To appear in *Core Knowledge and Conceptual Change*, Oxford University Press. This file is a pre-print and may contain errors or omissions not present in the final published version.

Concepts as Explanatory Structures: Evidence from Word Learning and the Development of
Lexical Flexibility

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Abstract

By some theories, children are guided by explanatory frameworks, which motivate them to understand why objects have the properties they do. In this chapter, I describe how language development can inform such theories, by reviewing previous work on how children extend new words, and more recent work on how children learn to use words *flexibly*, with multiple, related meanings (e.g., shattered/drinking *glass*; thirsty/tasty *chicken*). Interestingly, some scholars have proposed that the different meanings of flexible words reflect different modes of explanation, raising the possibility that children's understanding of flexible words will lend insight into the role of explanatory structures in conceptual development. To this end, this chapter presents a background on lexical flexibility, and brings together recent evidence on how it is acquired, represented, and instantiated across languages. Together, these recent developments provide new support for the idea that explanatory frameworks shape how children conceptualize the world.

Keywords: *Theory theory, Word Learning, Lexical Flexibility, Polysemy*

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One central difference among theories of conceptual development is their emphasis on our ability to explain and make sense of the world (Murphy & Medin, 1985; for a review of theories of concepts, see Laurence & Margolis, 1999; Murphy, 2002). For example, according to most empiricist and constructivist theories – like the classical and prototype theory of concepts (e.g., Carnap, 1932; Katz, 1972; Locke, 1690; Rosch & Mervis, 1975; Smith & Medin, 1981) – conceptual development consists primarily of learning what has to be true of something for it to be categorized as a member of a particular type, with less emphasis on learning *why* it has the properties it does. Thus, by tabulating how perceived features in the world co-occur, children create representations that capture regularities and support categorization – e.g., such that objects with four legs and flat surfaces are *tables*, and such that furry quadrupeds that bark are *dogs*. Only later in life do children understand why regularities exist, and pick up on the abstract causal structure of these concepts (e.g., Quine, 1977; Sloutsky, Kloos & Fisher, 2007). In contrast, according to the theory theory of concepts (Carey, 1985, 2009; Gelman & Wellman, 1991; Gopnik & Meltzoff, 1997; Keil, 1989; Murphy & Medin, 1985), children do not track regularities blindly, but instead seek explanations for why those regularities exist from early in life. Thus, guided by explanatory theories of what artifacts and natural kinds are, even young children may invoke a table's intended function to understand its physical structure and material, and a dog's internal essence to understand its appearance and behavior.

In this chapter, I consider what children's word learning can tell us about their conceptual development, and in particular, the degree to which explanatory theories structure children's early concepts. Previous studies have primarily explored this issue by testing whether young

children extend new words based exclusively on perceptual features like shape – as predicted by empiricist theories – or can instead use more abstract conceptual factors like intended function or essence as cues to kind membership – as predicted by the theory theory (see, e.g., Bloom, 2000; Booth & Waxman, 2002; Booth, Waxman & Huang, 2005; Diesendruck, Markson & Bloom, 2003; Gelman & Bloom, 2000; Gelman & Wellman, 1991; Gentner, 1978; Keil, 1989, 1994; Kemler Nelson, 1995; Kemler Nelson et al., 2000; Landau, Smith & Jones, 1988; Smith, Jones & Landau, 1996; Smith et al., 2002; Tomikawa & Dodd, 1980).

In what follows, I will review this previous work, after first setting out some philosophical considerations that motivate the theory theory and that differentiate it from other theories of conceptual development. Then, I will discuss recent evidence for another aspect of word learning that could lend insight into the role of explanatory theories in conceptual development: how children learn to use words flexibly, with multiple distinct but related meanings. By some accounts, flexible uses of words – e.g., the use of words to label animals and meat (e.g., tasty/thirsty *chicken*), or materials and artifacts (e.g., shattered/drinking *glass*) – require adopting different explanatory stances toward an entity (e.g., Keil, 1994; Moravcsik, 1975, 1981, 1990; Pustejovsky, 1995, 1998; Prasada, 2000). This raises the possibility that understanding how flexible words are acquired will also lend insight into the role of explanatory theories in conceptual development.

Section 1. Concepts as Explanatory Structures: Theoretical Motivations

When we look out at the world, we see tokens of different conceptual types – e.g., tokens drawn from the categories of *birds*, *trees*, *roads*, *cars*, etc. Critically, we also conceive of these categories as coherent, and not as arbitrary collections of things. Thus, we do not believe it is an accident that different tokens of birds are grouped together, or that the sets of properties that we

associate with birds co-occur in the ways they do – e.g., that birds have wings, fly, lay eggs, build nests, etc. This intuition – that our concepts are non-arbitrary and coherent – is difficult to explain for empiricist and constructivist theories of conceptual development. On these theories, children can construct concepts from any set of inter-correlated properties, regardless of how *ad-hoc* the groupings of properties are; expectations of coherence do not constrain the concepts that we construct.

