

# Developmental Psychology

## **Figuring Out Function: Children's and Adults' Use of Ownership Information in Judgments of Artifact Function**

Konika Banerjee, Jonathan F. Kominsky, Madhawe Fernando, and Frank C. Keil

Online First Publication, September 28, 2015. <http://dx.doi.org/10.1037/a0039751>

### CITATION

Banerjee, K., Kominsky, J. F., Fernando, M., & Keil, F. C. (2015, September 28). Figuring Out Function: Children's and Adults' Use of Ownership Information in Judgments of Artifact Function. *Developmental Psychology*. Advance online publication.

<http://dx.doi.org/10.1037/a0039751>

# Figuring Out Function: Children's and Adults' Use of Ownership Information in Judgments of Artifact Function

Konika Banerjee and Jonathan F. Kominsky  
Yale University

Madhawe Fernando  
University of Melbourne

Frank C. Keil  
Yale University

Across 3 experiments, we found evidence that information about who owns an artifact influenced 5- to 10-year-old children's and adults' judgments about that artifact's primary function. Children's and adults' use of ownership information was underpinned by their inference that owners are typically familiar with owned artifacts and are therefore likely to know their primary functions. Accordingly, when this inference was undermined—when an artifact's owner was said to be unfamiliar with the owned artifact—ownership was no longer used as a privileged heuristic cue to artifact function. These experiments also revealed age-related differences in how ownership information was prioritized relative to another well-studied source of information known to influence artifact cognition, namely, information about an artifact's original designer-intended function. Specifically, older children and adults were more likely than younger children to prioritize design information over ownership information. Our results suggest that children and adults differ in how they weight the relative importance of these 2 sources of function-relevant information—likely reflecting age-related changes in children's and adults' sensitivity to ownership and design information across development.

*Keywords:* artifacts, function, ownership, design stance

In the first decade of life, children must learn to classify the functions of a myriad human-made artifacts that they encounter for the first time (Bloom, 2004; Margolis & Laurence, 2007). For example, they must discover that gloves are for keeping hands warm, that scissors are for cutting, and that towels are for drying. Their ability to learn such information is vital for developing technological efficiency as tool users (Tomasello, 1999; Tomasello & Rakoczy, 2003), for acquiring the shared conventional knowledge of their culture (Callanan, Siegel, & Luce, 2007; Diesendruck, Carmel, & Markson, 2010; Diesendruck & Markson, 2011; Defeyter, Hearing, & German, 2009; German, Truxaw, & Defeyter, 2007; Tomasello, 1999; Wohlgelemer, Diesendruck, & Markson, 2010), and for successfully navigating coordinated social interactions that require an understanding of artifacts' normative uses (e.g., giving money to a bus driver to gain entry to the

bus; Tomasello & Rakoczy, 2003). But given young children's limited experience with a wide range of artifacts, what strategies do they use to figure out function?

In some cases, children may learn about artifact functions through direct pedagogical instruction (Callanan et al., 2007), and by the second or third year of life, young children rapidly encode artifact functions simply by watching adult teachers demonstrate their proper use (Casler & Kelemen, 2005, 2007; Casler, Terzian, & Greene, 2009). However, children often lack access to direct didactic information about artifact properties. In such cases, children must instead rely on their own more informal observations and interactions with artifacts and their knowledge about the people who use them to inform their beliefs about artifact function (Callanan et al., 2007; Cimpian & Cadena, 2010; Siegel & Callanan, 2007; Tomasello, 1999; Tomasello & Rakoczy, 2003; Phillips, Seston, & Kelemen, 2012). How, then, do children draw inferences about what artifacts are for in the absence of explicit teaching?

Previous research on children's developing artifact cognition suggests that children often consider the identities of the individuals who interact with artifacts when faced with this challenge. For example, one well-studied topic among developmental psychologists is whether young children adopt a "design stance" (Dennett, 1987) toward artifacts—construing them as having been created by a designer for a specific intended purpose. If so, then children should expect that artifacts are "for" whatever function their designer originally intended them to perform, rather than for any alternative function for which another person might subsequently use them (Kelemen, 1999; Kelemen & Carey, 2007; German & Johnson, 2002; Matan & Carey, 2001).

---

Konika Banerjee and Jonathan F. Kominsky, Department of Psychology, Yale University; Madhawe Fernando, Department of Psychology, University of Melbourne; Frank C. Keil, Department of Psychology, Yale University.

We thank Taryn Bipat, Molly Elson, Ethan Gacek, Deena Gottlieb, Rachel Han, Marjorie Lam, Emily Shaw, and Sinjihn Smith for help with data collection. We also thank three anonymous reviewers for their helpful comments on previous drafts of the manuscript.

Correspondence concerning this article should be addressed to Konika Banerjee or Jonathan F. Kominsky, Department of Psychology, Yale University, 2 Hillhouse Avenue, New Haven, CT 06510. E-mail: konika.banerjee@yale.edu or jonathan.kominsky@yale.edu

While adults tend to reason about artifacts in this design-centered way (Bloom, 1996; Kelemen, 1999; Kelemen & Carey, 2007; German & Johnson, 2002; Matan & Carey, 2001; see also Hall, 1995; Rips, 1989), the extent to which young children similarly appreciate the role of original intended design in constraining artifact form and function is a matter of considerable debate (see Kelemen & Carey, 2007, for a review). Some researchers have argued for precocious design understanding in young children, citing evidence that by the age of 4, children favor an artifact's original intended function over both idiosyncratic and frequent alternative intended functions when deciding that artifact's primary function (Kelemen, 1999). They also refer to studies showing that young children prioritize the designer's intended function over an object's perceptual appearance when deciding how to categorize novel artifacts (Jaswal, 2006; Kemler Nelson, 1999; Kemler Nelson, Frankenfield, Morris, & Blair, 2000; Kemler Nelson, Russell, Duke, & Jones, 2000).

However, other more recent studies suggest that young children may fail to privilege design information and that a mature design stance may not organize children's artifact concepts before the age of 6 or 7 (Defeyter, Avons, & German, 2007; Defeyter & German, 2003; Defeyter et al., 2009; German & Defeyter, 2000; German & Johnson, 2002; German et al., 2007; Matan & Carey, 2001; Truxaw, Krasnow, Woods, & German, 2006). These studies find that younger children do not reliably link artifact functions to designer intentions, but instead assign functions based on any goal-directed use for which an artifact might be used in the present (Defeyter et al., 2009; German & Johnson, 2002; Matan & Carey, 2001). Based on these sorts of results, some have argued that prior to age 6 or 7, children fail to appreciate the significance of original intended design in accounting for artifacts' core properties, including their primary function (Defeyter et al., 2007; Defeyter & German, 2003; Defeyter et al., 2009; German & Defeyter, 2000; German & Johnson, 2002; German et al., 2007; Matan & Carey, 2001; Truxaw et al., 2006).

Although the precise timeline underlying the emergence of the design stance in childhood is disputed, children do increasingly attend to information about the intentional agents who create and currently use artifacts when deciding what those artifacts are for. Consistent with this view, children may also be sensitive to information about how artifacts are conventionally used by the majority of people in their community when making judgments of artifact function (Callanan et al., 2007; German et al., 2007; Kalish & Sabbagh, 2007; Siegel & Callanan, 2007; Tomasello, 1999).

