EARLY CHILDHOOD DEVELOPMENT AND LATER OUTCOME

Edited by
Sabina M. Pauen
University of Heidelberg

CAMBRIDGE
UNIVERSITY PRESS

5 Learning about Language: Acquiring the Spoken and Written Word

Sandra R. Waxman and Usha Goswami

Language acquisition is critical not only in infancy, but also for later achievement. Language supports cognitive and social development, enhances memory and reasoning abilities, and underpins the development of executive function – the capacity to organize and manage one's own behavior. For example, because language permits children to construct extended, temporally organized, narratively coherent representations of their own experiences that can be accessed efficiently, language acquisition can promote capacities as fundamental as memory. Language acquisition is tuned by the language input children receive. By the time they enter school, there is considerable variability in the language experiences and language capacities of young children. Hart and Risley (1995) estimated that by four years of age, children from high-SES families in the United States had been exposed to around 44 million utterances, compared to 12 million utterances for lower SES children (see also, Huttenlocher et al. 2002). Because these enormous differences in young children's language exposure affect their subsequent learning and development, language interventions aimed at providing young children with richer and more complex linguistic experiences (and going beyond "empty language" such as "Don't do that," "bring it here") have well-documented positive effects on how well children flourish in school (Landry 2005).

Because a primary function of language is, of course, communication, infants need to learn what words *mean*. To succeed, infants must identify not only the relevant linguistic units and conceptual units, but must establish a mapping between them. But how do infants accomplish this task? And how do they learn that for any given scene (e.g., a cardinal flying behind a stone fence), we can use not only different words (e.g., "bird," "cardinal") but also different *kinds* of words (e.g., nouns, adjectives, verbs) to focus in on different aspects of the scene (e.g., "bird," "red," "flying," respectively).

Because words are perhaps the primary unit of language, in this chapter, we focus on the acquisition of words in spoken and written language. We adopt a cross-linguistic developmental approach, focusing on evidence from infants and young children. With regard to spoken language, Waxman (Waxman & Gelman 2009; Waxman & Markow 1995) has proposed that infants cross the threshold into word-learning equipped with a broad initial expectation linking words to concepts, and that this initial expectation becomes increasingly fine-tuned on the basis of infants' experience with the objects and events they encounter and the native language they hear. In addition to linking words and concepts, infants and young children must also learn the sound structure of spoken words, and how to reproduce these sound structures exactly. With regard to written language, this awareness of sound structure, or phonology, is critical for learning to read, a key educational achievement. Goswami has developed a cross-language theory of phonological development and reading acquisition, which we also illustrate in the second part of this chapter.

Learning What Words Mean

Even before they begin to speak, infants have already begun to establish a repertoire of concepts and to focus on the sound patterns of their native language. Consider first the infants' conceptual capacities. In the first year of life, infants begin to form categories that capture important relations among the objects and events that they encounter, and use these early concepts as a foundation for learning about new objects and events (Waxman & Gelman 2009). Infants' early object and event categories provide strong starting points for the more elaborated concepts and theories that emerge later in development. In other words, there is conceptual continuity from infancy through adulthood.

Consider next, infants' burgeoning language capacities. Infants begin to recognize a few words (notably, their own names) at about 7 months of age, and typically produce their first words by their first birthdays. Infants' first words tend to be those that refer to important individuals (e.g., "Mama"), objects (e.g., "cup," "doggie"), social routines (e.g., "night-night"), and actions (e.g., "up"). Across languages, infants tend to show a "noun advantage," with nouns referring to basic-level object categories being the predominant form (Bornstein et al. 2004, provide a cross-linguistic review). By their second birthdays, infants typically have command of hundreds of

words; they also typically begin to combine words to form short phrases that respect the grammatical properties of their native language.

The Puzzle of Word-Learning

To learn the meaning of a word, infants must solve a difficult three-part puzzle: they must (1) parse the relevant *word* from the ongoing stream of speech, (2) identify the relevant entity or relation in the ongoing stream of activity in the *world*, and (3) establish a word-to-world mapping. Put differently, successful word-learning rests on an ability to discover the relevant linguistic units, the relevant conceptual units, and the mappings between them.

Solving each piece of this puzzle depends on infants' ability to recruit other perceptual and psychological capacities. For example, consider what it takes for an infant to parse a word from fluent speech. We know that newborns prefer human speech – and particularly infant-directed speech – over other kinds of auditory stimulation. We also know that the function of infant-directed speech changes with development. Within the first six months, infant-directed speech serves primarily to engage and modulate infants' attention. But in the latter six months, infants begin to cull words from the speech stream, and to pay attention to the morphologic, phonetic, and prosodic cues that mark word and phrase boundaries in their language (Jusczyk & Aslin 1995; Kemler Nelson et al. 1989). At this point, infants begin to distinguish two very broad classes of words: *open class* words (or, *content* words, including nouns, adjectives, verbs) and *closed class* words (or, *function* words, including determiners and prepositions). Infants as young as six months of age prefer listening to open class words (Gomez 2002; Shi & Werker 2003). This early listening preference provides an important step on the way to establishing meaning, for it insures that infants will pay particular attention to just those words (the open class, content words) that will serve to anchor their first word-to-world mappings. (Morgan & Demuth 1996; Werker et al. 1996).

