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Why are *dunkels* sticky? Preschoolers infer functionality and intentional creation for artifact properties learned from generic language

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ABSTRACT

Artifacts pose a potential learning problem for children because the mapping between their features and their functions is often not transparent. In solving this problem, children are likely to rely on a number of information sources (e.g., others' actions, affordances). We argue that children's sensitivity to nuances in the language used to describe artifacts is an important, but so far unacknowledged, piece of this puzzle. Specifically, we hypothesize that children are sensitive to whether an unfamiliar artifact's features are highlighted using generic (e.g., "Dunkels are sticky") or non-generic (e.g., "This dunkel is sticky") language. Across two studies, older—but not younger—preschoolers who heard such features introduced via generic statements inferred that they are a functional part of the artifact's design more often than children who heard the same features introduced via non-generic statements. The ability to pick up on this linguistic cue may expand considerably the amount of conceptual information about artifacts that children derive from conversations with adults.

1. Introduction

Over the first few years of life, children encounter a great diversity of artifacts, from bottles and blankets to computers and game consoles to highways and bridges (Bloom, 2004; Margolis & Laurence, 2007; Norman, 2002). Even setting aside their sheer variety, artifacts are likely to pose a complex learning problem. Although they are each created for a specific purpose, often that purpose bears only a loose relationship to their external appearance (German, Truxaw, & Defeyter, 2007; Keil, Greif, & Kerner, 2007; Petrosky, 1994; cf. Gibson, 1986). Thus, when examining an unfamiliar artifact, it is often hard to tell (a) which features are functional and which are not, and (b) which features are part of its intentional design and which are the unintended result of sustained use, accidents, etc. These ambiguities arise even in the case of relatively simple artifacts such as keys, paperclips, or erasers, whose perceptual features do not provide many useful clues to a naive user. For example, the irregular teeth on the shaft of a key might look like the result of some accident, but in fact they are intentionally created and essential to its function.

It is likely that children rely on a number of information sources to solve this learning problem. First, children learn about artifacts by observing and imitating others' actions on them (e.g., Carpenter, Call, & Tomasello, 2005; Gergely, Bekkering, & Király, 2002; Meltzoff, 1988; Williamson & Markman, 2006), perhaps especially when these actions are tailored to children's limited processing abilities (e.g., Brand, Baldwin, & Ashburn, 2002) and accompanied by ostensive signals such as direct eye contact (e.g., Csibra & Gergely, 2009). For example, a parent might call a toddler's name before slowly and deliberately demonstrating how to use an eraser on some pencil marks, thereby providing evi-

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dence about what this artifact is for. Second, adults might also describe artifact functions during the course of their conversations with children (e.g., Callanan, 1990; Callanan, Siegel, & Luce, 2007; Gelman, Coley, Rosengren, Hartman, & Pappas, 1998). For example, a parent might say, while pointing to a truck, that it "keeps cement in there, and it rolls to keep mixing it when it's wet" (Gelman et al., 1998, p. 93). Third, some artifact features do have detectable affordances, in that their physical configuration suggests certain possibilities for action (Adolph, Eppler, & Gibson, 1993; Gibson, 1986). For example, thin, sharp edges might afford cutting (e.g., Needham & Baillargeon, 1997; Tzelnic, Kuhlmeier, & Hauser, 2008), hollow insides might afford containment (e.g., Hespos & Baillargeon, 2006), and rigid flat surfaces might afford crushing soft objects (e.g., DiYanni & Kelemen, 2008).

In this paper, we identify an important, and previously overlooked, source of information that children might also capitalize on when learning about artifacts. Our hypothesis is that children can infer whether an artifact's features are intentional and functional from some of the more subtle aspects of how others talk about them. Specifically, children may be attuned to whether an artifact feature is described using kind-referring generic language (e.g., "*Keys* have a jagged edge") vs. non-generic language (e.g., "*My key* has a jagged edge"). We hypothesize children are more likely to infer that a feature is *functional* (Experiment 1) and *intentional* (Experiment 2) if it is described as applying to an entire kind—even though the speaker makes no overt reference to functions or intentional creation.