By contrast, according to the theory theory, our concepts do not simply represent sets of co-instantiated properties, but are also structured by explanatory relations we perceive between different properties, and are thus coherent by virtue of these relations (Keil, 1994; Murphy & Medin, 1985). Thus, when we think of birds, we do not simply think of entities that have wings, fly, lay eggs, and build nests. Rather, we draw explanatory connections between these properties: e.g., birds may have wings because they are needed for flight, they may lay eggs in order to reproduce, and these and other bird properties may be caused by an internal, hidden bird “essence” (Keil, 1989, 1994; Gelman & Wellman, 1991).

This expectation that concepts should be coherent, and have explanatory structure – which is predicted under the theory theory – could have important consequences for conceptual development. By empiricist and constructivist theories, children may initially play a relatively passive role in concept acquisition: as they are exposed to tokens of a category, children tabulate co-occurrences of features, and gradually form summary representations that abstract across tokens. In contrast, according to the theory theory, children’s desire to explain why things are the way they are leads them to adopt a more reflective and active role in conceptual development from the start. It leads them, for instance, to ask adults for explanations of why things are the way they are (e.g., Callanan & Oakes, 1992; Kemler Nelson, Chan & Holt, 2004), to generate

and test possible explanations by exploring and intervening upon the world (e.g., Gopnik & Meltzoff, 1997; Schultz, Gopnik & Glymour, 2007), and even to revise their theories when confronted with explanatory gaps (e.g., Carey, 1985, 2009).

What kinds of explanations might children seek? Theory theorists have argued that there are multiple distinct kinds of explanations that we use to understand the world (e.g., Dennett, 1987); these different explanations have been referred to in the literature variously as *explanatory stances*, *modes of explanation*, or *modes of construal*. For example, an answer to why an entity has the properties it does could appeal to how those properties are caused by the deeper essence of the kind: e.g., birds may fly because of an internal, unobservable essence (referred to as the *physical stance* or *causal mode of explanation*). An entity's properties can also be explained in terms of the functions those properties afford: e.g., chairs may have four legs, flat surfaces, and be made of solid materials because they are meant to be sat upon (referred to as the *teleological* or *design stance*). Further, such properties can also be explained by appealing to intentional mental states: e.g., birds lay eggs because they want to reproduce (referred to as the *intentional stance*). Finally, an entity's properties can also be explained in a non-mechanistic way, by understanding an entity to have its properties simply because of the kind of thing it is: e.g., dogs have four legs because they are dogs (referred to as the *formal stance*; see Prasada & Dillingham, 2006, 2009; Prasada, this volume). The relevance and utility of these different explanatory stances can depend on the nature of the entity being explained: e.g., while formal explanations can be applied across content domains, causal explanations are more sensible for natural kinds, teleological explanations are more sensible for artifacts, and intentional explanations are more sensible for intentional beings (Keil, 1994; Prasada & Dillingham, 2006, 2009). The theory theory accounts for these differences by arguing that concepts are embedded

within overarching framework theories – e.g., theories of natural kinds, artifacts, etc. – which constrain how different explanatory stances are applied for different concepts.

The explanatory stances described above have a long intellectual history, rooted in Aristotelian metaphysics. Aristotle proposed that all good explanations for why things are the way they are appeal to one or more of four *aitia*, or explanatory causes: the material that constitutes the entity, the kind of thing it is, what is responsible for the entity’s existence, and its purpose or function (Moravcsik, 1974, 1981). These explanatory causes allow us to understand one aspect of an entity in terms of another. Thus, a table may have the material and structure it does to support its function, and it may have its function because it was designed by an agent. Recently, several scholars have built on Aristotle’s proposal, and have interpreted it as a psychological claim about how we understand and speak about the world (Moravcsik, 1974, 1981; Pustejovsky, 1995, 1998); as I will discuss in Section 3, flexible word use has been critical evidence for this claim.

An explanation-based system of reasoning could powerfully shape conceptual development, by constraining how we reason about the relations between a novel entity’s material, form, function, and how it comes into being. Prasada (2000), for instance, argues that using an explanation-based system based on Aristotelian *aitia*, we can make rich inferences from sparse data. For example, after observing a single exemplar of a bird nest, we can conclude that: 1) the bird nest has a specific, non-arbitrary form, 2) this form must have been created by an agent, likely a bird, and 3) the bird must have created the nest for a specific function, likely to hold eggs, because the nest’s material and structure would support this. Critically, because these inferences are arrived at logically, and do not make reference to specific properties of the nest being observed, they can be applied generically, to all bird nests. This could make sense of why

we can make generic statements like “Bird nests are built by birds” and “Bird nests are for holding eggs”, even when such generalizations can be subject to exception (Prasada, 2000).

