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Learning language from within: Children use semantic generalizations to infer word meanings

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ABSTRACT

One reason that word learning presents a challenge for children is because pairings between word forms and meanings are arbitrary conventions that children must learn via observation – e.g., the fact that "shovel" labels shovels. The present studies explore cases in which children might bypass observational learning and spontaneously infer new word meanings: By exploiting the fact that many words are flexible and systematically encode multiple, related meanings. For example, words like *shovel* and *hammer* are nouns for instruments, and verbs for activities involving those instruments. The present studies explored whether 3- to 5-year-old children possess semantic generalizations about lexical flexibility, and can use these generalizations to infer new word meanings: Upon learning that *dax* labels an activity involving an instrument, do children spontaneously infer that *dax* can also label the instrument itself? Across four studies, we show that at least by age four, children spontaneously generalize instrument-activity flexibility to new words. Together, our findings point to a powerful way in which children may build their vocabulary, by leveraging the fact that words are linked to multiple meanings in systematic ways.

1. Introduction

One reason that word learning presents a challenge for children is that the relation between a word form and its meaning is arbitrary (Saussure, 1916/2011). There is no principled reason, for example, that English speakers use the word "shovel" to label shovels, as opposed to hammers or combs: This is merely one among many conventions that children must learn, either through direct, ostensive evidence or indirectly through overhearing (Akhtar, 2005). Here, we explore whether, in some cases, children might bypass observation to *learn from within*, by spontaneously inferring new word meanings. In particular, we ask whether children can exploit lexical flexibility: The systematic use of words to encode multiple, related meanings (Barner & Bale, 2002; Copestake & Briscoe, 1995; Pustejovsky, 1995). For example, many of the same English root morphemes can be used to label instruments, as nouns, and activities involving those instruments, as verbs (e.g., *shovel*, *hammer*, *mix/mixer*, *wash/washer*; Adams, 1973; Clark & Clark, 1979; Jespersen, 1942; Marchand, 1969; see Table 1 for other examples of lexical flexibility). The present studies explore young children's use of semantic generalizations about lexical flexibility to bypass observational learning: Upon learning one meaning of a new word via observation (e.g., that *dax* labels an activity), can children spontaneously infer another possible meaning of the word that follows a generalization (e.g., that *dax* can label the instrument itself)?

Lexical flexibility characterizes most words of moderate to high frequency (Nerlich, Todd, Herman, & Clarke, 2003), and is widespread in English (Chomsky, 2001; Copestake & Briscoe, 1995; Lakoff, 1987; Nunberg, 1979; Ostler & Atkins, 1992; Pustejovsky, 1995, 1998) and in other languages (Kamei & Wakao, 1992; Peters & Peters, 2000; Srinivasan & Rabagliati, 2015; Youn et al., 2016). Flexible uses of words can take many different forms, including metaphor (the use of a word from one semantic domain to describe another; e.g., "Christmas is *approaching*"), metonymy (using a word to label an item or something associated with that item; e.g., the *White House* made an announcement), and morphological conversion (extending a word to another grammatical category; e.g., "She *shoveled* the snow"; Table 1). Although these various kinds of flexibility can be distinguished (see, e.g., Cruse,

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Table 1
Patterns of lexical flexibility in English.

Patterns and participating words	Examples
Instrument for Activity (*shovel*, *hammer*, *wash*/*washer*, etc.)	She has a *shovel* / She *shoveled* the snow
Agent for Activity (*nurse*, *boss*, *bake*/*baker*, *sing*/*singer*, etc.)	She is the new *boss* / She *bossed* her employees around
Substance for Transfer to Goal (*water*, *paint*, *salt*, etc.)	There *water* is warm / He *watered* the plants
Animal for Meat (*chicken*, *lamb*, *turkey*, etc.)	The *chicken* is well-fed / The *chicken* is well-salted
Object for Representational Content (*book*, *magazine*, *newspaper*)	She spilled coffee on the *book* / She thinks it is an interesting *book*
Space for Time (*long*, *on*, *around*)	The table is *long* / The movie is *long*
Body Part for Object Part (*leg*, *arm*, *back*, etc.)	He broke his *leg* / That chair has a wooden *leg*
Material for Artifact (*glass*, *tin*, *iron*, etc.)	There is broken *glass* on the floor / He drank water from the *glass*
Object for Aperture (*door*, *window*, *goal*, etc.)	They installed a new *door* / The man walked through the *door*
Place for Institution (*White House*, *Wall Street*, *City Hall*, etc.)	The *White House* has been renovated / The *White House* announced a new policy

1986; Klepousniotou, Titone, & Romero, 2008), they are similar in that they often yield systematic patterns in which a word's meanings are related in predictable and generalizable ways (a phenomenon known as "regular polysemy"; Apresjan, 1974; Table 1). Multiple words in English, for example, can be used to label instruments and their associated activities (e.g., *hammer*, *shovel*), and this pattern can be generalized to new words (e.g., Will you *Segway* to the park? Can you *FaceTime* us once you get there?).[1]