Children's (and adults') artifact concepts may therefore be shaped both by information about the artifact's original intended design function and also by information about the artifact's current intended use. In other words, children come to appreciate—if only implicitly at first, but eventually, explicitly—the social nature of artifacts and their meanings (see Bloom, 1996, 2000; Callanan et al., 2007; Diesendruck et al., 2010; Siegel & Callanan, 2007; Tomasello, 1999; Tomasello & Rakoczy, 2003; Wohlgeleitner et al., 2010). That is, they reason about artifact functions as more than just inherent or intrinsic features of physical objects themselves, but rather as reflections of the intentions of the individuals who both created them and currently use them.

Here, we further investigate children's use of social information in making judgments about artifact function by focusing on a novel source of information hypothesized to influence these judgments,

namely, information about artifact ownership. Although extensive research has previously examined the influence of other social informational cues on children's artifact concepts, few studies have investigated how information about who owns an artifact may affect these judgments (but see Kim & Kalish, 2009). This is surprising given young children's early emerging sensitivity to issues concerning artifact ownership status (Friedman & Neary, 2008; Friedman, Neary, Defeyter, & Malcolm, 2011; Friedman, Van de Vondervoort, Defeyter, & Neary, 2013; Kim & Kalish, 2009; Neary, Friedman, & Burnstein, 2009; Neary, Van de Vondervoort, & Friedman, 2012; Noles & Keil, 2011) and also given the centrality of ownership information in disputes over artifact possession and proper use in early childhood (Hay & Ross, 1982; Kim & Kalish, 2009).

Ownership information shares several important features with artifact design information, and it might therefore influence children's reasoning about artifacts in similar ways. Specifically, as with information about artifact design, ownership information is an invisible property of artifacts that reflects the intentions of the individuals who interact with them (i.e., artifact owners and borrowers) rather than any inherent or intrinsic feature of the physical objects themselves (Kim & Kalish, 2009). Moreover, children readily infer information about artifact ownership—as they eventually also do for artifact design intent—from observations of how people interact with artifacts. For example, preschoolers indirectly infer ownership by monitoring easily observable cues such as who has first contact with an artifact and also who controls permission to use that artifact (Friedman et al., 2011; Friedman et al., 2013; Friedman & Neary, 2008; Kim & Kalish, 2009; Neary et al., 2009).

We predict that ownership may influence children's and adults' judgments of artifact function if an owner is generally presumed to have knowledge of an artifact's primary function simply by virtue of possessing the artifact, and therefore being highly familiar with its function-relevant physical affordances and conventional usage. If so, then the function for which an owner uses an artifact may serve as a reasonably accurate (albeit indirect) proxy for an artifact's true primary function. In general, this may be a fairly useful heuristic. For instance, it seems safe to assume that a person who owns a stapler probably uses it to staple pages (a stapler's primary function), rather than as a doorstop. Similarly, one might reasonably expect that a person who owns a towel most likely uses it for drying, rather than as a tablecloth. In this way, children and adults may infer that artifact owners typically use artifacts for their "true" purposes. Accordingly, a different individual who is less familiar with an artifact and who uses it for a function other than the owner's function may be presumed to use it for some alternative, secondary purpose for which the artifact may be suitably functional, but not primarily "for." In sum, although ownership information may not be the core conceptual basis on which children determine artifact function, it may serve as a readily available and pragmatically useful secondary heuristic cue that relies on more primary function-relevant information (e.g., artifact familiarity) to guide artifact inferences.

A second goal of the present experiments was to explore how information about artifact ownership may interact with other relevant sources of information in shaping children's and adults' judgments of artifact function. In general, children may have access to various sources of such function-relevant information when making these judgments, including what an object is called,

what it was originally made for, what it is currently being used to do, and by whom (although certain types of information, such as an artifact's original intended function, may generally be less readily available than other types of information, such as an artifact's current use; Defeyter & German, 2003; German et al., 2007). In contrast to previous studies that have primarily attempted to identify what type of information children and adults attend to in making function judgments (e.g., design or convention information), with the tacit and sometimes explicit assumption that it must be one or the other, we focus instead on how they prioritize various sources of function-relevant information when they are simultaneously available to them. We do so operating under the assumption that they may be influenced by multiple types of information, but to differing relative degrees at different ages. To investigate this idea of prioritization, we investigate 5- to 10-year-old children's and adults' use of ownership information in determining artifact primary function when they are simultaneously provided with information about an artifact's original intended design.

We explore the issues outlined here in three experiments using a methodology adapted from German and Johnson's (2002) study of children's use of design information in making artifact function judgments. In each experiment, we presented children and adults with novel artifacts with unfamiliar labels (e.g., tog or fep) that were said to be used in different ways by two different individuals with distinct relationships to the artifacts (i.e., the artifact's owner, its borrower, or its original designer). Across experiments, we varied which two individuals and their uses were contrasted; participants were either given information about how the artifact's owner and borrower used it (Experiments 1 and 2) or about how its owner and designer used it (Experiment 3).

Finally, children and adults were asked which of the two uses described for each artifact was its true function (i.e., "what is it really for?"). Thus, across all three experiments, we varied the availability of information about the identity of the individuals who used the artifacts before assessing participants' judgments of the artifacts' primary function. Doing so allowed us to examine in detail how children and adults use ownership information in determining artifact function, and also to investigate how they evaluate and prioritize information about artifact ownership and original design, and whether their strategies for reconciling these distinct sources of information change over the course of development.

We expected to find evidence for the independent influence of both ownership and design information on individuals' judgments about artifact function, at every age that we tested. That is, we expected that both children and adults would attend to both sources of information and see each as relevant to the task of determining an artifact's primary function. At the same time, we expected that children and adults might differ in how they weight the relative importance of these two types of function-relevant information when pitted against each other—perhaps reflecting age-related changes in children's and adults' sensitivity to ownership and design information across development. Specifically, we expected that with age and the emergence of a robust design stance around middle childhood, older participants would increasingly value original design information in determining artifact function relative to younger participants. We further suspected that this developmental trend would interact with sensitivity to ownership information—which itself

may or may not undergo developmental change—resulting in age-related differences in how these two information sources are prioritized. Evidence of such a pattern would support the more general proposal that children's and adults' judgments about artifact function are multifaceted and involve evaluating and differentially weighting the importance of various sources of function-relevant information available to them. Thus, the experiments reported here allowed us to evaluate the broader hypothesis that a rich multidimensional architecture underlies children's and adults' teleological judgments about artifact function.

### Experiment 1: Owner Versus Borrower

In Experiment 1, we first sought to establish whether children and adults use information about who owns an artifact to guide their inferences about what that artifact is for, in the absence of other function-relevant information. Specifically, we asked whether participants would privilege the function for which an owner uses an artifact over the function for which a borrower uses the artifact, when making judgments about that artifact's primary function.

