Count Nouns, Sortal Concepts, and the Nature of Early Words

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Early words consist of mostly count nouns. A subset of our concepts, sortals, underpins our representations of count nouns. A sortal concept is a concept that provides principles of individuation and principles of identity (Hirsch, 1982; Macnamara, 1986; Wiggins, 1980). To answer the question “how many?” we need to specify “how many what.” If we are interested in counting the number of things in a room, we would receive different answers by asking “how many tables,” “how many chairs,” or “how many legs.” Similarly, to answer the question “is it the same,” we need to specify “the same what.” A person may not be the “the same baby” as she was 17 years ago, but she may still be “the same person.” Our identity criteria are also sortal-relative in the sense that the same property difference may or may not indicate a change of identity, depending on the kind of object in question (e.g., a change in size and color indicates a change in identity for a chair but not necessarily for a plant). Sortals are the concepts that provide the criteria to enumerate and track identity over time and they are lexica- lized as count nouns in languages that make the count—mass distinction (Baker, 2003; Hirsch, 1982; Macnamara, 1986; Wiggins, 1980). All concepts provide principles of application (i.e., specifying what falls under the concept), but not all concepts provide principles of individuation and identity. Consider the concept 100. We cannot count “the red” in a room, unless we specify a sortal, for example, ‘red shirts,’ ‘red lights,’ or ‘red-heads.’ We
also cannot count "the good" but we can count the number of "good people," "good thieves," or "good knives." Similarly, we cannot ask whether something is "the same red" or "the same good" unless we mean "the same red shirt" or "the same good thief." The interpretation of red or good differs drastically depending on whether the noun is 'shirt,' 'head,' 'person,' or 'thief' (for a more nuanced discussion of adjective meanings, see Partee, 1990). Generally speaking the interpretation of predicates (be they adjectives, verbs, or other grammatical classes) depends on the noun. Mass nouns such as sand and water differ from count nouns in that they do not provide principles of individuation and identity in a straightforward way. Some have suggested that portions of substance provide principles of individuation and identity (e.g., Hirsch, 1982). For example, we can distinguish one pile of sand from two, and three glasses of water from five glasses of water.

This chapter has two main sections. In section 1, I review a body of research investigating how representations of sortal concepts develop in infancy and how learning count nouns may play a causal role in constructing these concepts. In section 2, I suggest that the work on sortal concepts as well as on related research argue against the traditional view of early word learning, namely, that early words are fundamentally different in character from later words.

1. Object Individuation and Sortal Concepts

Object individuation is the process by which one establishes the number of distinct objects in an event. In particular, it is concerned with the process whereby an object is seen at time 1 and an object is seen on time 2, and the question arises as to whether they are the same object seen on two different occasions or two distinct objects. As mentioned above, a sortal concept is a concept that provides principles of individuation and principles of identity.

This section focuses on the developmental origin of the representation of sortal concepts. I use the criteria by which children and adults individuate objects as a means for investigating when children begin to represent sortal concepts. For adults, at least three sources of information are regularly employed in individuating objects: spatiotemporal information, property (or featural) information, and sortal information. The use of spatiotemporal information includes generalizations such as objects travel on spatiotemporally continuous paths, or two objects cannot occupy the same space at the same time. The use of property information includes generalizations such as objects do not usually change shape, size, or color. The use of sortal information includes principles such as objects do not change kind membership; thus, if an object seen at time 1 falls under one sortal concept and an object seen at time 2 falls under another sortal concept, they must be two distinct objects. Furthermore, property information is sortal-relative such that property differences are weighted differently depending on the kind of object under consideration. Note that for adults, property information is
sortal-relative for known kinds (and kinds that can be easily assimilated to known kinds), but we also use property information in a domain-general way (e.g., objects tend to have regular shapes and don’t usually change color).

The developmental evidence I review suggests that young infants use spatiotemporal information for object individuation, but it is only later that they begin to use property information to do so. It is later still in development that they begin to use sortal information for object individuation, and the emergence of this ability coincides with when infants start to comprehend their first words for objects. I argue that (1) it may be adaptive to rely on spatiotemporal information for object individuation early on, and the use of property information is secondary: (2) the use of sortal information may require conceptual change on the part of the infant; and (3) language learning may play an important role in inducing such conceptual reorganization.

