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Brief article

A developmental dissociation between category and function judgments about novel artifacts

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ABSTRACT

Two studies investigated the relative importance of information about intended design and current use on judgments about the function (Experiment 1) or category (Experiment 2) of novel artifacts in preschool children and adults. Adults assigned function and name on the basis of information about design across all conditions, while children's decisions about function dissociated from decisions about category. Function judgments (in both 4 and 6-year-olds) were neutral between design and current use, both when the current use was idiosyncratic (e.g. performed by just one agent) and conventional (performed by many people; Experiment 1). By contrast, where category judgments were required for the very same objects (Experiment 2), children named according to design intentions – but only if the alternate function was idiosyncratic. Judging function and assigning category are thus cognitive tasks that draw on different information across development, a fact that should be captured by theories of developing artifact concept structure.

1. Introduction

Research on our mature capacity to represent and reason about artifact kinds has addressed formal aspects of artifact conceptual structure (Prasada, 2000), patterns of artifact categorization (Bloom, 1996; Malt & Sloman, 2007) and function judgment (German & Johnson, 2002; Kelemen, 1999), the brain mechanisms underlying tool use (Johnson-Frey, 2004) and dissociations resulting from brain injury (Mahon & Caramazza, 2007), as well as possible variation in artifact concepts across cultural context (Barrett, Laurence, & Margolis, 2008; German & Barrett, 2005).

Developmentally, the focus has been on what information is at the core of early artifact representations, and to what extent this information might change over development (e.g. Defeyter & German, 2003; German, Truxaw, & Defeyter, 2007; Kelemen & Carey, 2007). Infants' notions of object function are evidenced in understanding tool use and means-end relationships (Schlesinger & Langer, 1999; Willats, 1999) and in imitation of conventional object function (Abravanel & Gingold, 1985). Toddlers rapidly learn mappings between specific tools and specific functions (Casler & Kelemen, 2007), engage in effective simple tool use (Brown, 1990) and under some circumstances extend new words on the basis of shared function (even when surface similarity is different; Diesendruck, Markson, & Bloom, 2003; Kemler Nelson, Russell, Duke, & Jones, 2000; Truxaw, Krasnow, Woods, & German, 2006). Children's questions about novel artifacts focus on learning functions, and these questions persist in the face of answers that are implausible, given the mechanical structure of the object (Asher & Kemler Nelson, 2008).

One point of focal debate in this field concerns whether this early sensitivity to 'design' – the appreciation of a link between object mechanical structure and function – relies on or indicates an explicit insight into historical aspects of design; the idea that artifact functions stem from the intentions of an 'original designer', sometimes termed an

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explicit 'design stance'.[1] While some have argued that even young children privilege the design intentions over the goals of other social agents in reasoning about artifacts (e.g. Asher & Kemler Nelson, 2008; Diesendruck et al., 2003; Kelemen, 1999; Kelemen & Carey, 2007), others have suggested that explicit insight into design might be achieved somewhat later (i.e. after age 5; German & Johnson, 2002; Matan & Carey, 2001; Truxaw et al., 2006) – with earlier judgments about artifact function based on any observed goals, *provided mechanical information is neutral* (German et al., 2007).

An issue often obscured in this debate is the possible difference between *categorizing* artifacts (e.g. what is it?) versus determining the *function* of artifacts (e.g. what is it *for*?). German and Johnson (2002) showed that these judgments can dissociate; when presented with two plausible candidate functions for a novel artifact, its design (e.g. "what it was made for") and its current use (e.g. "what its owner uses it for"), 5-year-old children had no preference between the two. When provided with candidate *names* for the very same artifacts, children preferred the label provided by the designer.

Jaswal (2006) showed that understanding of a maker's naming rights extends to allowing children to infer *function* on the basis of a familiar category name. When provided with objects resembling one category, but which were named by their makers with a different name (e.g. a key like object was labelled as a spoon), children judged function on the basis of maker's name. In a control condition, where the conflicting name was supplied by someone who 'found' the object, naming followed appearance. Categorization based on design can thus license function judgments, even though function judgments themselves do not appear to be based on intended design.

In the current paper we clarify and extend the evidence for the developmental dissociation demonstrated in German and Johnson (2002). In Experiment 1, we replicate the function judgment results of German and Johnson (2002). Groups of adults and children (4- and 6-year-olds) were presented with novel objects and required to make judgments about their function (e.g. asked "what is it for?"). In Experiment 2 we address categorization – improving the German and Johnson (2002) method. While German and Johnson used arbitrary 'names' and the task asked about "what the entity was called", here we ask directly about category. Moreover, to preserve a close minimal pair design, we derived category names directly from the functions themselves, such that an entity "for catching fish" or "for carrying bottles" in the function task ("what is it for?" Experiment 1) might be either a "fish catcher" or "bottle carrier" in the categorization task (Experiment 2).