To date, no research has examined whether children use information about ownership to inform their teleological judgments about artifact primary function. However, previous research has found that by the age of 4, children (and also adults) believe that artifact owners—but not artifact finders, borrowers, or sellers—have the unique authority to use, alter, dispose of, and control others' use of owned artifacts (Kim & Kalish, 2009). Given this, we predicted that children of all ages as well as adults in Experiment 1 would also privilege an owner's function over a borrower's function when deciding what a series of artifacts were really for. To test this, we introduced participants to novel artifacts that were used in different ways by the artifacts' owner and borrower. We then asked participants to decide which of these two functions the artifacts were really for.

### Method

**Participants.** Participants were 20 children ages 5–6 years old (nine boys, eight girls, three unknown), 20 children ages 7–8 years old (five boys, 11 girls, four unknown), 20 children ages 9–10 years old (12 boys, seven girls, one unknown), and 40 adults (26 men, 14 women). Two additional children (ages 5 and 6 years) were excluded due to unwillingness to complete the experiment. Children were tested at local Connecticut elementary schools and children's museums or else were recruited from Yale University's child participant database and tested in the lab at the university. Adults residing in the United States were recruited through the research survey website, Amazon Mechanical Turk, and received \$0.50 for completing the experiment.

**Materials and procedure.** Adapting the paradigm used by German and Johnson (2002), we presented children and adults with a series of eight novel artifacts that were used in different ways by their owner and by their borrower. The novel artifacts were referenced using unfamiliar nonsense labels (e.g., tog, fep, grak). For example, participants heard,

Let's talk about an object called a tog. The person who owns the tog uses it to reach things that are up high. One day, a different person

asked to borrow the tog and the owner gave it to them. The person who borrowed the tog uses it to store water.

Each trial was accompanied by a cartoon depiction of the artifact's owner and borrower (stick-figure characters distinguished by the color of their t-shirts) and also by a cartoon depiction of both the owner's function (e.g., "to reach things that are up high") and the borrower's function (e.g., "to store water"; see Figure 1). For example, the function "to store water" was depicted by an image of water. Each character and his corresponding function were displayed one at a time on an iPad screen for children (adults did not see these images). Participants never viewed images of the artifacts themselves. They received one of four artifact presentation orders, across which we counterbalanced whether the owner's function or the borrower's function was described first, and also which artifact function was matched with the owner versus with the borrower.

Next, children received two comprehension check questions to confirm that they successfully encoded both the owner's function and the borrower's function for each artifact. These questions were "What does the person who owns the [artifact] use it for?" and "What does the person who borrowed the [artifact] use it for?" While asking the check questions, images of both the owner and the borrower were displayed simultaneously side-by-side, with images of their respective functions appearing directly underneath them. Children could answer the check questions either verbally or by tapping on an image of either function. If children answered either check question incorrectly, we repeated the description of both the owner's function and the borrower's function. Subsequently, children were again asked the same two check questions. If children failed either check question a second time, their responses for that particular trial were excluded.

Finally, children were asked to make a judgment about each artifact's primary function by answering the question, "What is the [artifact] *really* for?" Adults were asked this same question, but they did not receive the comprehension check questions beforehand because they had the full text for each trial (reminding them of the relevant information) in front of them while making their judgment.

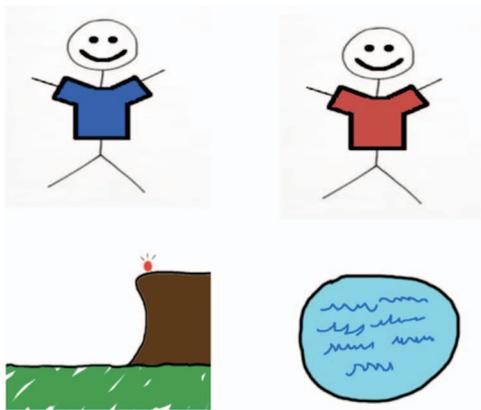


Figure 1. Experiment 1 sample stimuli depicting the artifact owner and borrower, as well as their associated artifact functions ("to reach things that are up high" and "to store water"). See the online article for the color version of this figure.

## Results

In Experiment 1, and in all subsequent experiments, we excluded trials on which children failed to answer both comprehension check questions correctly after two attempts. For the present experiment, this excluded a total of 25 trials (5% of all trials). For each participant, we then calculated the proportion of successful trials for which he or she selected the owner's function as the artifact's primary function. For each age group, we compared this proportion to chance (.5), using a one-sample *t* test. As Figure 2 shows, participants of all ages preferred the owner's function significantly more often than would be expected by chance: 5–6-year-olds:  $M = .60$ ,  $SD = .19$ ,  $t(19) = 2.29$ ,  $p = .03$ ,  $d = 1.05$ ; 7–8-year-olds:  $M = .66$ ,  $SD = .24$ ,  $t(19) = 2.88$ ,  $p = .01$ ,  $d = 1.32$ ; 9–10-year-olds:  $M = .69$ ,  $SD = .23$ ,  $t(19) = 3.67$ ,  $p = .002$ ,  $d = 1.68$ ; adults:  $M = .69$ ,  $SD = .25$ ,  $t(39) = 4.85$ ,  $p < .001$ ,  $d = 1.55$ . Thus, children and adults favored the owner's function over the borrower's function when deciding what a series of novel artifacts were really for. A one-way ANOVA revealed no effect of age group on participants' preference for the owner's function,  $F(3, 96) = .77$ ,  $p = .51$ .

## Discussion

As predicted, 5- to 10-year-old children and adults consistently favored an artifact owner's intended function over a borrower's intended function when deciding what a series of novel artifacts were really for. Thus, not only do children and adults afford owners the unique authority to use and manipulate owned artifacts as they wish (Kim & Kalish, 2009), but they also see ownership information as being relevant to understanding an artifact's primary function.

Having established that children and adults take into account information about who owns an artifact when deciding what that artifact is really for, we next sought to investigate why they may do so. One possibility is that owners are presumed to be familiar with owned artifacts' function-relevant physical affordances and conventional uses simply by virtue of possessing them, and perhaps they are therefore also presumed to be familiar with those artifacts' true primary functions. We tested this possibility directly in Experiment 2.