Using the violation-of-expectancy looking time methodology (Spelke, 1985), a number of studies have shown that infants as young as 2.5–4 months represent persisting objects, and they employ spatiotemporal information to determine how many objects are in an event. In a seminal study, Spelke et al. (1995) showed that if objects appear to have traveled on spatiotemporally discontinuous paths (Figure 10.1), the infants posited two distinct objects in the event. That is, they looked longer at the unexpected outcome of one object than the expected outcome of two objects. Other laboratories have replicated and extended these findings (Aguirre and Baillargeon, 1999; Simon et al., 1995; Spelke, 1990; Wynn, 1992). These studies have been taken as evidence that infants represent the sortal concept \textit{object} (Xu, 1997, 2003; Xu and Carey, 1996), although it is a matter of controversy whether \textit{object} is a full-fledged sortal (e.g., Hirsch, 1997; Wiggins, 1997).

What about the use of property or sortal information for object individuation? Can infants use object properties, such as the shape, size, and color of objects, or sortal concepts such as \textit{duck} or \textit{ball} in deciding how many objects are in an event? Some studies suggest that it is not until twelve months of age that infants are able to use property or sortal-kind information in the service of object individuation (Xu and Carey, 1996). In these experiments, infants saw an object (e.g., a toy duck) appear from behind an opaque screen then return behind it. Then they saw an object (e.g., a ball) appear from behind the same screen then return behind it (Figure 10.2). This event was repeated several times. Then the screen was removed to reveal either two objects (the duck and the ball, the expected outcome) or just one of the two objects (the duck or the ball, the unexpected outcome). Infants’ looking times for these outcomes were recorded. At ten months, infants did not look longer at the unexpected outcome of one object; their looking times were not different from their baseline preference for two objects. At twelve months, however, infants looked longer at the unexpected outcome of one
object. Xu and Carey (1996) suggested that ten-month-old infants did not use property or sortal information to establish a representation of two distinct objects, whereas twelve-month-old infants did. Importantly, control experiments showed that the infants had encoded the perceptual differences between the objects—they habituated faster to a sequence of duck, duck, duck relative to a sequence of duck, ball, duck, ball—but they failed to use these differences to compute the number of objects in the event. Other laboratories have replicated and extended these findings using looking time as well as manual search measures (Bonatti et al., 2002; Kroijgaard, 2000; Rivera and Zawayden, 2007; Van de Walle et al., 2000; Wilcox and Baillargeon, 1998a; Xu et al., 1999, 2004).
Crucial for our investigation of sortal concepts, we needed to ask whether twelve-month-old infants’ success was based on their representations of sortal concepts (e.g., the difference between a duck and a ball), or whether it was based on property differences (e.g., the difference between a yellow, irregularly shaped object and a round, red and green object). Xu et al. (2004) conducted a series of experiments to tease these possibilities apart. The same is-it-one-or-two task was used, but sometimes the infants saw two objects that differed only in color (e.g., a red ball and a green ball), size (e.g., a small ball and a large ball), or a combination of these features. In each case, although the infants had encoded the perceptual differences between the objects, they failed to use these property differences to establish a representation of two objects. Shape contrasts were also investigated: when difference in shape signaled a sortal contrast (e.g., a plastic, yellow cup and a plastic, yellow bottle), infants succeeded. When a similarly salient shape difference (measured by habituation rate) did not signal a sortal contrast.
e.g., a plastic, yellow regular cup and a plastic, yellow sippy cup), infants again failed to infer the presence of two objects. Thus, sortal representations appear to be the basis of success at twelve months. Parallel results were found using doll-heads (Bonatti et al., 2002) at ten months—with an ontological distinction such as human versus nonhuman, infants succeeded on the individuation task with the contrast a doll head versus a cup, but they failed with a female doll versus a male doll. Taken together, these studies suggest that representations of sortal concepts begin to emerge at around ten to twelve months.

