotemporal cues), (c) after a delay, and (d) after receiving a distracter task that drew their attention away from the target objects and toward an independent dimension (desirability). That 3-year-olds attend to object history, despite their well-known reliance on surface perceptual features on many cognitive tasks, suggests that unobservable historical features are foundational in human cognition. Children need not have bothered to track individual objects. Given that in each object set, the items were functionally equivalent, and in 50% of object sets, the items were perceptually indistinguishable, it would have been unsurprising if children either were unmotivated to put in the effort to track individual objects, or did so only under the easiest of conditions (on immediate test).

The second major result was that, for children, ownership provoked object tracking more than a control condition of labeling. Note that this result differs from prior demonstrations that children generalize object labels more than ownership or other historical information (Waxman & Booth, 2000; Behrend et al., 2001). Children's responses did not indicate a greater willingness to generalize the response to non-target items in the label condition, but rather greater attention to and tracking of the target in the ownership condition. This result is consistent with the finding that infants link goals to particular agents but treat the referents of labeling as general across individuals (Buresh & Woodward, 2007). It may also be that the self-relevant nature of the ownership condition played a role in these effects (see Cunningham, Vergunst, Macrae, & Turk, in press; Ross, Anderson, & Campbell, 2011, for evidence that children show superior memory for objects assigned to the self, and Turk, van Bussel, Waiter, & Macrae, 2011, for evidence that self-owned items elicit a memory advantage and unique neural signature, compared to other-owned items).

Although purely speculative at this point, we suggest that object tracking is tightly linked to a propensity for tracking people and agents. We posit that objects are deemed worthy of tracking when they participate in socially relevant actions, a claim consistent with infants' early person (Csibra & Gergely, 2009; Woodward, 1998) and interpersonal interaction tracking (Hamlin, Wynn, & Bloom, 2007). Owned objects are special because of their links to human owners, and in some cases objects may even be said to "stand in" for their human owners. Obviously, however, more focused research would be required to support these ideas.

In contrast to the children, adults uniformly tracked object identity, regardless of the task (ownership vs. label; immediate vs. delay). Perhaps presenting adults with a more challenging tracking task would provoke tracking patterns comparable to those of children. However, it is also notable that both conditions in these experiments (label as well as ownership) entailed purposeful action on the part of the experimenter. Perhaps intentional communication is sufficient to provoke object and action tracking in adults. Thus, removing the intentionality from the experimenter's actions (e.g., the experimenter absent-mindedly touching one object while talking about something else) might attenuate adult object tracking in cases where information about specific objects is less essential, as it is during a labeling task.

Many open questions remain. For example, under what conditions do children (and adults) engage in object tracking? What if objects were involved in non-intentional actions? What if a non-human entity (such as a machine) highlighted a target object (as in Meltzoff, 1995)? How about children with autism—do they likewise preferentially track owned objects?

Finally, given the early emergence of a capacity to track objects, we wish to return to the questions raised at the beginning of the paper. The most troubling ethical aspects of tracking entities over time involve tracking of people. The idea of tracking an individual person without her knowledge or against her will is troubling when considering human rights and individual autonomy. We suggest that tracking of property evokes similar moral responses and considerations. In part this stems from the practical consideration that tracking property can permit one to reconstruct the actions or location of the person possessing the property. However, we suspect that objections to tracking property belonging to another would persist even without that consideration. This is a direction that would be interesting to pursue in future research.

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Notes

1. Openly tracking a person or the person's possessions when he or she is in public view may not raise the same issues, as when a spectator tracks a horse during a race, or an audience member tracks an actor's wine glass during a theater performance. On the other hand, even public tracking may be unsettling, as with stalking.
2. By "object tracking," we refer to attending to and discriminating a particular individual object over time, and not the tracking of object kinds per se. However, tracking an individual can also be informed by kind-relevant information (e.g., if a

ball rolled behind the couch and upon checking behind the couch I saw only a mouse, I would infer that these were two distinct individuals).

3. Note that this is a conservative estimate of chance, as it assumes that participants chose exactly one object per trial. In actuality, however, on some trials participants selected more than one object.

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