To review, the theory predicts that children’s early concepts will not reduce to bundles of co-occurring perceptual features, but will instead have explanatory structure. Critically, this also predicts that children early use of words – e.g., how they extend a newly-learned word – will not depend on perceptual factors alone, but instead on theory-like intuitions of what kind of entity they think the word labels, and what properties define that entity. In the next section, I evaluate this prediction in the context of previous studies of children’s word learning.

Section 2. Explanatory Concepts and Word Learning

Word learning provides a window onto conceptual development because it centrally involves concept-related behaviors like reference and categorization: we use words to label entities that are within the extension of our concepts, taking into account grammatical properties of the words themselves (e.g., whether they appear in mass or count syntax). Thus, we can gain insight into children’s concepts (e.g., *dog*, *table*, etc.) by observing how they learn, use, and generalize words that correspond to those concepts (e.g., “dog”, “table”, etc.).

When applied to word learning, the theory predicts that even young children should extend words according to the abstract, explanatory factors that are argued to structure concepts. For example, children should not simply use words like *dog* and *table* to label things that look like dogs or tables, but rather should extend these words according to deeper, more causally-central properties, such as whether entities are likely to have the intended function of tables, or the essence of dogs. Relatedly, children’s word extensions should be sensitive to the kind of thing they think a word refers to: e.g., they should extend a word for a new object

differently if they construe the object as an artifact as opposed to as a natural kind, because intuitive framework theories of artifacts and natural kinds will privilege different properties of the object (Keil, 1994).

Interestingly, some studies of children's early word learning have provided evidence that appears to contradict these predictions of the theory theory. Specifically, when two- and three-year-olds are taught a novel count noun to label an object, they show a "shape bias": they prefer to extend the word to other objects that share the same shape (but that may differ in texture, color, or size), but not to other objects that differ in shape (but that may be similar in other ways; see Landau, Smith & Jones, 1988, 1998; Smith, Jones & Landau, 1996; Smith et al., 2002). Perhaps more strikingly, some of these studies also find that children continue to show a shape bias even when they could instead base their word extension on deeper, more causally-central conceptual factors. For example, some studies have found that children prefer to extend a novel word for an object that has a specific function to a similarly-shaped object that has a different function, compared to a differently-shaped object that has the same function (Gentner, 1978; Tomikawa & Dodd, 1980; Landau, Smith, & Jones, 1998; Smith, Jones & Landau, 1996).

On first glance, this finding – that children show a shape bias and fail to take into account conceptual factors like function when extending count nouns – would suggest that children have associated words that appear in count noun syntax with collections of items that share perceptual properties but that otherwise lack deep explanatory structure (Landau et al., 1998; Smith et al., 2002). However, another possibility is that children base their word extension on shape because shape is causally related to deeper, conceptual properties that structure children's concepts, such that shape can be used as a cue to kind membership (see e.g., Bloom, 2000). For example, an artifact's shape is often diagnostic of its intended function (e.g., balls are round so that they can

be rolled), and an animal's shape is often diagnostic of its behavior (e.g., bird wings enable flight) and underlying biological essence.

The idea that the shape bias stems from children's use of shape as a cue to deeper conceptual properties has been supported by several studies. First, even before mastering language, children appear to use shape as a cue to kind membership. For example, Graham and Diesendruck (2010) found that 15-month-olds use shape as a basis for generalizing non-obvious properties between novel objects, suggesting that they expect shape-matched objects to be members of a common kind. Thus, after being shown that a novel object made a rattling noise when shaken, infants were more likely to attempt shaking another novel object that matched in shape, as opposed to other novel objects that matched in color or texture. Second, the shape bias is attenuated in contexts where shape is unlikely to be a reliable cue to deeper conceptual properties. When given information that made sense of why two objects might share the same shape without being members of the same kind – i.e., that one object was a container for the other object – 3-year-olds were less likely to show a shape bias (Diesendruck, Markson & Bloom, 2003). Third, a number of studies have followed up on earlier studies that pitted shape against function, and have found that when objects have affordances to suggest that they have been designed to fulfill specific functions, children do not show a shape bias, but instead favor function when extending words (Kemler Nelson, 1995; Kemler Nelson et al., 2000).

Perhaps most relevant to the predictions of the theory theory, children's labeling behavior also shifts according to how they construe objects. For example, Keil (1994) found that manipulating the ontological status of a labeled object affects how children then extend that word. Thus, when an object is described as a kind of rock, children extend the novel word for that object to other objects of similar colors and textures (ignoring shape), but when the same

object is described as a frog, children instead show a shape bias. Other studies with younger children have confirmed that, by at least age two, children's higher-level construal of an object (e.g., as an artifact vs. animal) affects word extension, attesting to the influence of intuitive framework theories on children's early concepts (Booth & Waxman, 2002; Booth, Waxman & Huang, 2005).