Early word-learning also calls on infants' ability to identify objects and events in their environment, and to notice commonalities among them. Even in the first six months of life, infants have a great deal of core knowledge, including abstract notions of animacy, intentionality, and physical causation (Baillargeon 2000; Pauen & Träuble 2009; Spelke 2000). They also have a repertoire of prelinguistic concepts, including category-based (e.g., cup, dog) and property-based (e.g., red, soft) commonalities. Because these concepts emerge before infants begin to learn words, it is reasonable to assume that these concepts are independent of language and are universally available. Each concept that the infant is capable of representing is, in essence, a candidate for word-meaning. What infants must do, then, is to home in on *which* words refer to *which* of a range of available concepts.

This brings us to the third piece of the word-learning puzzle, known as the mapping problem. In solving this piece of the puzzle, infants reveal an ability to grasp the symbolic and referential power of words. Moreover, they draw on fundamental notions related to human behavior: inferring the goals and intentions of others (Waxman & Gelman 2009). For example, the ability to map a word to its referent is predicated on an ability to infer that the speaker *intended to name* the designated object (Fennell & Waxman 2010; Jaswal 2004). By their first birthdays, infants have begun to make such connections.

Finally, if infants are to extend words appropriately beyond the particular individual(s) with which they were introduced, infants must go beyond word-to-*object* mappings to establish word-to-*concept* mappings (Gelman 2006; Waxman & Leddon 2009; Waxman & Lidz 2006). In essence, then, to apply a word (e.g., *bird*) to a new and (as yet) unlabeled object, infants must make an inference regarding the novel word's extension.

Different Kinds of Words Highlight Different Aspects of a Scene

To make matters more complicated, many different *types* of words can be appropriately offered in a single naming episode, with each type of word highlighting a different aspect of the very same scene and each supporting a unique pattern of extension. For example, across languages, nouns (count nouns, if there is a mass-count distinction in the language) ("Look, it's a *bird*") typically refer to the named object itself and are extended spontaneously to other members of the same object kind (other birds); proper nouns ("Look, it's *Clara*") also refer to the named individual, but these are not extended further. Adjectives can also be applied correctly to that individual ("Look, it's *red*"); they refer to a property of the individual, and are extended to other objects sharing that property, whether or not they are birds. Verbs, in contrast, are used to describe the event, or the relation in which the individual(s) are participating ("Look, it's *pecking*, or *flying*"), and are extended to other relations of the same type.

For over a decade, we have known that by two-and-a-half years of age, children are sensitive to many of these links between kinds of words and kinds of relations among objects, and recruit them in the process of word-learning (for a review, see Waxman & Lidz 2006). Thus, they have the *linguistic* capacity to distinguish among the relevant syntactic forms (e.g., count noun vs. adjective) and the *conceptual* or *perceptual* ability to appreciate many different kinds of relations, and a tacit expectation that these linguistic and conceptual abilities are linked.

But how do these links emerge? Which, if any, are available as infants begin the process of word-learning, and how are these links shaped over the course of development? As we have pointed out, even before they reach their first birthdays or produce their first words, infants have a rich repertoire of concepts and perceptual categories. But in addition, they harbor a broad tacit expectation that novel (open class) words, independent of their grammatical form, highlight commonalities among named objects. This broad initial link serves (at least) three essential functions. First, words direct attention to commonalities, and in this way facilitate the formation of an expanding repertoire of concepts, including those that infants may not have detected as readily in the absence of a novel word. Second, this broad initial expectation (that words refer to commonalities) supports the establishment of a rudimentary lexicon. Third, and perhaps most radically, this broad initial expectation sets the stage for the discovery of more specific expectations linking *particular* types of words (nouns, adjectives, verbs) to *particular* types of meaning (object categories, object properties, event categories) in the particular language being acquired by the infant. In other words, infants' initial broad expectation (linking words (in general) to commonalities (in general)) will direct their attention in such a way as to promote their discovery of the distinct grammatical forms present in their native language, and the ways these link to meaning.

Naming and Categorization

In a series of experiments, Waxman and her colleagues examined the influence of novel words in infants ranging from 12 months of age (see Waxman & Markow 1995 for a complete description). We used a novelty-preference task (see Figure 5.1 for a sample set of stimuli and introductory phrases). During a familiarization phase, an experimenter offered an infant four different toys from a given category (e.g., four animals) one at a time, in random order. This was immediately followed by a test phase, in which the experimenter simultaneously presented both (1) a new member of the now-familiar category (e.g., another animal) and (2) an object from a novel category (e.g., a fruit). To identify the influence of novel words, infants were randomly assigned to different conditions, each varying in the experimenter's comments during familiarization. Each infant completed this task with four different sets of objects.