We ran conditions with current functions that were idiosyncratic to a single user and also where it was shared across users (e.g. "performed by everybody"), in order to address a recent claim that design information is ignored by younger children only if the current function is considered conventional (Siegal & Callanan, 2007).

2. Experiment 1

2.1. Subjects

Forty undergraduate students (mean age 23 years, range 18–25) participated for class credit, along with 80 children recruited from primary schools serving a variety of social backgrounds. Each group was randomly assigned to either the "conventional" or "idiosyncratic" function conditions. The 'conventional' condition comprised were 20 4-year-olds ($M = 4.6$, range 4.1–4.9), 20 6-year-olds ($M = 6.3$, range 5.6–6.9) and 20 adults. The 'idiosyncratic' condition comprised 20 4-year-olds ($M = 4.5$, range 4.2–4.9) and 20 6-year-olds ($M = 6.3$, range 5.9–6.8).[2]

2.2. Materials and procedure

A set of four objects was selected from a larger set of 30 line drawings of novel objects based on pre-testing where forty adult participants rated plausibility of each candidate functions for each object. In the set used, 85% or more of the participants rated the candidate functions as equally plausible.

In the conventional function condition subjects received four trials. Each trial involved a novel artifact described as designed by one person for one function and now used by everybody for a different function (e.g. "See this? Everyone *uses* this for carrying bottles and it is really good for this. Look, this is where you put the bottles so you can carry them. So what does everyone use it for? Jack *made* it for catching goldfish and it is really good for this too. Look, this is where the fish swim in so you can catch them. What did Jack make it for?"). Having responded to control questions correctly[3] subjects were asked to judge function in a forced choice question (e.g. "What is it really for? Is it for carrying bottles or catching fish?"). Line drawings illustrated each function as shown in Fig. 1.

The idiosyncratic function condition was identical in all respects save the fact that current use information was specific to one named agent (e.g. "Sally uses it for carrying bottles and it is really good for this too").

The specific functions assigned to design or current use, and the order in which candidate functions appeared (chronological or reversed) was counterbalanced across subjects.

Children were tested individually in their classroom. Each trial started with the presentation of the picture of the artifact, followed by the function information accompanied by the relevant pictures. All pictures remained in view at the time of the test question. Adult participants were tested individually in a lab cubicle.

[1] The term is borrowed from Dennett (1987), though as Barrett et al. (2008) note, Dennett's characterization is in fact neutral with respect to whether any explicit understanding of the intentions of a historical designer is required.

[2] We chose 4- and 6-year-olds following Matan and Carey (2001) who showed a developmental change in categorization between age 4 and 6.

[3] In the event of errors, children were recycled through the story and asked again. No child required more then one correction.

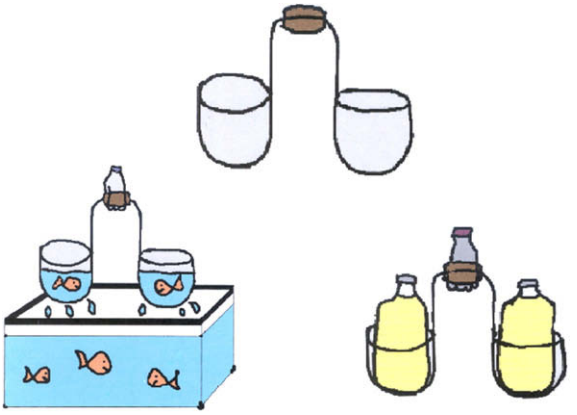

Fig. 1. Example of novel object and function pictures used in Experiments 1 and 2. Additional pictures of the individual designer, the idiosyncratic current user and a group of current users were used in preschool studies, but are not shown here.

2.3. Results and discussion

Subjects received a score of 1 for each design-based judgement. There were no effects of specific function assignment or order (chronological versus reversed). Mean scores in each condition in each age group appear in Table 1.

These results were submitted to a 2 (condition, 'idiosyncratic' versus 'conventional') by 3 (age group, 4-year-olds versus 6-year-olds versus adults) analysis of variance (ANOVA) revealing a main effect of age group ($F_{2,120} = 11.71$, $p < .0001$, $\eta^2 = .17$). The main effect of condition and the interaction were not significant ($Fs < 1$, *N.S.*). Analysis of each condition against chance (chance = 2.0 from 4.0) indicated that while adults in both conditions assigned functions on the basis of information about design, children were at chance.