The above discussion suggests that children's word meanings do not reduce to bundles of perceptual features, but instead have explanatory structure. In the spirit of this proposal, some studies have explored whether children's use of words in fact reveals a sophisticated ability to adopt systematically different explanatory stances toward entities in the world, as discussed in Section 1. For example, if children are able to adopt a *physical stance* toward natural kinds, they should use natural kind labels to pick out entities that putatively share the same biological essence. And if children are able to adopt a *design stance* toward artifacts, they should use artifact labels to pick out objects that share the same, original intended function.

In support of the idea that children are able to adopt the *physical stance*, and expect words for natural kinds to label category members that share a common essence, studies have shown that four-year-olds readily generalize biologically-relevant properties (e.g., means of breathing) among labeled category members, even when the category members are perceptually-different (e.g., when one "bug" looks like a bug, and the other "bug" looks like a leaf; Gelman & Markman, 1986, 1987). Importantly, children can also use information related to biological essence to determine whether an entity is likely to be a category member, and thus can be referred to using a category label. For example, by at least age five, children recognize that an animal of one natural kind (e.g., a raccoon) cannot easily be transformed into an animal of

another kind (e.g., a skunk), and that kind membership depends critically on internal properties (Keil, 1989; see also Gelman & Wellman, 1991).

A number of studies have also shown that young children have an early appreciation of some aspects of the *design stance* – i.e., the ability to reason about an object’s properties and kind membership in terms of its creators’ intended function, as opposed to its appearance or current use (Bloom, 1996; Dennett, 1987; Gelman & Bloom, 2000; German & Johnson, 2002; Matan & Carey, 2001). For example, when two-year-olds are introduced to a new artifact, they tend to assume that it is “for” a single specific purpose; after they learn this function, they avoid using the object for an alternative purpose (Casler & Keleman, 2005). Further, even three-year-olds recognize the role of a creator’s intention in determining category membership. For instance, when children are given evidence that an entity’s structure was intentionally created, children are more likely to construe it as an object (e.g., and call it a “knife”), but can construe the very same entity as a substance (e.g., and call it “plastic”) when given evidence that its structure was created accidentally (Gelman & Bloom, 2000).

Together, the studies described above indicate that young children’s early use of words is not based solely on perceptual factors, but is guided more generally by intuitions of what kind of entity they think a word labels and the conceptually-deep properties that define those entities (e.g., like biological essence and intended function), which suggests that children have at least a rudimentary understanding of different explanatory stances from early in life.¹ These findings are difficult to explain for theories of conceptual development in which children’s early concepts –

¹ A full appreciation of the design stance, for example, continues to develop over childhood. For example, children initially fail to privilege an object’s original design over its current use when deciding category membership (see e.g., German & Johnson, 2002; Matan & Carey, 2001), and may initially have a “promiscuous teleology”, in which they over-apply teleological explanations to non-living natural objects (e.g., stating that clouds are “for raining” and that mountains are “for climbing”; Keleman, 1999).

and concept-related behaviors like word learning and extension – are solely dependent on perceptual factors. Below, I describe how evidence from how children learn to use words flexibly, with multiple meanings, might provide an additional source of clues about the role of explanatory structures in conceptual development.

Section 3. Lexical Flexibility and Explanatory Concepts

One striking feature of our use of words is that we do not use different, unique words for each idea we wish to convey. Instead, many – if not most – words can be used flexibly, whereby a single word can be used to label multiple distinct but related ideas. For example, rather than labeling a chicken and its edible meat using two separate words, in English we use the same word, *chicken*. As indicated in Table 1, such lexical flexibility is both widespread and systematic: multiple words in English, for example, can alternately label an animal or its meat (e.g., tasty/thirsty *chicken*; also true of *turkey*, *fish*, etc.), materials and artifacts composed of those materials (e.g., shattered/drinking *glass*; also true of *tin*, *iron*, etc.), tools and actions involving those tools (e.g., the red *shovel/shovel* the snow; also true of *hammer*, *rake*, etc.) and more.² But what might lexical flexibility reveal about conceptual structure, and by extension, what might we learn about conceptual development from observing how children learn to use words flexibly?

Table 1. Examples of Lexical Flexibility in English.

² Here, I use the term *lexical flexibility* as a superordinate term, to denote a number of distinct ways in which words are used to label related meanings. These include metonymy (where one aspect of a concept is used to stand for another; e.g., The gallery has a *Rothko*, where *Rothko* refers to one of Rothko's paintings), metaphor (where words from one conceptual domain are used to describe another; e.g., *spending* money vs. time), and morphological conversion (where a word from one grammatical category is converted into another; e.g., expensive *shovel* vs. *shoveled* the snow).