It is controversial, however, whether infants younger than twelve months are able to use property information for object individuation. The evidence is mixed, depending on the task demands and the specifics of the dependent measures. Using simplified versions of the object individuation task, some evidence suggests that at around ten months (or even younger) infants are able to use property information for object individuation (looking-time measure: Wilcox, 1999; Wilcox and Balza, 1999a, 1999b; Wilcox and Chapa, 2004; Wilcox and Schweinle, 2002; manual search measure: Xu and Baker, 2005), but some have provided alternative interpretations for these results (e.g., Xu, 2005; Xu et al., 2004).

How do infants acquire sortal concepts? It seems a suspicious coincidence that most infants begin to comprehend words for basic-level object categories at around ten to twelve months, and they also begin to represent (basic-level) sortal concepts such as duck and ball at around the same time. My colleagues and I explored the hypothesis that perhaps learning words for object categories plays an important role in acquiring sortal concepts (Xu, 2002; Xu et al., 2005). Nine-month-old infants were presented with the is-it-one-or-two task described above. This time, however, when each object emerged from behind the screen, the experimenter said, “Look, a duck!” or “Look, a ball!” With just a few repetitions of these labels, infants looked longer at the unexpected outcome of one object than the expected outcome of two objects on the test trials. Infants also succeeded when two unfamiliar objects and nonsense words were used. However, they failed when both objects were labeled “a toy,” or when two distinct tones, sounds, or emotional expressions were provided. We suggested that infants expect words (count nouns) to refer to sortals and that the use of two distinct labels signaled to the infant that two kinds of objects were presented in the event, so two objects must be behind the screen. Other laboratories have replicated and extended these results (Fineberg, 2003; Rivera and Zawaydeh, 2005).

But perhaps the words simply provided the 9-month-old infants with a mnemonic on-line during the experiment, with no lasting effects for representations of sortal concepts in the real world. Some evidence suggests that this is not the case: word learning may be integral to acquiring these concepts. In two studies, parents of ten- and eleven-month-old infants were asked to report on their infants’ word comprehension for a set of highly familiar objects. When these objects were used in the is-it-one-or-

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two object task without labeling, the results showed that infants who knew both words for the objects used in the task succeeded but those who did not know the words failed (Rivera and Zawaydeh, 2007; Xu and Carey, 1996). Another study asked whether labeling alone could guide the process of establishing representations of distinct objects. Using a manual search method, twelve-month-old infants were shown to be able to use the presence of labels to determine how many objects were in a box whose content was invisible to them (Xu et al., 2005). When infants heard the content of the box labeled with two words, they expected to find two objects inside; when they heard just one word repeated, they expected to find only one object inside the box. This effect appeared to be language-specific since infants did not expect to find two objects when two emotional expressions were used.

Do infants, like adults, expect two distinct labels to refer to two kinds of objects and not just two individual objects? In some recent studies, nine-month-old infants were tested to see if they had the same expectation about words (Dewar and Xu, 2007). Infants were first shown two possible outcomes, either two identical objects or two objects differing in shape, color, and surface pattern. Then the infants were given linguistic information about the content of the box using either two labels or one label. Looking-time results showed that infants expected to see the different object outcome when they heard two labels and the identical object outcome when they heard just one label. Furthermore, follow-up experiments showed that infants’ expectations were not satisfied by just any difference between the two objects: they expected two different labels to map onto two differently shaped objects. Color alone was not sufficient to satisfy infants’ expectations. Since shape is a perceptual dimension often correlated with kind membership (at least for the kinds of objects we used in the experiments) and color is not, it appears that even nine-month-old infants expect distinct count nouns to map onto distinct kinds of objects, not just individual objects.