### Experiment 2: Unfamiliar Owner Versus Unfamiliar Borrower

In Experiment 2, we again introduced children to a series of novel artifacts that were used in different ways by their owner and by their borrower. However, this time, to test whether the ownership preference observed in the previous experiment was driven by the presumption that owners are familiar with their owned artifacts (e.g., familiar with their function-relevant physical affordances and/or conventional uses), participants were told that neither the artifacts' owner nor borrower had any prior knowledge of the artifacts' functions. In other words, both the owner and the borrower were said to be equally and completely unfamiliar with the artifacts. By doing so, we undermined the possible inference that the artifacts' owner was more familiar with the artifacts, and therefore more knowledgeable of the artifact's true primary function, than their borrower. We predicted that if presumptions

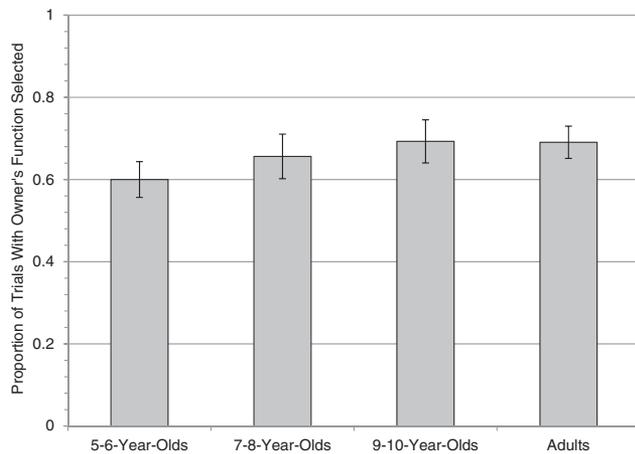


Figure 2. Experiment 1 function judgments.

of an owner's familiarity with an artifact underpin children's and adults' owner preference in Experiment 1, then severing this association in the current experiment should reduce (and perhaps altogether eliminate) individuals' preference for the owner's intended function.

## Method

**Participants.** Participants were 20 children ages 5–6 years old (10 boys, 10 girls), 20 children ages 7–8 years old (eight boys, 12 girls), 20 children ages 9–10 years old (nine boys, 11 girls), and 40 adults (20 men, 20 women). One additional child (age 5) was excluded due to unwillingness to complete the experiment. Children were tested at local Connecticut children's museums or else were recruited from Yale University's child participant database and tested in the lab at the university. Adults residing in the United States were recruited through the research survey website, Amazon Mechanical Turk, and received \$0.50 for completing the experiment.

**Materials and procedure.** Testing materials and procedures were identical to those used in Experiment 1, with the following modifications: In Experiment 2, participants were again given information about how a series of novel artifacts were used by their owner and by their borrower, but this time they were explicitly told that neither the owner nor the borrower was familiar with the artifacts and that neither had any prior knowledge of those artifacts' functions. Specifically, participants heard,

Let's talk about an object called a Tog. The person who owns the Tog just got it as a gift. The person who owns the Tog has never seen or used the Tog before, and doesn't know anything about it. The person who owns the Tog uses it to reach things that are up high. One day, a different person saw the Tog for the first time, and asked to borrow the Tog and the owner gave it to them. The person who borrowed the Tog had never seen or used the Tog before, and didn't know anything about it. The person who borrowed the Tog uses it to store water.

Participants were then again asked to choose what each artifact was really for: the unfamiliar owner's function or the unfamiliar borrower's function.

## Results

Results were analyzed in the same manner as in Experiment 1. Eight individual trials (1.9% of all trials) were excluded due to children's failure to answer comprehension check questions correctly. For each participant, we then calculated the proportion of successful trials for which he or she selected the unfamiliar owner's function as the artifact's primary function. For each age group, we compared this proportion to chance (.5), using a one-sample *t* test. As Figure 2 shows, participants of all ages showed no systematic preference for either the owner's function or the borrower's function, and their responses were indistinguishable from chance: 5–6-year-olds:  $M = .54$ ,  $SD = .21$ ,  $t(19) = .82$ ,  $p = .42$ ; 7–8-year-olds:  $M = .53$ ,  $SD = .20$ ,  $t(19) = .65$ ,  $p = .53$ ; 9–10-year-olds:  $M = .53$ ,  $SD = .17$ ,  $t(19) = .75$ ,  $p = .46$ ; adults:  $M = .54$ ,  $SD = .26$ ,  $t(19) = 1.08$ ,  $p = .29$ . A one-way ANOVA revealed no effect of age group on participants' preference for the owner's function,  $F(3, 96) = .032$ ,  $p = .99$ .

## Discussion

When told that the owner and borrower of a series of novel artifacts were both entirely and equally unfamiliar with those artifacts, 5- to 10-year-old children and adults favored neither the owner's intended function nor the borrower's intended function when deciding what those artifacts were really for. Instead, participants of all ages chose equally between both functions. This result contrasts with that of Experiment 1, in which children and adults exhibited a robust preference for the owner's function when no explicit information was provided about either the owner's or the borrower's prior familiarity with an artifact. Thus, consistent with our prediction, blocking the inference that an artifact's owner is familiar with the owned artifact in Experiment 2 undermined and fully eliminated participants' preference for the owner's function. The assumption that owners are familiar with owned artifacts' true functions therefore seems to underpin the use of ownership information in judgments of artifact primary function.

Having thus established in Experiments 1 and 2 that children and adults are sensitive to ownership information as a proxy for familiarity with an artifact when making judgments about artifact function, we next explored how ownership information is prioritized relative to a different source of function-relevant information known to influence artifact cognition—namely, information about an artifact's original designer-intended function.

## Experiment 3: Owner Versus Designer

In Experiment 3, we introduced participants to a series of novel artifacts that were used in different ways by their owner and by their original designer. We then asked participants to decide which of the two described functions the artifacts were really for.

As discussed previously, there is considerable debate concerning the precise age at which children adopt a design stance understanding of artifacts and begin to construe artifacts as having been created by a designer for a specific intended purpose (see Kelemen & Carey, 2007 for a review). Indeed, the available evidence on children's use of design information in guiding judgments about artifact primary function is mixed, although it seems to emerge sometime between 4 and 7 years of age (Defeyter et al., 2007;

Defeyter & German, 2003; Defeyter et al., 2009; German & Johnson, 2002; German et al., 2007; Kelemen, 1999; Kelemen & Carey, 2007; Matan & Carey, 2001; Truxaw et al., 2006). Further, it is clear that with age, children increasingly attend to information about original design when reasoning about artifact functions, and adults also do so reliably (Bloom, 1996, 2000; Kelemen, 1999; Kelemen & Carey, 2007; German & Johnson, 2002; Matan & Carey, 2001; see also Hall, 1995; Rips, 1989).

Given this, although we were uncertain how artifact ownership information would be prioritized relative to original design information, we suspected that the development of a more mature design stance throughout middle childhood might drive developmental changes in how ownership and design information are weighted relative to each other. Specifically, we suspected that more a robust design stance among older children and adults might encourage them to prioritize design information over ownership information to a greater degree than younger children. To test this, in Experiment 3, we introduced children and adults to a series of novel artifacts that were used in different ways by their owner and by their original designer. We then asked participants to decide which of these two functions the artifacts were really for.

## Method

**Participants.** Participants were 20 children ages 5–6 years old (10 boys, eight girls, two unknown), 20 children ages 7–8 years old (nine boys, six girls, five unknown), 20 children ages 9–10 years old (seven boys, nine girls, four unknown), and 40 adults (22 men, 17 women, one unknown). Four additional children (ages 5, 6, 7, and 10 years) were excluded due either to inattention or experimenter error. Children and adults were recruited and tested as in the previous experiments.

**Materials and procedure.** Testing materials and procedures were identical to those used in Experiment 1, with the following modifications: In Experiment 3, participants were given information about how a series of novel artifacts were used by their owner and by their original designer. Specifically, the contrast in Experiment 3 was between “the person who *now* owns the [artifact]” and a person who “a long time ago *made* the [artifact].” Correspondingly, children in Experiment 3 heard the following comprehension check questions: “what does the person who owns the [artifact] use it for?” and “what was the [artifact] made for a long time ago?” Participants were then again asked to choose what each artifact was really for: its owner’s function or its designer’s function.