Patterns and Participating Words	Examples
Animal for Meat (<i>chicken, turkey, fish</i> , etc.)	The <i>chicken</i> was thirsty / The <i>chicken</i> was tasty
Artist for Product (<i>Picasso, Camus, Mozart</i> , etc.)	<i>Picasso</i> was born in 1881 / That museum has a <i>Picasso</i>
Body Part for Object Part (<i>leg, arm, back</i> , etc.)	He has a cut on his <i>leg</i> / That table has wooden <i>legs</i>
Container for Contents (<i>pot, bowl, box</i> , etc.)	He scrubbed the <i>pot</i> with a sponge / He stirred the <i>pot</i>
Material for Artifact (<i>glass, tin, iron</i> , etc.)	She bought a sheet of <i>glass</i> / She poured water into the <i>glass</i>
Object for Aperture (<i>door, window, goal</i> , etc.)	He painted the <i>door</i> / He walked through the <i>door</i>
Object for Representational Content (<i>book, magazine, DVD</i> , etc.)	The <i>book</i> has a red cover / The <i>book</i> is fascinating
Place for Institution (<i>White House, Wall Street, City Hall</i> , etc.)	The <i>White House</i> is being painted / The <i>White House</i> made an announcement
Substance for Transfer to Goal (<i>salt, butter, water, paint</i>)	He bought some <i>salt</i> / He <i>salted</i> the soup
Substance for Transfer to Sources (<i>weed, milk, dust, juice</i>)	She poured the <i>milk</i> into the glass / She <i>milked</i> the cow
Tool for Action Involving Tool (<i>hammer, shovel, rake, bike</i>)	She has a <i>hammer</i> / She <i>hammered</i> the nail

One possibility is that lexical flexibility does not reveal much about conceptual structure or development because concepts do not place strong constraints on flexible word use. By this account, new meanings of words – e.g., the use of *google* as a verb to refer to searching for information – are created, and enter into a language whenever such innovations are communicatively beneficial. This process places only weak conceptual constraints on innovation: speakers only need to grasp the relationship between the word’s new and older meanings (e.g., between the novel verbal meaning of *google* and its original nominal meaning), but these meanings can otherwise be related in any number of ways. Because flexible uses of words are argued to be relatively arbitrary and unpredictable, it follows that the different meanings of a flexible word would also be difficult to derive from a single core meaning (Lehrer,

1990; Murphy, 2007), and would instead have to be learned and represented separately, similarly to unrelated homophones like *bat* (which can label an animal or baseball equipment).³

However, some considerations suggest that there may be constraints on flexible word use. First, while we do not perceive relations between unrelated homophones, we readily grasp relations between the different meanings of flexible words like *chicken*, and this difference seems to be reflected in lexical structure, as several experimental studies have confirmed that flexible words and homophones are represented and processed differently (Rodd, Gaskell & Marslen-Wilson, 2002; Frazier & Rayner, 1990; Frisson & Pickering, 1999; but see Klein & Murphy, 2001 and Klepousniotou, Titone & Romero, 2008, for evidence that some flexible words may be represented similarly to homophones). Second, the proposal that flexible word use is relatively unconstrained does not square with the fact that flexible uses of words often fall into systematic patterns, as illustrated in Table 1. Additionally, the fact that these patterns are generative, and can be extended to new words (Murphy, 1997) – e.g., the innovative verbal use of *google* extends the tool for action pattern – is unexpected, if the different meanings of flexible words have to be individually memorized and cannot be derived.

The above discussion motivates a different view of lexical flexibility, in which the different uses of flexible words are not arbitrary, but are instead constrained by conceptual structure.⁴ Indeed, by some accounts, lexical items are explanatory structures, and different uses

³ Consistent with this idea – that the meanings of flexible words are distinctly represented and weakly-constrained by conceptual structure – there are examples in which meanings sometimes drift apart from one another: e.g., it is possible to drink from a *glass* that is made of plastic (rather than glass), or to *land* on water (rather than on land).

⁴ In Section 4, I describe the results of a cross-linguistic survey that explores whether there are parallels in lexical flexibility across different languages, suggestive of conceptual constraints. One issue to consider here is whether, across different languages, word-forms are marked as they alternate between different meanings. In English, for example, the same word-form *chicken* can label animal and meat meanings, and the same word-form *hammer* can label tool (noun) and

of flexible words reflect our ability to adopt different explanatory stances. For example, following Moravcsik's interpretation of Aristotelian *aitia* (Moravcsik, 1975, 1981, 1990), Pustejovsky (1995) argues that all lexical items include *qualia structures* that capture how we conceptualize and speak about the world; these structures are templates that can include information about the physical characteristics that distinguish an entity from other things (e.g., its shape, size, color, etc.), its part-whole constitution and what it is made of, its purpose and function, and how it comes into being. These qualia roles are argued to give rise to and constrain lexical flexibility, such that different uses of a flexible word foreground different aspects of its qualia structure, resulting in different explanatory stances. For example, when we use *glass* in its artifact sense to label something (e.g., the drinking *glass*), we construe the entity as something with a specific physical form that was created with a specific function in mind; this use of *glass* seems to correspond to the *teleological/design* stance described in Section 1. In contrast, this stance is not taken when *glass* is used in its material sense (e.g., the smooth *glass*): here we focus on the entity's material, but accept variations in its physical form and function.