In sum, these studies suggest that the criteria by which infants individuate objects change over the course of the first year of life. Spatiotemporal information may be primary early on, and property and sortal information is employed later. This developmental trajectory may be adaptive since no physical objects violate spatiotemporal continuity whereas property or sortal information depends on learning about different sorts of objects in the real world. By the end of the first year of life, infants begin to represent (basic-level) sortal concepts such as duck and ball. This conceptual change allows the infants to see the world in terms of kinds of things and not just objects with various properties. From this point on infants, like adults, presumably begin to organize property information around sortals—the same property difference may or may not indicate a change of object identity depending on the kind of thing it is. Furthermore, learning words for objects may play an important role in the acquisition of sortal concepts (the concept of person/human may be an exception; see Bonatti et al., 2002).
Other aspects of conceptual development have also been shown to be influenced by linguistic information. In several categorization studies, Waxman and her colleagues found that the presence of a count noun facilitated categorization in infants as young as nine months, and the facilitation effects are linked to grammatical classes by about thirteen months (Balaban and Waxman, 1996; Waxman, 1999; Waxman and Braun, 2003; Waxman and Markow, 1995). In several inductive inference studies, Graham and her colleagues found that providing a count noun label allowed thirteen- to eighteen-month-old infants to make inferences about nonobvious properties of objects (e.g., squeeze an object to make a sound) above and beyond perceptual similarity (Graham et al., 2004; Welder and Graham, 2001). These labeling effects become more fine-tuned according to grammatical classes (noun vs. adjective) by eighteen months (Joshi and Xu, 2006). These studies converge with the results of the object individuation studies: infants expect count nouns to map onto kinds of objects at the beginning of word learning, and this expectation leads them to use labeling as a source of information for identifying the kinds in their environment. The labeling event ("Look, a rabbit!") informs the infant that she should set up a mental symbol that represents a sortal concept. Furthermore, the kind of object this word refers to has an essence that determines its internal and surface properties. In this sense, words may be "essence-placeholders" for young children (Gelman, 2003; Medin and Ortony, 1989; Xu, 2002, 2005).

2. Early Word Learning

In this section, I suggest that the research on object individuation, categorization, and inductive inference in infancy also bears on how we think about the nature of early words. In particular, I argue that these data support the view that even children's earliest words for objects refer to kinds, that is, the principle of generalization. I also touch on two other characterizations of words—the principle of reference and the principle of conventionality, but the discussion is short and more speculative since a detailed discussion is beyond the scope of this chapter.

Many studies have tried to teach infants between ten and eighteen months a new word (a count noun) for a novel object in a laboratory setting. The results are mixed. Under some circumstances, thirteen- to fourteen-month-old infants succeed in learning a new word rather quickly with just a few exposures (e.g., Waxman and Booth, 2001; Woodward et al., 1994). Other times it takes a lot of repetitions for infants at fourteen to fifteen months of age to establish word–object mappings (e.g., Hollich et al., 2000; Schaeffer and Plunkett, 1998; Werker et al., 1998). Some studies showed successful generalization to objects of the same kind at thirteen to fourteen months (e.g., Waxman and Booth, 2001; Woodward et al., 1994), while others found it difficult to show generalization of a new word until fifteen months of age (e.g., Hollich et al., 2000).
Many researchers have suggested that the slow rate of vocabulary development early on reflects a different process of learning. A few standard facts can be found in any textbook on language development and developmental psychology in general. First, most infants begin to comprehend single words at around ten to twelve months. Production follows, but individual children vary a great deal in when they reliably produce words. Second, many of the early words are names for objects. Third, early word learning appears to be very slow and effortful. Vocabulary grows very slowly, and infants may show comprehension of a word intermittently. Fourth, for many children, the rate of vocabulary learning takes off at around eighteen months, that is, the “vocabulary spurt” (although see Bloom, 2000; Ganger and Brent, 2004).

Based on this characterization of early words, many have suggested that early words are also different in character compared with later words. Three characteristics have been suggested: (1) early words are context-bound, (2) early words are the result of associative learning, and (3) early words are idiosyncratic (e.g., Dromi, 1987; Golinkoff et al., 1994; Lock, 1980; McShane, 1979). In contrast, the more mature lexicon shows rather different characteristics. Three characteristics have been suggested for the count nouns in the lexicon: (1) principle of generalization: count nouns refer to kinds/sortals, (2) principle of reference: count nouns refer to, and are not merely associated with, objects, and (3) principle of conventionality: word meanings are shared by members of a particular linguistic community (e.g., Baldwin, 1993; Bloom, 2000; Clark, 1983; Diesendruck and Markson, 2001; Landau et al., 1998; Markman, 1989).