## Results

Results were analyzed in the same manner as in Experiments 1 and 2. Twenty-six individual trials (5% of all trials) were excluded due to children’s failure to answer comprehension check questions correctly. We found that 5–6-year-olds ( $M = .55$ ,  $SD = .28$ ) and 7–8-year-olds ( $M = .43$ ,  $SD = .26$ ) did not differ significantly from chance responding when choosing between the owner’s function and the designer’s function,  $t(19) = .84$  and  $-1.23$ , respectively, both  $ps > .20$ . Thus, younger children between the ages of 5 and 8 years showed no systematic preference for either the owner’s function or the designer’s function when deciding what a series of novel artifacts were really for. In contrast, 9–10-

year-olds ( $M = .37$ ,  $SD = .32$ ) favored the designer’s function marginally more often than would be expected by chance,  $t(19) = -1.88$ ,  $p = .075$ ,  $d = .86$ , indicating a slight preference for the designer’s function over the owner’s function. Adults ( $M = .26$ ,  $SD = .31$ ) favored the designer’s intended function significantly more often than would be expected by chance,  $t(39) = -4.93$ ,  $p < .001$ ,  $d = 1.58$ , revealing a preference for the designer’s function over the owner’s function. These results are presented in Figure 3.

A one-way ANOVA revealed a significant effect of age group on participants’ judgments of artifact primary function,  $F(3, 96) = 4.73$ ,  $p < .001$ ,  $\eta_p^2 = .13$ . Planned least significant difference pairwise comparisons indicated that adults differed significantly from both 5–6-year-olds,  $p < .001$ , and from 7–8-year-olds,  $p = .037$ . Specifically, adults showed a significantly stronger designer preference than did children between the ages of 5 and 8. However, adults did not differ from 9–10-year-olds,  $p = .18$ . Among children, only 9–10-year olds differed marginally from 5–6-year-olds,  $p = .051$ , with the oldest children revealing a somewhat stronger designer preference than the youngest children. No other age group comparisons were statistically significant (see Figure 4).

## Discussion

Consistent with our prediction, there were age-related differences in how children and adults prioritized ownership information and original design information when deciding what a series of novel artifacts were really for. Specifically, younger children, 5–8-year-olds, showed no preference for either the owner’s function or the designer’s function. In contrast, older children, 9–10-year-olds, showed a marginal preference for the designer’s function, and adults showed a strong preference for the designer’s function. It appears that with age, children and adults increasingly believe that an artifact’s true function is a feature of its original designer’s intentions, rather than something that is determined by an artifact’s subsequent owner.

We propose the following explanation for this developmental trend: As Experiments 1 and 2 found, in the absence of other function-relevant information, children as young as 5 years of age who are tasked with determining an artifact’s primary function

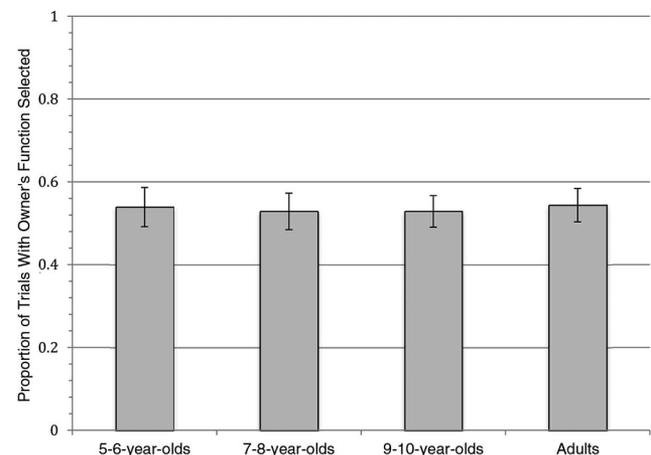


Figure 3. Experiment 2 function judgments.

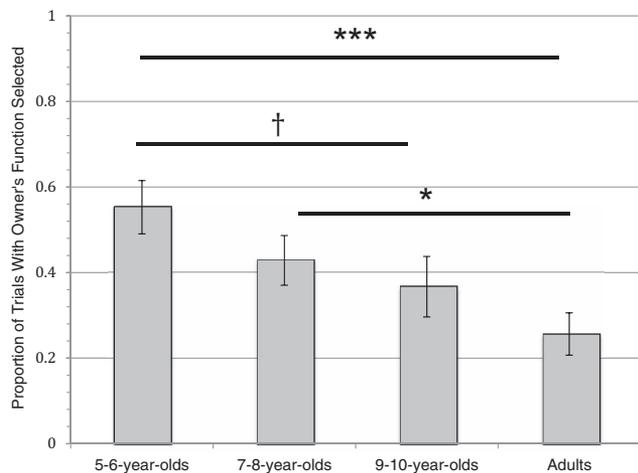


Figure 4. Experiment 3 function judgments. †  $p \leq .10$ . \*  $p \leq .05$ . \*\*  $p \leq .01$ . \*\*\*  $p \leq .001$ .

take into account artifact ownership information when it is inferred to be a reliable cue to artifact familiarity. But given only an immature or, at best, novice design understanding in middle childhood, 5–8-year-olds may be agnostic in choosing between an owner's intended function and a designer's intended function when deciding an artifact's primary function, as both may be seen as being relevant to some extent, perhaps equivalently so. Note that younger children's ambivalence in choosing between the artifact owner's function and the designer's function is unlikely to reflect a belief that both types of information are wholly irrelevant to determining an artifact's true function (i.e., what would amount to chance responding). Instead, when considered in parallel with the results of Experiment 1—which found evidence of a robust ownership preference in function judgments at every age tested—this finding suggests that young children attend to *both* ownership information and design information, and that these compete with each other. Thus, the lack of a strong preference for either the designer's function or the owners' function in Experiment 3 likely reflects an unresolved tension in young children's reasoning about these two sources of function-relevant information, with neither being viewed as significantly more important than the other for inferring artifact functions.

### General Discussion

When tasked with the challenge of figuring out what artifacts are really for, children and adults are able to make use of multiple sources of function-relevant information. Consistent with our prediction, we found evidence across three experiments that information about an artifact's ownership and original design influence individuals' judgments about that artifact's primary function, at every age that we tested.

We show for the first time that young children and adults use information about who owns an artifact to figure out what that artifact is really for. Specifically, in Experiment 1, children and adults privileged an owner's function over a borrower's function when determining an artifact's primary function, in the absence of other function-relevant information. Moreover, we found no age-

related differences in children's and adults' owner function preference, suggesting that sensitivity to ownership information for determining artifact function is both early emerging and stable across the course of development.