Pustejovsky has argued that many different forms of lexical flexibility arise from the interaction between context and a word's qualia structure (Pustejovsky, 1995, 1998). For example, flexible words like *book* or *CD* could have qualia information about physical properties

action (verb) meanings (see Table 1). But in other languages, these same alternations could be realized via devices like compounding or morphological conversion, such that different word-forms are used for different meanings. For example, words for specific meats could correspond to compounds that are created from words for animals in combination with the general word for meat (as is the case in Mandarin Chinese), and some languages might not permit zero-derivation conversion of verbs from nouns (as in the English use of *hammer*). Still, if we find that languages generally encode the same patterns of flexibility (e.g., animal for meat, tool for action, etc.), but vary in how they mark word-forms as they alternate between different meanings, we would still need to explain *why* languages use productive linguistic devices to capture the same conceptual shifts in meaning (e.g., between animals and meat, tools and actions, etc.), which is the focus of this chapter.

foregrounded in contexts that describe physical objects (e.g., The *book* is heavy), and information about the functions of these objects foregrounded in contexts that describe informational content (e.g., The *book* is intriguing). Similarly, words like *door* or *window* could have qualia information about physical properties foregrounded when used to label physical objects (e.g., He painted the *door*), and information about their part-whole structure foregrounded when used to label apertures (e.g., He walked through the *door*). Adjectives like *fast* or *good* could also get their different meanings by recruiting qualia information of the nouns they modify: e.g., a *fast* car, a *fast* motorway, and a *fast* typist, are all “fast” in different ways, presumably because cars, motorways and typists each have different functions. Finally, in contexts where predicates require an event as an argument, nouns can be coerced to yield event meanings (a phenomenon referred to as *type coercion*), perhaps because relevant events can be found within the qualia structure of some nouns. Thus, when we “*begin* a book”, we mean that we have begun “reading a book” (using qualia information about the function of books) or begun “writing a book” (using qualia information about how books are created); by contrast, it is not sensible to “*begin* a rock”, perhaps because no relevant events involving rocks can be found within the qualia structure of *rock* (e.g., rocks don’t have functions and are not created by agents).⁵

Critically, if this proposal is correct – that flexible word use arises from explanatory lexical structures – then understanding how children learn to use words flexibly may also lend insight into the role of explanatory structures in conceptual development. Thus, while previous research has used children’s extension of a word within a single meaning as a window onto

⁵ The claim here is that qualia structure yields the initial, default interpretation of these words, but that given a strong enough supporting context, other interpretations will also be possible (Pustejovsky, 1995, 1998). For example, among employees at a book-binding business, one could imagine that “*begin* the book” could refer to beginning to bind a book.

conceptual development (as reviewed in Section 2), we might also learn something about early conceptual structure by exploring how children extend words flexibly, across multiple meanings.

Section 4. The Development of Lexical Flexibility

Let's assume for a moment that Pustejovsky and others are right, and that flexible uses of words reflect that concepts have explanatory structure. If this is correct, then according to the theory theory, children should find lexical flexibility intuitive, due to an early-developing ability to adopt different explanatory stances toward entities in the world. Thus, studies regarding the development of lexical flexibility could provide a source of insight into the role of explanatory structure in children's early concepts.

Interestingly, most classic and contemporary accounts of word learning predict, *contra* the theory theory, that children should have difficulty learning to use words flexibly. In particular, while some linguists and philosophers have argued that flexibility is fundamental to word meaning (Keil, 1994; Moravcsik, 1975, 1981, 1990; Pustejovsky, 1995, 1998; Prasada, 2000), developmental psychologists have typically assumed that children's task in learning a word is to link a word form to a single category of meaning; indeed, by many accounts of word learning, this assumption itself guides the learning process (e.g., Markman, 1989; Yu & Smith, 2007). But critically, this assumption might lead children astray when learning flexible words. For example, if children assume that words only have a single meaning, they might initially treat the different meanings of flexible words like *glass* or *chicken* as separate and unrelated homophones. Or, they might fail to understand that the different meanings of flexible words are distinct, and instead conflate them as instantiations of a single, overly-broad meaning (e.g., a category that includes both chicken animals and meat).

While there has not been a great deal of work into the development of lexical flexibility,

what work there is suggests that children are not confused by lexical flexibility, but instead find it intuitive. Early work on this topic focused on how children use words in their spontaneous speech, and showed that beginning around age two, children creatively extend words to new meanings: e.g., children creatively use words for space to describe time (“Mommy, can I have some reading *behind* dinner”; Bowerman, 1983) words for tools to describe actions involving those tools (“Don’t *broom* my mess”; Clark, 1982), and words for objects to describe placing those objects in goal locations (“I’m *crackering* my soup”; Clark, 1982; see also Kuczaj, 1978; Maratsos & Chalkley, 1971; Smith, 1933). Importantly, these innovations are related to attested patterns of flexible word use – e.g., the innovative use of *broom* is similar to attested uses of *hammer* and *shovel* – suggesting that from early in life, children form generalizations about flexible word use, and use them to coin new word meanings and fill communicative gaps.