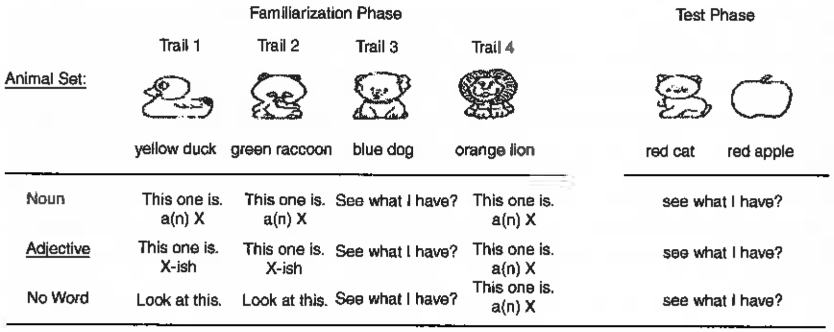

Figure 5.1. Sample set of stimuli and introductory phrases used by Waxman and Markow (1995).

We reasoned as follows: If infants detect the novel word, and if novel words direct infants' attention to commonalities among objects, then infants who hear novel words during familiarization should be more likely than those in the No Word condition to form object categories. Including both a Novel Noun and Novel Adjective condition permitted us to test the specificity of infants' initial expectation. If the expectation is initially general, as we have proposed, then infants hearing either novel nouns or adjectives should be more likely than those hearing no novel words to form object categories.

The data were consistent with this prediction: Infants on the threshold of producing language reliably detected the novel words, and these novel words (both adjectives and nouns) directed infants' attention to commonalities among the objects. In essence, then, words serve as "invitations to form categories." This invitation has several consequences. First, novel words invite infants to discover similarities among objects that might otherwise have gone unnoticed (Gelman 2006; Gentner & Namy 1999; Keates & Graham 2008; Welder & Graham 2006). Second, naming has dramatic consequences in situations in which infants have already formed object categories. After all, infants' knowledge about these categories is not as detailed as that of an older child or adult. Novel words are instrumental in motivating infants and young children to discover the deeper commonalities that underlie our richly structured object categories (Ahn & Luhmann 2004; Barsalou et al. 2008; Gelman & Kalish 2006; Landau 1994; Macnamara 1994; Markman 1989; Murphy 2004). Most importantly, the results of this series document that a link between words and concepts is in place early enough to guide infants in their very first efforts to establish word-to-world mappings.

When Do Infants Tease Apart Different Kinds of Words and Map Them to Different Kinds of Meaning?

Another closely related experimental series reveals even more precise and nuanced effects. By 14 months of age, different *kinds* of words highlight different *kinds* of commonalities. Infants were familiarized to objects sharing *both* category- and property-based commonalities (e.g., four purple animals). See Figure 5.2.

As predicted, at 11 months, infants' link was broad: They mapped novel words (either nouns or adjectives) broadly to either category- or property-based relations (Waxman & Booth 2003). But by 14 months, their expectations were more nuanced: Infants mapped nouns specifically to category-based (and not to property-based) commonalities, but they continued to map adjectives broadly to either category- or property-based relations (Waxman & Booth 2001). Later, by 18 to 21 months, infants' mappings are more precise: Infants hearing these objects described with novel nouns focused on object categories (e.g., animal); those hearing the same objects described with novel adjectives focused on object properties (e.g., purple things) (Booth & Waxman 2009; Waxman & Markow 1998).

Another series of experiments illustrated infants' acquisition of verbs. For most infants, and across most languages, verbs do not appear in appreciable number in infants' lexicons until roughly 20- to 24-months of age, several months after the appearance of nouns (for reviews, see Gleitman et al. 2005; Waxman & Lidz 2006). What accounts for this developmental phenomenon, favoring the acquisition of nouns over verbs? The conceptual underpinnings of verb meaning appear to be in place, at least in rudimentary ways, by the time infants reach their first birthdays. By 7 to 12 months, infants are sensitive to fundamental components of events, including notions of animacy, agency, and cause (Buresh, Wilson-Brune, & Woodward 2006; Casasola & Cohen 2000; Gergely et al. 1995; Gertner, Fisher, & Eisengart 2006; Leslie & Keeble 1987; Pauen & Träuble 2009; Sommerville, Woodward, & Needham 2005; Wagner & Carey 2005). Between 12 and 24 months, infants demonstrate sensitivity to other key elements of verb-meaning, including changes of state, result, manner, and path of motion (Bunger & Lidz 2004; Pruden et al. 2004; Pulverman et al. 2006).