This result is consistent with a substantial body of evidence suggesting that ownership information looms large in young children's artifact cognition and is a highly salient feature of individuals' interactions with artifacts beginning early in life (Hay & Ross, 1982; Friedman & Neary, 2008; Friedman et al., 2011; Friedman, Van de Vondervoort, Defeyter, & Neary, 2013; Kim & Kalish, 2009; Neary, Friedman, & Burnstein, 2009; Neary, Van de Vondervoort, & Friedman, 2012; Noles & Keil, 2011). Given children's early emerging attentiveness to artifact ownership, ownership information may generally function as a salient and readily accessible cue to other function-relevant artifact features that are not as easily or directly observable (e.g., familiarity). In other words, children may piggyback on a quick and efficient ownership detection system to acquire information that can be used as a reliable cue for inferring artifact function. Pragmatically, even for adults, ownership may be a highly efficient heuristic for inferring artifact function if adults expect not only that owners are familiar with owned artifacts' function-relevant physical affordances and conventional uses, but also that the desire to own an artifact is almost always linked to knowledge of what that artifact is for and, moreover, that that function must therefore be valued by the owner.

One further implication of Experiment 1's findings is that, contrary to the suggestion that children prior to age 6 infer artifact function on the basis of any intended function for which an artifact is used (Defeyter et al., 2003; Defeyter et al., 2009; German et al., 2007; German & Defeyter, 2000), children do in fact reliably distinguish among different functions, and systematically favor some over others. Indeed, Experiments 1 and 2 reveal that both information about the identity of the individuals who use an artifact and also information about how familiar those individuals are with the artifact, influence children's judgments of that artifact's primary function. This is strong evidence that children make sophisticated evaluations of distinct intended functions when determining artifact primary function, rather than indiscriminately accepting any intended function.

Experiment 2 further advanced our understanding of children's and adults' use of ownership information in judgments of artifact function by directly testing the possibility that a preference for the owner's intended function is rooted in the presumption that owners are familiar with owned artifacts (e.g., familiar with their physical affordances and conventional uses) and are therefore likely to know their primary functions. Specifically, when both an artifact's owner and borrower were explicitly said to be entirely unfamiliar with the owned artifact, children's and adult's preference for the owner's intended function vanished; they no longer favored the owner's function over the borrower's function, but were instead ambivalent in choosing between the two. We conclude from these results that information about who owns an artifact influences children's and adults' function judgments to the extent that ownership information is seen as a proxy for familiarity with an artifact, which in turn may reliably signal knowledge of an artifact's primary use. Accordingly, when the inference that ownership entails familiarity with an artifact is undermined, ownership is no longer viewed as a reliable cue to artifact function.

While the present research is the first to establish the pivotal role of ownership in children's judgments of artifact function, our findings also suggest that ownership information itself is not the core conceptual cue into artifact properties. Rather, ownership, as a readily available and behaviorally salient artifact feature, is a pragmatically useful secondary heuristic cue that relies on a different, more primary, indicator of function (artifact familiarity) to inform function judgments. Thus, the present experiments are also the first to demonstrate how highly salient secondary cues to artifact function may reliably correlate with privileged primary cues to function, and may thereby inform children's artifact cognition. Finally, our research reveals that strategies for prioritizing secondary heuristic cues (e.g., ownership information) with other more primary function-relevant cues (e.g., original design information) change over time. Investigating how primary and secondary heuristic cues to artifact function interact over development is an important new direction for research.

Although ownership information may broadly index artifact familiarity, there may be other aspects of ownership that underpin children's use of ownership information in making function judgments, but which the present experiments did not directly address. For example, previous work has found that that children believe that artifact owners, but not nonowners, retain the right to use, alter, dispose of, and control others' use of owned artifacts (Kim & Kalish, 2009). Accordingly, it may be that an owner's presumed authority over artifact usage also plays a role in children's use of ownership information for making function judgments. However, the results of Experiment 2 suggest that if this is the case, then presumed authority over an owned artifact is insufficient for establishing artifact primary function if the owner is known to be unfamiliar with the artifact. Thus, it may be that presumptions of authority contribute to children's willingness to privilege an owner's intended function over an alternative intended function, but only when the owner is inferred to be familiar with the owned artifact. Future research could investigate this possibility further, for example by examining children's function judgments when both an artifact's owner and borrower are highly and equally familiar with the artifact, but use the artifact in different ways.

A further novel finding of our experiments is that a developmental shift occurs in how children and adults weight artifact ownership information against design information when making judgments about artifact primary function. Specifically, Experiment 3 found that older children (9–10-year-olds) and adults privileged an artifact designer's original intended function over a subsequent owner's function, perhaps because a mature design stance leads them to construe artifacts as fundamentally "for" their original design function. However, younger children (5–8-year-olds) showed no preference for either function, likely reflecting their relatively fragile understanding that both ownership information and design information are relevant to determining primary function, but also their inability to resolve the issue of which is the more important factor. Taken together, these findings support the view that although design information appears to play a role in younger children's judgments about artifact function by at least the age of 5, it may not become a critical factor that overtakes other competing considerations until later in development.

Various distinct aspects of artifact design information could, in theory, compete with ownership information in determining how children and adults prioritize both sources of information when

deciding what artifacts are really for. For example, just as Experiment 2 found that ownership information acts as a proxy for artifact familiarity, it may also be that presumptions of familiarity similarly underlie the use of design information in individuals' judgments of artifact function. Specifically, it may be that, as with artifact owners, artifact designers are also presumed to be familiar with designed artifacts, and therefore to have knowledge of their primary function. If so, then perhaps children failed to prioritize either the owner's function or the designer's function in Experiment 3 simply because they had difficulty determining who is more familiar with an artifact—its owner or its designer. Adults, on the other hand, may have inferred that artifact designers are necessarily more familiar with the artifacts they created than are subsequent owners, and perhaps this led them to prioritize the designer's function over the owner's function.

Another compatible interpretation of Experiment 3 is that children's and adults' function judgments were influenced by the inference that the artifacts' original designer also, at one point, owned those artifacts. Specifically, participants may have interpreted the relevant contrast in Experiment 3 as being between the function endorsed by the artifact's current owner (the person who owns it *now*) and the function endorsed by the person who both previously created and also previously owned the artifact. If so, then the observed developmental changes in children's judgments of function may have been driven in part by older participants' greater appreciation that two cues to primary function (original creation plus previous ownership) are superior than one cue to function (current ownership alone). Future research might evaluate this possibility more directly by assessing children's and adults' function judgments when an artifact's original designer is explicitly stated to have never previously owned the artifact and to be less familiar with the artifact than its current owner.

A different possibility, and one that we see as more likely, is that individuals' use of design information for determining artifact function does not simply reduce to presumptions of familiarity. Instead, design information may be seen as providing an altogether different sort of information that older individuals regard as a fundamentally better cue to artifact primary function than familiarity alone. Specifically, older children and adults who possess a more robust design stance may be relatively more inclined to prioritize design information over ownership information because they increasingly construe artifact functions as reflections of the intentions of the designers who create them (Kelemen, 1999; Kelemen & Carey, 2007; German & Johnson, 2002; Matan & Carey, 2001). In other words, over the course of development, individuals increasingly come to understand artifacts as fundamentally and enduringly *for* their original designer-intended function. Consequently, with age, older children (and adults) may privilege to a greater extent the designer's intended function over alternative functions for which an artifact may be used when deciding what those artifacts are really for.