While adults judge function on the basis of design in both conventional and idiosyncratic function conditions, young children select the design and current functions equally often. The finding that even when the alternate function is described as shared by "everybody", adults remain inclined to select the design function conflicts with that reported by Siegal and Callanan (2007).

The results across the children replicate the findings of German and Johnson (2002); children were equally likely to select functions on the basis of design or current (idiosyncratic) use, whether that alternate use is a shared or an idiosyncratic use generated by an individual agent. There was no difference between the 4-year-old group and the 6-year-old group, unlike Matan and Carey (2001).

In Experiment 2, we assess categorization. If children's *category* judgments are based on information about design, as claimed by German and Johnson (2002), and children can infer categories from functions, just as they infer functions from categories (Jaswal, 2006), then children will categorize these objects by design, and ignore current use, at least in the case of idiosyncratic current use.

For the case of conventional current use, as German and Johnson (2002) point out, categorization and function judgment differ in that where a specific category label assigned to a given kind is arbitrary (e.g. there is nothing about the structural and mechanical properties of, say, a chair, that demand it be *called a chair*), the function of an artifact *is* constrained by the structural and mechanical properties of the object (see also German et al. (2007)). The fact that there is no "structure-label constraint" predicts that category labels may be more a matter of shared convention than are artifact functions, and this might be reflected in shared use across many people being weighed more heavily in categorization than in function judgment.

3. Experiment 2

3.1. Subjects

Forty undergraduate students (mean age 22 years, range 18–23) participated for course credit, and were pseudo-randomly assigned to either the idiosyncratic or conventional condition. Eighty children recruited from primary schools serving a variety of social backgrounds were assigned to either the conventional condition (20 4-year-olds, $M = 4.5$, range 4.0–4.8; 20 6-year-olds, $M = 6.2$, range 5.8–6.8), or the idiosyncratic condition (20 4-year-olds, $M = 4.5$, range 4.1–4.9 and 20 6-year-olds, $M = 6.2$, range 5.10–6.5). There were approximately equal numbers of males and females in each cell.

3.2. Materials and procedure

The materials and procedure were exactly the same as those used in Experiment 1, except that the test question was changed to be a question about the object's category. Thus, instead of being asked whether the object was *for* carrying bottles or catching fish, subjects were asked what

Table 1
Mean number of design-based judgements (from 4, *SD*s in paretheses) for each age group in conventional and idiosyncratic conditions when judging function (Experiment 1) or categorizing (Experiment 2) novel artifacts.

	Experiment 1: Function assignment		Experiment 2: Categorization	
	Conventional	Idiosyncratic	Conventional	Idiosyncratic
Four-year-olds	1.85 (1.49)	2.05 (1.39)	2.30 (1.17)	**3.10** (**1.12**)[b]
Six-year-olds	1.70 (1.53)	2.05 (1.32)	1.40 (1.35)	**2.85** (**1.50**)[a]
Adults	**3.25** (**1.16**)[b]	**3.05** (**0.95**)[b]	**3.00** (**1.30**)[b]	**3.10** (**1.12**)[b]

Note: Scores different from chance appear in bold (*t*-tests against chance assessed as a score of 2.0).
[a] $t_{(19)} > 2.80$, $p < .05$.
[b] $ts_{(19)} > 3.40$, $ps < .001$.

it's name was (e.g. "What is it really? Is it a bottle carrier or a fish catcher?").

3.3. Results and discussion

Subjects received a score of 1 for each design-based judgement. There were no effects of specific function assignment or order (chronological versus reversed). Mean scores in each condition in each age group appear alongside those from Experiment 1 in Table 1.

These results were submitted to a 2 (condition, 'idiosyncratic' versus 'conventional' function) by 3 (age group, '4-year-olds' versus 6-year-olds versus 'adults') analysis of variance which revealed main effects of condition ($F_{1,120} = 13.22$, $p < .0001$, $\eta^2 = .10$) and age group ($F_{2,120} = 6.35$, $p < .005$, $\eta^2 = .10$). The interaction fell short of significance ($F_{1,120} = 2.58$, $p = .08$, $\eta^2 = .04$).

Analysis of each condition against chance (with chance defined as a score of 2.0 from 4.0, see Table 1) indicated that while adults, as in Experiment 1, selected the category based on the design function information, in both idiosyncratic and conventional conditions, children's category judgments depended on condition. In the idiosyncratic condition, children selected the category of the object based on the intended use designated by the designer of the object, suggesting that they made the inference from designer's intention to category. Note that this same inference was not made when the task was to select the function of the object (Experiment 1). Again, there were no differences between 4- and 6-year-olds (*contra* Matan & Carey, 2001).

In the conventional function condition children's judgements were split between the two candidate functions, just as they were for function judgments in both conditions of Experiment 1, suggesting that information that many people use the same name for an object disrupts a tendency to rely on a designer's right to assign an object category.