Critically, the fact that words often have multiple meanings, and that these meanings are often related in regular, predictable ways, suggests that children may not need to learn all pairings between word forms and meanings one-by-one, through observation. Instead, if children understand the semantic relations through which words can alternate between meanings, they could spontaneously infer new form-meaning pairings in many cases. Imagine, for example, a child who has not learned that rakes are called "rakes" but has observed an activity involving a rake labeled as "raking". Rather than awaiting additional observational evidence for what rakes are called, the child could make a spontaneous inference. Guided by an understanding that words can label instruments or their associated activities, the child could infer that the rake can be labeled using the same root morpheme that describes its functional use: i.e., it could be called a "rake" (similar to cases like *hammer* and *shovel*, where the noun and verb meanings have identical word-forms), or perhaps a "raker" (similar to cases like *mix*/*mixer* and *chop*/*chopper*, where the noun forms require the additional suffix *-er*). This inference could accelerate word learning, by allowing children to anticipate many conventional form-meaning pairings that conform to the "instrument and associated activity" pattern. Inferences related to other regular patterns of lexical flexibility could have similar facilitative effects: e.g., children could anticipate that words for animals will also label their meats (e.g., *chicken*, *lamb*, *fish*, etc.), that words for physical media will also label their informational content (e.g., *book*, *newspaper*, *magazine*, etc.), and so on (Table 1).[2,3]

The present study explores whether children can infer new form-meaning pairings by exploiting lexical flexibility, and thus by learning language from within. To do so, children need to understand two properties of the language they are learning: (1) The semantic relations that license regular lexical flexibility in their language (e.g., between instruments and activities, animals and meat, etc.), and (2) The word-formation devices through which lexical flexibility is expressed in their language, i.e., the ways in which the word-form must be transformed, if at all, as it expresses different meanings (e.g., through affixation). But how might children's understanding of these two properties of language develop? It is clear that children have to learn the word-formation devices that express lexical flexibility in their language, given that these devices are differentially employed across languages. For example, in English, new word meanings are often expressed via zero-derivation – i.e., without any changes to existing word-forms – as in the case of nouns derived from verbs (three *jumps*; two *swings*, etc.) and verbs derived from nouns (*shovel* the snow; *button* the shirt, etc.). English also often makes use of suffixes to form new nouns from verbs (He used a *mixer*; She is a *teacher*, etc.). By contrast, zero-derivation is less common in Semitic languages like Hebrew. In Hebrew, noun and verb forms are often related by a common 3- or 4-consonant root, and differ with respect to the vowels that populate the root. For example, the verb *grow* in Hebrew, *gadal*, can be nominalized as *gdila* (Berman, 1999; Ravid & Avidor, 1998).

The above discussion suggests that children have to learn which word-formation options are available and productive to express lexical flexibility in their language. But how does children's understanding of the *semantic relations* that license lexical flexibility develop, e.g., their understanding that the same root can be used to denote an instrument and its associated activity? One possibility is that, just as word-formation devices vary from language to language, the semantic relations that license lexical flexibility also differ, and thus need to be learned by children. If true, this would constitute a substantial learning challenge for children, since there is in principle an unbounded number of possible semantic relations between word meanings, most of which will not provide a basis for lexical flexibility in a particular language. For example, although English permits many animal words to label their derived meat (*chicken*, *lamb*) and fur (*mink*, *chinchilla*), it does not permit these words to label other animal products (e.g., eggs, milk, etc.) or other items associated with animals (e.g., barn, hay, etc.). In face of such limits, and in absence of prior constraints on their hypotheses, learners might require a great deal of exposure to flexible words in the input to learn which semantic relations license flexibility in their language, and might thus only gradually construct semantic generalizations about flexibility.

The account described above – in which children have to learn which semantic relations license lexical flexibility in their language from the linguistic input – would predict that semantic generalizations regarding flexibility should be gradually abstracted from concrete exemplars. A related account of how children form linguistic generalizations can be found in usage-based theories of how children learn abstract syntax-semantics mappings: By these theories,

[1] Of course, there are exceptions to these regular patterns: e.g., *broom* does not label an action involving brooms. Exceptions to patterns can be thought of as "irregular" words that block a regular pattern (see e.g., Pinker, 1991, for a similar argument in the domain of morphology). Flexible patterns can be blocked by synonymy (e.g., *to broom* is blocked by *to sweep*), and by homophony (e.g., we can *summer* or *winter* in Paris, but we cannot *spring* or *fall* there because those words have other meanings; see, e.g., Barner & Bale, 2002, 2005; Clark, 1987, 1993; Clark & Clark, 1979). The presence of exceptions does not preclude the need for explaining "regular" words, or the fact that regular patterns can be generalized to new words.

[2] This account would predict that, in some cases, children will over-generalize flexible patterns, e.g., such that *broom* is used to denote sweeping and *cutter* used to denote a knife. As we review below, such overgeneralizations have been documented both in production and comprehension.

[3] Some flexible words (referred to as "irregular polysemy"; Apresjan, 1974) do not appear to participate in predictable, generalizable patterns. For example, the word *arms* can label a body part or weapons, and *board* can label a physical object or administrative organization. Insofar as these words do not appear to fall into larger patterns, children would not be able to use semantic generalizations to acquire them.