In sum, our experiments offer support for the view that a rich, multidimensional architecture underlies artifact function judgments, beginning early in development. Rather than being driven by a single key factor (e.g., the construction of the design stance) that emerges at a particular point in development and henceforth provides the core of children's artifact understanding, inferences about artifact judgment instead appear to be influenced by multiple sources of information to which even young children attend. Spe-

cifically, we find that by the age of 5, information about an artifact's ownership and original intended design use are both available to be used in individuals' artifact function judgments—but what may change is how these are prioritized relative to each other over the course of development. Consequently, the task of figuring out function is shaped not only by certain core competencies (or stances) that orient children to salient artifact properties, but also by the dynamic ways in which these competencies interplay from childhood through adulthood.

## References

- Bloom, P. (1996). Intention, history, and artifact concepts. *Cognition*, *60*, 1–29. [http://dx.doi.org/10.1016/0010-0277\(95\)00699-0](http://dx.doi.org/10.1016/0010-0277(95)00699-0)
- Bloom, P. (2000). *How children learn the meanings of words*. Cambridge, MA: MIT Press.
- Bloom, P. (2004). *Descartes' baby: How the science of child development explains what makes us human*. New York, NY: Basic Books.
- Callanan, M. A., Siegel, D. R., & Luce, M. R. (2007). Conventionality in family conversations about everyday objects. *New Directions for Child and Adolescent Development*, *2007*, 83–97. <http://dx.doi.org/10.1002/cd.184>
- Casler, K., & Kelemen, D. (2005). Young children's rapid learning about artifacts. *Developmental Science*, *8*, 472–480. <http://dx.doi.org/10.1111/j.1467-7687.2005.00438.x>
- Casler, K., & Kelemen, D. (2007). Reasoning about artifacts at 24 months: The developing teleo-functional stance. *Cognition*, *103*, 120–130. <http://dx.doi.org/10.1016/j.cognition.2006.02.006>
- Casler, K., Terziyan, T., & Greene, K. (2009). Toddlers view artifact function normatively. *Cognitive Development*, *24*, 240–247. <http://dx.doi.org/10.1016/j.cogdev.2009.03.005>
- Cimpian, A., & Cadena, C. (2010). Why are dunkels sticky? Preschoolers infer functionality and intentional creation for artifact properties learned from generic language. *Cognition*, *117*, 62–68. <http://dx.doi.org/10.1016/j.cognition.2010.06.011>
- Defeyter, M. A., Avons, S. E., & German, T. C. (2007). Developmental changes in information central to artifact representation: Evidence from “functional fluency” tasks. *Developmental Science*, *10*, 538–546. <http://dx.doi.org/10.1111/j.1467-7687.2007.00617.x>
- Defeyter, M. A., & German, T. P. (2003). Acquiring an understanding of design: Evidence from children's insight problem solving. *Cognition*, *89*, 133–155. [http://dx.doi.org/10.1016/S0010-0277\(03\)00098-2](http://dx.doi.org/10.1016/S0010-0277(03)00098-2)
- Defeyter, M. A., Hearing, J., & German, T. C. (2009). A developmental dissociation between category and function judgments about novel artifacts. *Cognition*, *110*, 260–264. <http://dx.doi.org/10.1016/j.cognition.2008.10.014>
- Dennett, D. C. (1987). *The intentional stance*. Cambridge, MA: MIT Press.
- Diesendruck, G., Carmel, N., & Markson, L. (2010). Children's sensitivity to the conventionality of sources. *Child Development*, *81*, 652–668. <http://dx.doi.org/10.1111/j.1467-8624.2009.01421.x>
- Diesendruck, G., & Markson, L. (2011). Children's assumption of the conventionality of culture. *Child Development Perspectives*, *5*, 189–195. <http://dx.doi.org/10.1111/j.1750-8606.2010.00156.x>
- Friedman, O., & Neary, K. R. (2008). Determining who owns what: Do children infer ownership from first possession? *Cognition*, *107*, 829–849. <http://dx.doi.org/10.1016/j.cognition.2007.12.002>
- Friedman, O., Neary, K. R., Defeyter, M. A., & Malcolm, S. L. (2011). Ownership and object history. *New Directions for Child and Adolescent Development*, *2011*, 79–89. <http://dx.doi.org/10.1002/cd.298>
- Friedman, O., Van de Vondervoort, J. W., Defeyter, M. A., & Neary, K. R. (2013). First possession, history, and young children's ownership judgments. *Child Development*, *84*, 1519–1525. <http://dx.doi.org/10.1111/cdev.12080>
- German, T. P., & Defeyter, M. A. (2000). Immunity to functional fixedness in young children. *Psychonomic Bulletin & Review*, *7*, 707–712. <http://dx.doi.org/10.3758/BF03213010>
- German, T. P., & Johnson, S. C. (2002). Function and the origins of the design stance. *Journal of Cognition and Development*, *3*, 279–300. [http://dx.doi.org/10.1207/S15327647JCD0303\\_2](http://dx.doi.org/10.1207/S15327647JCD0303_2)
- German, T. P., Truxaw, D., & Defeyter, M. A. (2007). The role of information about “convention,” “design,” and “goal” in representing artificial kinds. *New Directions for Child and Adolescent Development*, *2007*, 69–81. <http://dx.doi.org/10.1002/cd.183>
- Hall, D. G. (1995). *Artifacts and origins*. Unpublished manuscript.
- Hay, D. F., & Ross, H. S. (1982). The social nature of early conflict. *Child Development*, *53*, 105–113. <http://dx.doi.org/10.2307/1129642>
- Jaswal, V. K. (2006). Preschoolers favor the creator's label when reasoning about an artifact's function. *Cognition*, *99*(3), B83–B92. <http://dx.doi.org/10.1016/j.cognition.2005.07.006>
- Kalish, C. W., & Sabbagh, M. A. (2007). Conventionality and cognitive development: Learning to think the right way. *New Directions for Child and Adolescent Development*, *2007*, 1–9. <http://dx.doi.org/10.1002/cd.178>
- Kelemen, D. (1999). The scope of teleological thinking in preschool children. *Cognition*, *70*, 241–272. [http://dx.doi.org/10.1016/S0010-0277\(99\)00010-4](http://dx.doi.org/10.1016/S0010-0277(99)00010-4)
- Kelemen, D., & Carey, S. (2007). The essence of artifacts: Developing the design stance. In E. Margolis & S. Lawrence (Eds.), *Creation of the mind: Essays on artifacts and their representation* (pp. 212–230). Oxford, United Kingdom: Oxford University Press.
- Kemler Nelson, D. G. (1999). Attention to functional properties in toddlers' naming and problem-solving. *Cognitive Development*, *14*, 77–100. [http://dx.doi.org/10.1016/S0885-2014\(99\)80019-7](http://dx.doi.org/10.1016/S0885-2014(99)80019-7)
- Kemler Nelson, D. G., Frankenfield, A., Morris, C., & Blair, E. (2000). Young children's use of functional information to categorize artifacts: Three factors that matter. *Cognition*, *77*, 133–168. [http://dx.doi.org/10.1016/S0010-0277\(00\)00097-4](http://dx.doi.org/10.1016/S0010-0277(00)00097-4)
- Kemler Nelson, D. G., Russell, R., Duke, N., & Jones, K. (2000). Two-year-olds will name artifacts by their functions. *Child Development*, *71*, 1271–1288. <http://dx.doi.org/10.1111/1467-8624.00228>
- Kim, S., & Kalish, C. W. (2009). Children's ascriptions of property rights with changes of ownership. *Cognitive Development*, *24*, 322–336. <http://dx.doi.org/10.1016/j.cogdev.2009.03.004>
- Margolis, E., & Lawrence, S. (Eds.). (2007). *Creations of the mind: Theories of artifacts and their representation*. New York, NY: Oxford University Press.
- Matan, A., & Carey, S. (2001). Developmental changes within the core of artifact concepts. *Cognition*, *78*, 1–26. [http://dx.doi.org/10.1016/S0010-0277\(00\)00094-9](http://dx.doi.org/10.1016/S0010-0277(00)00094-9)
- Neary, K. R., Friedman, O., & Burnstein, C. L. (2009). Preschoolers infer ownership from “control of permission.” *Developmental Psychology*, *45*, 873–876. <http://dx.doi.org/10.1037/a0014088>
- Neary, K. R., Van de Vondervoort, J. W., & Friedman, O. (2012). Artifacts and natural kinds: Children's judgments about whether objects are owned. *Developmental Psychology*, *48*, 149–158. <http://dx.doi.org/10.1037/a0025661>
- Noles, N. S., & Keil, F. C. (2011). Exploring ownership in a developmental context. *New Directions for Child and Adolescent Development*, *2011*, 91–103. <http://dx.doi.org/10.1002/cd.299>
- Phillips, B., Seston, R., & Kelemen, D. (2012). Learning about tool categories via eavesdropping. *Child Development*, *83*, 2057–2072. <http://dx.doi.org/10.1111/j.1467-8624.2012.01827.x>
- Rips, L. J. (1989). Similarity, typicality, and categorization. In S. Vosniadou & A. Ortony (Eds.), *Similarity and analogical reasoning* (pp. 21–59). Cambridge, MA: Cambridge University Press. <http://dx.doi.org/10.1017/CBO9780511529863.004>