More recent experimental evidence confirms that children have sophisticated knowledge of lexical flexibility from early in life (Lippeveld & Oshima-Takane, 2015; Rabagliati, Marcus & Pyllkanen, 2010, 2013; Srinivasan & Snedeker, 2011, 2014; Al-Mughairy, Foushee, Barner & Srinivasan, 2015). To begin, by age four, children can resolve the correct meaning of a flexible word in context (e.g., recognizing the difference between a *roasted* vs. *hungry chicken*; Rabagliati, Pyllkanen & Marcus, 2013). Children of this age are also sensitive to the difference between flexible words and homophones: although they allow a novel word to alternate between the different meanings of flexible words – e.g., between a *chicken* animal and *chicken* meat – they expect unrelated homophones like baseball *bat* and animal *bat* to correspond to different words (Srinivasan & Snedeker, 2011, 2014). Finally, four-year-olds can even use their knowledge of patterns of lexical flexibility to infer the meanings of new words (Al-Mughairy et al., 2015; Srinivasan & Snedeker, 2014). For example, after being taught that a first novel word

labels a novel action involving a novel tool, children do not allow a second novel word to label the tool itself, suggesting that they expect the first novel word to label both the action *and* the tool, similar to how words like *hammer* and *shovel* are used (Al-Mughairy et al., 2015). This last finding – which fits with the previously-discussed finding that children coin new word meanings in their spontaneous speech – suggests that children have formed generalizations about lexical flexibility, and can use them to anticipate new word meanings.

Stepping back, if we assume that lexical flexibility reflects that lexical concepts have explanatory structure, then the studies described above – which demonstrate that young children find lexical flexibility intuitive – would suggest that children’s early concepts do not reduce to bundles of perceptual features, but are instead structured by abstract, explanatory factors. In particular, children’s understanding of lexical flexibility might reveal their cognitive ability to adopt different explanatory stances, which could constrain their expectations about the different meanings flexible words can take. Further, children’s expectations about flexible word use might even *shape* the nature of lexical flexibility. In particular, although language users routinely coin new meanings for words, it may be that only those innovations that are the most learnable for children, given their cognitive biases, are the ones that survive and enter into languages. Thus, the patterns of lexical flexibility that exist today (e.g., animal for meat, material for artifact, etc.) could consist of innovations (e.g., using *chicken* to label meat, *long* to label duration, etc.) that were historically the most learnable for children (Srinivasan & Rabagliati, 2015).

This resulting purported fit between children’s conceptual structure and patterns of lexical flexibility provides a possible answer as to why lexical flexibility exists as a useful feature of language, and motivates a new view of word learning. Imagine, for a moment, that there was no lexical flexibility in language, such that we had to use a separate word to express

each basic meaning we wished to convey (e.g., separate words for chicken animals and meat, glass material and drinking vessels, etc.). If this were the case, the lexicon would have to be much larger than it currently is, and building it would be a very slow process, given that word-meaning mappings are arbitrary (e.g., there is nothing inherent in the sound “dog” that links it to the concept DOG; Saussure, 1959) and have to be learned one-by-one, through observation. Lexical flexibility may arise in languages to reduce this burden: when words are linked to multiple meanings in predictable ways that fit with how children construe the world, learning one meaning for a word (e.g., the tool meaning of *hammer*, or the animal meaning of *chicken*) will give clues to its other possible meanings (e.g., the action meaning of *hammer*, or the meat meaning of *chicken*). This could greatly simplify the task of word learning: to learn multiple word-meaning pairings, children would only need to acquire one word-meaning pairing by observation, and could then infer the word’s other meanings spontaneously, in absence of observational evidence (Al-Mughairy et al., 2015; Srinivasan & Rabagliati, 2015). This proposal would also help explain why flexible words are widespread, and more prevalent in language than homophones: while flexibility could facilitate word learning by allowing children to infer new word meanings, homophones could not confer such an advantage, since they are by definition unrelated.

The proposal that children’s early concepts are explanatory structures, and constrain their acquisition of flexible words, makes one key additional prediction about the nature of lexical flexibility and its relation to word learning. Specifically, if lexical flexibility is constrained by early-developing properties of conceptual structure, then different languages should employ largely similar patterns of lexical flexibility (Srinivasan & Rabagliati, 2015; see also Zhu & Malt, 2014). In particular, because children growing up in different linguistic communities are

likely to construe the world in similar ways, they should also expect words to have multiple meanings in similar ways. Thus, as different languages change over generations of learners, they should each develop the same patterns of lexical flexibility (e.g., animal for meat, material for artifact, etc.), because these patterns would historically have been formed from the same kinds of easily-learnable innovations. A corollary of this idea is that those patterns of lexical flexibility that are less attested across languages are less prevalent because they are more difficult for children to learn.