This hypothesis is motivated by recent research suggesting that children construe the information they learn through generic language as "essential" or conceptually central (Cimpian & Markman, 2009, in press; Gelman, Raman, & Gentner, 2009; Hollander, Gelman, & Raman, 2009). For example, 4- and 5-year-olds who were told that *snakes* have holes in their teeth construed this novel feature as an enabler of other important biological processes (e.g., it helps them chew better), whereas children who were told that *a particular snake* has holes in its teeth were more likely to construe this feature in terms of prior mechanistic processes (e.g., he bit on something pointy; Cimpian & Markman, 2009). In the artifact domain, generics' essentialist implications might lead to the inference that the features talked about are related to the artifact's intended function, which—at least on some accounts—is its essence (e.g., Bloom, 1996, 2004; German & Johnson, 2002; Kelemen, 1999; Kelemen & Carey, 2007; Matan & Carey, 2001; cf. Siegel & Callanan, 2007). For example, a child who hears that *keys* have a jagged edge might infer that this feature was intentionally created to serve a function and is not merely the byproduct of a process such as wear-and-tear.

Given its emphasis on learning from others, the spirit of our proposal is broadly compatible with sociocultural accounts of artifact cognition, according to which children learn about the uses of artifacts by observing and interacting with more knowledgeable members of their community (e.g., Callanan et al., 2007; Rogoff, 1990; Siegel & Callanan, 2007; Tomasello, 1999). Also consistent with our hypothesis are recent arguments to the effect that subtle cues in adult-child conversations can be as valuable as explicit teaching because children often make inferences that go beyond what they hear rather than passively assimilating adult input in its exact form (Callanan, 2006; Gelman, 2009; Harris & Koenig, 2006; Keil, 1998; see also Cimpian, Arce, Markman, & Dweck, 2007; Kamins & Dweck, 1999).

Our strategy was simple: In both studies, we presented preschool-age children with unfamiliar artifacts and highlighted one of their features using either generic (e.g., "*Dunkels* are sticky") or non-generic (e.g., "*This dunkel* is sticky") language. In Experiment 1, we asked children to explain these properties and predicted that they would generate more functional explanations in the generic condition. In Experiment 2, we asked children whether the artifacts were "made like that" (i.e., with that feature) or whether "something happened"; here, we predicted that children would say the feature was created intentionally more often in the generic condition.

2. Experiment 1

2.1. Method

2.1.1. Participants

Forty-eight 4- and 5-year-old children participated (24 girls; mean age = 4;10; range = 4;0–5;8). An additional six children were tested but excluded because they did not complete the task. The children, all of whom were recruited in a small Midwestern city, were predominantly European American and came from a range of socioeconomic backgrounds.

2.1.2. Materials, design, and procedure

Children were randomly assigned to either the *generic* or the *non-generic* condition. These conditions differed only in the wording of the properties provided on each trial. The properties (e.g., being sticky) were chosen to be potentially—but not obviously—functional, and the artifacts were chosen to be unfamiliar to young children (see Fig. 1 for full list). On each of six trials, the experimenter first showed children a picture of an artifact and labeled it for them (e.g., "Okay, so now I want to show you this thing called a *dunkel*"). Children were then provided with the relevant property (e.g., "And here's something interesting about dunkels/this dunkel. Dunkels are/This dunkel is sticky"), which was repeated once (e.g., "They are/It is sticky"). Finally, children were asked to explain this property (e.g., "Why do you think that is? Why are dunkels/is this dunkel sticky?"). The order of the six items was counterbalanced across children. The testing sessions were conducted either in the lab or in a quiet room at a school and were videotaped for later transcription.

2.1.3. Coding

Children's explanations were coded for whether they made mention of a function (see Table 1 for examples). The coding was blind to the wording condition the responses came from. A second researcher coded 38 of the 48 transcripts to assess reliability. Agreement was 92.1%