Siegel, D. R., & Callanan, M. A. (2007). Artifacts as conventional objects. *Journal of Cognition and Development, 8*, 183–203. <http://dx.doi.org/10.1080/15248370701202414>

Tomasello, M. (1999). The human adaptation for culture. *Annual Review of Anthropology, 28*, 509–529. <http://dx.doi.org/10.1146/annurev.anthro.28.1.509>

Tomasello, M., & Rakoczy, H. (2003). What makes human cognition unique? From individual to shared to collective intentionality. *Mind & Language, 18*, 121–147. <http://dx.doi.org/10.1111/1468-0017.00217>

Truxaw, D., Krasnow, M. M., Woods, C., & German, T. P. (2006). Conditions under which function information attenuates name extension via shape. *Psychological Science, 17*, 367–371. <http://dx.doi.org/10.1111/j.1467-9280.2006.01713.x>

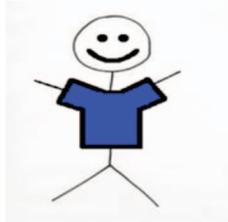
Wohlgeleitner, S., Diesendruck, G., & Markson, L. (2010). What is a conventional object function? The effects of intentionality and consistency of use. *Journal of Cognition and Development, 11*, 269–292. <http://dx.doi.org/10.1080/15248371003699985>

## Appendix

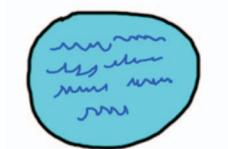
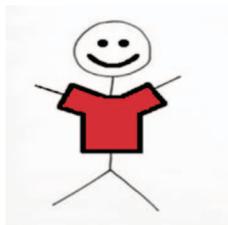
### Experiment 1 Stimuli

#### Trial 1: Tog

Let's talk about an object called a Tog. The person who owns the Tog uses it to reach things that are up high. See the online article for the color version of these figures.



One day, a different person asked to borrow the Tog and the owner gave it to them. The person who borrowed the Tog uses it to store water.



What does the person who *owns* the Tog use it for?

What does the person who *borrowed* the Tog use it for?

What is the Tog really for, reaching things up high or storing water?

The remaining trials follow the same script format outlined for Trial 1.

#### Trial 2: Zig

*Function 1:* Warm things up

*Function 2:* Light up the floor



#### Trial 3: Bem

*Function 1:* Water flowers

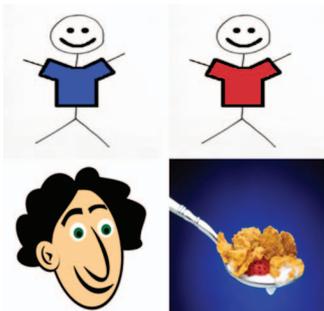
*Function 2:* Make tea



(Appendix continues)

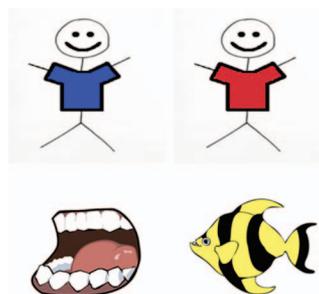
**Trial 4: Fep**

*Function 1:* Protect their head  
*Function 2:* Eat cereal out of



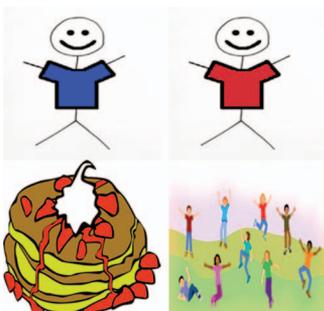
**Trial 7: Grak**

*Function 1:* Clean between their teeth  
*Function 2:* Catch fish



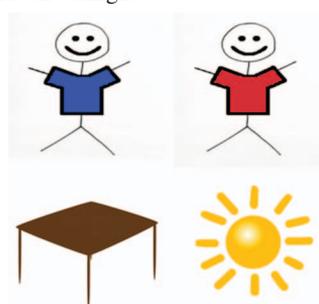
**Trial 5: Rin**

*Function 1:* Eat dinner on  
*Function 2:* Play games outside



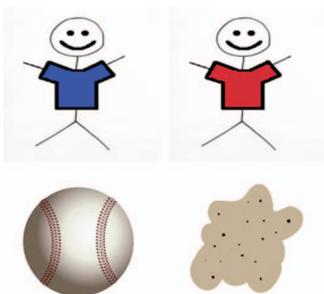
**Trial 8: Zav**

*Function 1:* Keep a table clean  
*Function 2:* Block sunlight



**Trial 6: Lif**

*Function 1:* Hit baseballs  
*Function 2:* Flatten dough



Received July 7, 2014  
 Revision received July 28, 2015  
 Accepted August 3, 2015 ■