Recent studies provide initial support for these predictions, consistent with the idea that lexical flexibility is constrained by early-developing explanatory concepts. For example, a large-scale cross-linguistic study found that, of 26 different patterns of lexical flexibility found in English (e.g., animal for meat, material for artifact, etc.), nearly all were attested in each of 14 other languages (Srinivasan & Rabagliati, 2015).^{6,7} Further, the one pattern that was the most absent across languages – the use of words for substances to label the transfer of those substances from sources (e.g., *milk* the cow, *dust* the table) – also happens to be difficult for

⁶ To assess the cross-linguistic regularity of these patterns, we asked respondents to indicate whether, in their native language, the same word-forms could be used to label different meanings, as in English. We considered a pattern (e.g., animal for meat) to be attested in a language if respondents judged that at least one word in that language exhibited the shift in meaning related to that pattern. Relevant to Footnote 4, we also highlighted to respondents that word-forms in their language could be marked as they alternated between different meanings (e.g., via compounding or morphological conversion). Given this instruction, it is likely that participants' responses reflected their judgments that the *same* word-forms in their language could alternate between different meanings, without undergoing any marking.

⁷ Interestingly, although the patterns were present across languages, they were sometimes instantiated in words in different ways. For example, while nearly all languages use words for materials to label artifacts derived from those materials, languages differ in *which* artifacts can be referred to: e.g., while English uses *glass* to label glass drinking vessels, the translation-equivalent in Russian instead labels mirrors. This suggests that while flexible uses of words must be learned (i.e., because languages differ in how patterns are instantiated in words), some types of lexical flexibility are easier to learn than others (i.e., because the same patterns appear across languages).

children to learn (Srinivasan & Barner, 2013). In particular, children learning English initially misinterpret the verbal uses of words like *milk* or *dust*, and assume that they denote the transfer of these substances toward goals rather than sources (e.g., such that *milk* the cow involves putting milk onto a cow). Together, these findings support the idea that children's early conceptual structure places constraints on lexical flexibility, such that flexible uses of words that are easier for children to conceptualize are more likely to be learned. Over the course of a language's history, flexible words that are more learnable may also be more likely to enter into the language and to form patterns, leading to cross-linguistic universals.

Conclusions and Future Directions

A central problem for the cognitive sciences is to characterize the nature of concepts, and how they arise in human development. In this chapter, I have considered what children's word learning can tell us about their conceptual development, and in particular, the degree to which children's early concepts have explanatory structure. Previous studies have primarily addressed this question by exploring how young children extend words within a single meaning, and have suggested that children's word extension is not based purely on perceptual factors, but instead on more abstract explanatory factors like intended function and essence. Building on this previous work, I have argued that children's flexible extension of words across multiple meanings can also provide insight into the nature of early conceptual development. In particular, children's early appreciation of lexical flexibility may reveal an early-developing cognitive ability to adopt different explanatory stances, which may both facilitate children's acquisition of lexical flexibility and constrain the structure of lexical flexibility across languages.

Recent work on the development of lexical flexibility has opened many new topics for further research into the nature of conceptual development and word learning. First, although

there are reasons to think that lexical flexibility is constrained by conceptual structure, there is currently no direct evidence that links children's ability to adopt different explanatory construals to their ability to learn and use the different meanings of flexible words. Such evidence is critical to our understanding of what the development of lexical flexibility reveals about conceptual development. One way that future studies could address this question by exploring whether receiving evidence that two meanings share the same flexible label invites children to adopt specific modes of construal. For example, after demonstrating that a use of an artifact is called *daxing* and that the artifact itself is also called a *dax*, children may adopt the design stance, and conceptualize the artifact's demonstrated use as the intended function of the artifact.

Second, future work should explore the degree to which lexical flexibility facilitates children's construction of the lexicon. As noted before, one possibility is that children's concepts allow them to pick up on patterns of lexical flexibility, such that after learning one meaning of a word, children can spontaneously infer the word's other meanings. If this ability is critical to lexical development, then we should find evidence that children can exploit patterns of lexical flexibility at the earliest stages of word learning, even before they have learned many flexible words.

Finally, if lexical flexibility does indeed provide a window onto conceptual structure, researchers can use examples of lexical flexibility as clues, to construct new and fruitful hypotheses about the nature of concepts. For example, motivated by our ability to call someone a *scientist* who either engages in the concrete activities of scientists (e.g., uses experimental methods) or who embodies the abstract values of scientists (e.g., engages in a search for truth), Knobe, Prasada & Newman (2013) find evidence that many of our concepts provide criteria for determining category membership in these two ways.

Acknowledgments

I would like to thank the editors, Justin Halberda, Sandeep Prasada, and Laura Wagner for helpful comments on earlier drafts. I am also grateful to Susan Carey for her insight and guidance, which helped me develop this line of research.

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