Is there evidence that early words/count nouns are fundamentally different from later words? The literature provides mixed results. In a seminal study, Huttenlocher and Smiley (1987) analyzed the spontaneous speech of very young children who were just beginning to learn their first words. They found no evidence that children’s early words were context-bound: that is, young children do not use the word car only when looking out the window as if the meaning of the word includes the context in which it had been learned. They also found very little overgeneralization in the comprehension data: that is, children did not use say the word dog to refer to all animals, but rather used it appropriately (see also Huttenlocher, 1974; Macnamara, 1982). Other studies have found more overgeneralization of early count nouns (e.g., Clark, 1983; Gelman et al., 1998; Naigles and Gelman, 1995; Nelson, 1973).

In the studies on early conceptual development reviewed above, we see a different picture: infants are very competent in using linguistic information for other cognitive tasks such as categorization, individuation, and inductive inference as early as nine to thirteen months. This seems to pose a puzzle: on the one hand, learning specific mappings between words and objects is difficult for infants younger than eighteen months; on the other hand, children of the same age are already able to use linguistic information
to facilitate their conceptual development. How can we reconcile these findings? Here is a suggestion: success in the conceptual tasks only requires the infants to use abstract properties of words, namely, the expectation that words map onto sorts and sortal concepts support categorization, individuation, and inductive inference. Success in learning new words for objects, however, requires specific mappings that include learning the phonological form of the word, the appearance of the object, and the mapping between the two. This process requires attentional resources that may be scarce in infants.

Principle of Generalization

For older children and adults, count nouns refer to kinds of individuals. What are some cognitive functions of kind representations? There are at least three. Kind concepts allow us to categorize objects. If several objects are all called “blicket,” we know that they are members of the same kind category (note exceptions such as “bat”). Kind concepts also allow us to individuate objects. If an object is seen at time 1 and it is called a “blicket,” and an object is seen at time 2 and it is called a “flep,” we infer that since they are different kinds they also must be two numerically distinct objects (note that this is likely to be a default assumption since there are cases such as “a dog” vs. “a pet” or “an animal” vs. “a poodle”). Lastly, kind concepts support inductive inference. If we know that blickets make a distinct sound, we infer that the next blicket we encounter would make the same sound.

A growing body of work on early conceptual development has investigated whether kind concepts support these three cognitive functions in infants. The emphasis in this work has been the relationship between early words and early conceptual development, that is, to ask the question of whether infants’ conceptual representations are influenced by providing a label in the form of a count noun while the infants are engaged in a particular cognitive task. Here I turn this work on its head by using the same data as evidence for understanding the nature of early words.

Waxman and her colleagues have published a large number of studies providing evidence that when the infants are given a count noun label, they categorize objects more quickly and efficiently (Balaban and Waxman 1996; Waxman 1999; Waxman and Booth, 2001; Waxman and Braun 2005; Waxman and Markow, 1995). In one of the first studies of this kind, Balaban and Waxman (1996) presented nine-month-old infants with a categorization task. The infants were shown a series of pictures of say rabbits, during familiarization. For one group of infants, the word “rabbit” was heard on some of the trials. For another group of infants, a tone was heard on some of the trials. On the test trials, the infants were shown two pictures—a picture of a new rabbit they had not seen before (a new exemplar from the same category), and a picture of a pig (an exemplar from a new category). The infant’s categorization was facilitated. The presence of the pre-exposure trials in the infants’ mind was present.

The prevalence in the participants’ minds of the kind concepts makes a difference.

Principle

The explanation of the facility in this domain involves making the slow process of learning more efficient by providing the infant with a label that indicates the presence of an object.
from a different category). They found that the infants who had heard the count noun during familiarization spent more time looking at the pig (an exemplar from a different category) than the ones who had heard a tone. The idea is that the infants chose to look longer at an exemplar from a new category than a new exemplar from an old category, so they must have been habituated to the category of rabbits. These psychologists argued that the presence of a word facilitated categorization in young infants, and this facilitation effect may be language specific. In another study, Waxman and Braun (2005) showed that it is only the presence of consistent labeling (i.e., presenting the same word over and over again) that facilitated categorization. If the words were variable (e.g., “blicket,” “lep,” and “zav” in different trials), no facilitation effects were found. These results are consistent with their claim that it was not the mere presence of words but rather the presence of the same word that helped infants categorize the objects (see Waxman and Lidz, 2006, for an excellent review).