4. General discussion

Explicit information about the intentions of a designer influences adult judgments of both function (i.e. "what is it for?") and category (i.e. "what is it?"), both where the current alternative use is idiosyncratic and where it is 'conventional' (*contra* Siegal & Callanan, 2007).

Developmentally, the results point to a dramatic dissociation between function judgment and categorization. This dissociation goes beyond that reported in German and Johnson (2002) in that it shows that even when *based on the same information*, judgments of category behave differently than judgments of function. Judgments of function are influenced by the goals of *any* agents – i.e. the designer is not privileged – provided that mechanical information is neutral, and this is irrespective of whether current functions are 'idiosyncratic' or 'conventional'. By contrast, judgments of *category* privilege designer's intentions over an alternative category assigned by a single idiosyncratic user, suggesting that children can infer category from intended design information, just as they can infer function information from the designer's intended category (Jaswal, 2006). However, this design → category inference is disrupted by information that the current alternative use is shared by many people rather than being idiosyncratic, suggesting 'conventions' may be more important for categorization than for function judgment (e.g. German & Johnson, 2002; German et al., 2007).

Birch, Vauthier, and Bloom (2008) recently showed further evidence consistent with the idea that aspects of function assignment and categorization might dissociate; while young children use the principle of mutual exclusivity in thinking about novel words for artifacts (e.g. if a novel word refers to one artifact, it does not apply to another too), they do not appear to extend this principle to newly learned functions.

Recognizing the distinction between function judgment and categorization will be critical in making sense of recent controversy about young children's intuitions in the domain of artifact knowledge. Many scholars appear to consider it settled that children as young as 2- and 3-years of age adopt a 'design stance' – in the strong sense we identified earlier in which *design intentions are privileged over other intentions*. Asher and Kemler Nelson, for example, argue that a recent data set is "most parsimoniously explained by attributing the design stance to children at an age earlier than has been commonly suggested" (2008, p. 481). These authors conducted a study where children's questions about the functions of novel artifacts are met by either plausible functions (given the structure) or implausible ones (which while "possible" and "demonstrated", explain few of the object's features). Faced with implausible answers, children continued to ask questions about function.

While this evidence shows children are aware of causal links between structure and function, the evidence does not show that such causal knowledge stems from any explicit consideration of the designer's intentions. Asher and Kemler Nelson acknowledge this, but remain committed to a stronger interpretation based on evidence for children's categorization based on broken objects (Kemler Nelson, Herron, & Morris, 2002), categorization in label extension tasks (Diesendruck et al., 2003; Gelman & Bloom, 2000), and their function judgment based on category (Jaswal, 2006). On closer inspection, however, evidence for children privileging design over other intentions in these cases is weak, even where categorization is used.

First, the capacity to distinguish broken objects from intentionally dysfunctional objects is restricted, for the youngest children, to judgments of *familiar* categories with which children may have experience (Kemler Nelson et al., 2002, Experiment 4). Where novel objects and functions were used, results suggest a later distinction between broken and intentionally dysfunctional objects (*ibid*, Experiments 1–3).

In the other cases, design information ("made for") was not pitted against another agents' goal, and thus the studies do not speak to the privileging of design over other goals. For example, Gelman and Bloom (2000) compared categorization for "intended" artifact creation against "accidental" creation and Jaswal (2006) compared "made for" information against "found by" information. While

Diesendruck et al. (2003) do compare "made for" information against information that the object "could do" the relevant function, their study was confounded because additional information about the function match and shape mismatch of extension items was provided *in the made for condition only*. When that additional support is added to the 'can do' and 'used for' conditions as well, children treat them equivalently (see Truxaw et al. (2006)).

All the above notwithstanding, the current evidence suggests that explicit intuitions about intentional design may initially solidify in categorization contexts, where children's documented tendency toward essentialism and theory construction may drive them toward seeking information about an object's origins (Kelemen & Carey, 2007). Nonetheless, the current results show that design-privileged *categorization*, even where reliably shown, may not entail design-privileged *function judgment*.

The recognition that elements of a constructed design stance might dissociate across contexts, and across task, rather than apply at all times to all kinds of task, will be an important consideration in continued research on these questions, and may shed light on why inconsistent results appear to be a common occurrence in this domain (see, e.g. Barrett et al., 2008; Malt & Sloman, 2007; Siegal & Callanan, 2007). Continued research efforts will gradually elucidate how each element that contributes to our unfolding understanding of design is engaged (either alone or in combination) in varied contexts and tasks where artifact concepts are deployed (see, e.g. Barrett et al., 2008; Defeyter, Avons, & German, 2007; German & Barrett, 2005).

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