The work reviewed above on object individuation and inductive inference provides two additional sources of evidence that infants who are at the beginning of language development expect count nouns to refer to sortals/kinds, and that these representations support induction to new instances.

Principle of Reference

If the slow rate of vocabulary acquisition early in development can be explained in terms of understanding abstract properties of words versus making specific mappings, we may also begin to question the second widespread claim about early words, that they are the result of associative learning. The fact that children learn words very slowly and laboriously before eighteen months has been taken as evidence that children do not understand that words refer to objects and they merely associate words with objects.

Two sources of evidence argue against this view. Research by Baldwin, Tomasello, and their colleagues provides strong evidence that infants understand the intentional nature of labeling from sixteen months on, and it seems reasonable to assume that understanding intention is part of understanding the referential nature of language (this is more of a psychologist’s view on reference; philosophers may have a different view on this matter). In a seminal study, Baldwin (1993) showed that sixteen- to eighteen-month-old infants used speaker’s gaze as critical information for finding the referent of a new word. If the speaker is looking into a bucket (with an object placed in it, not visually accessible to the infant) while the infant is looking at her own object, the infant takes the new word to refer to the object in the bucket. More recent studies suggest that as early as twelve months, infants appear to show some understanding of absent reference (e.g., Ganea, 2005; Saylor and Baldwin, 2004). That is, if a word is used to refer to something that is absent, infants show the appropriate search
behavior that one might see in older children and adults. Understanding of absent reference may be taken as evidence that words are mental symbols used to refer to categories of objects in the world.

**Principle of Conventionality**

Lastly, there is some evidence suggesting that thirteen- to fourteen-month-old infants assume that speakers of the same linguistic community use the same arbitrary sound-meaning pairs to make communication happen (Clark, 1983). Woodward et al. (1994) adopted a two-experimenter design in their word-learning task. One person taught the infant a new word, say “fep,” for an object, and then she left the room. A second person came in to test whether infant had learned the word by asking her to “give me the fep.” The second person was not present in the room during the teaching phase. Woodward et al. had adopted this design to avoid any experimenter bias, but it also provides a simple test for the principle of conventionality. The thirteen- to eighteen-month-old infants in these studies clearly assumed that the second person would use the same word for the same object even though she was not present when the infant was taught the new word. Similar findings were obtained by Kerlin et al. (2005). Furthermore, the principle of conventionality may only apply to words but not to preferences, for example, likes and dislikes as conveyed by emotional expressions. When a second person comes in to ask for the object she likes, fourteen-month-old infants did not assume that she would have the same preference as the first person (Kerlin et al., 2005).

A second aspect of the principle of conventionality—that the sound-meaning pairings are arbitrary—has not been tested empirically with very young children, to my knowledge (though see work by Piaget and Vygotsky with older children). It seems unlikely that children would think otherwise since the most common count nouns in the early lexicon demonstrate this principle very clearly. For example, the word dog does not resemble dogs any more than the word cat resembles cats in any way: the word spoon or cup also has no systematic relations with their referents.

In sum, both studies on early word learning and studies on early conceptual development suggest a strong continuity between early words and later words, contra standard claims in the child language literature. Although it is not easy for infants to acquire new words, the source of this difficulty may lie in the availability of limited processing and attentional resources, not in a fundamentally different understanding of the nature of early words.

**Concluding Remarks**

The concepts that are lexicalized as count nouns in a natural language such as English fulfill certain logical functions—they provide criteria for
individuation and identity; they are dubbed "sortals" by philosophers. This chapter reviews some of the recent work on the developmental origin of sortal concepts and its relationship to early word learning. We suggest that infants begin to represent sortal concepts toward the end of the first year and that the acquisition of count nouns that map onto object categories may play an important role in this process. This research speaks to the general issue of the relationship between language and concepts, except that instead of being concerned with how different languages may shape different forms of habitual thought (e.g., Boroditsky, 2001), this work is concerned with how universal properties of language (i.e., the fact that all languages have count nouns) may affect conceptual development.

This research also speaks to the issue of how to characterize children’s earliest words that refer to objects. I suggest that the data from early conceptual development provides evidence that early words refer to kinds, just like later words. The slow growth of the infant’s vocabulary early on may be due to processing difficulties as opposed to a fundamentally different process of acquiring word meanings.

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