Based on findings such as these, it seems clear that infants' delay in acquiring verbs cannot be attributed to an inability on their part to represent the kinds of concepts that underlie verb-meaning. What, then, might be holding them back? This relative delay appears to reflect a fundamental feature of verbs: The meaning of a verb depends on the linguistic arguments that it takes (and the relation among them). That is, to identify the

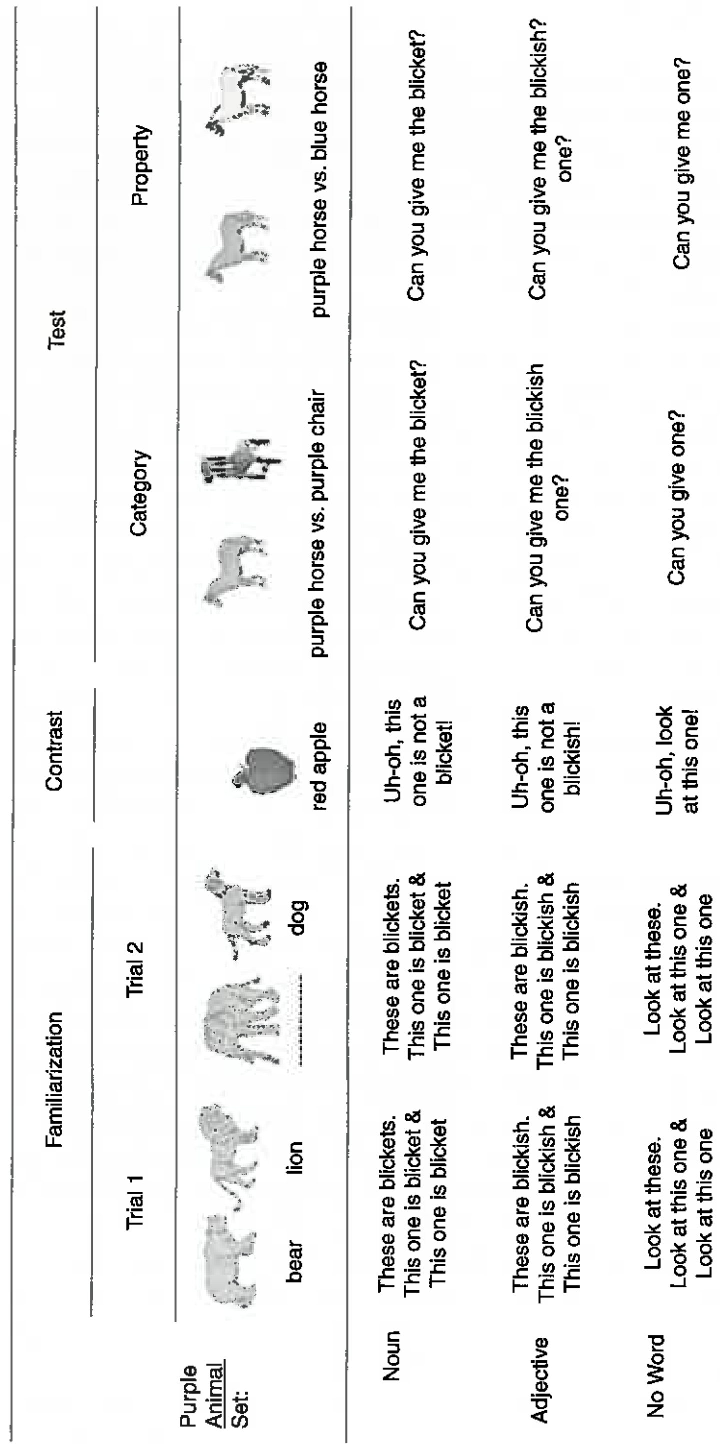

Figure 5.2. Sample set of stimuli and introductory phrases used by Waxman and Booth (2003).

event labeled by a verb, we depend on the noun phrases that represent the event participants and the linguistic relations among these phrases (Fisher et al. 1994; Gleitman et al. 2005; Landau & Gleitman 1985; Piccin & Waxman 2007; Waxman & Lidz 2006). Apparently, then, infants must first acquire at least some nouns before they can establish the meaning of verbs.

This fits well with the "noun advantage" in infants' earliest lexicons. By roughly 24 months, when infants begin to produce an appreciable number of verbs, they are also sensitive to a great deal of syntactic information (e.g., the number and types of frames in which novel verbs appear; the relations among the noun phrases in these frames) to establish a novel verb's meaning (Arunachalam & Waxman 2010; Akhtar & Tomasello 1996; Bunger & Lidz 2004; Fernandes et al. 2006; Fisher 2002; Gertner, Fisher, & Eisengart 2006; Gleitman 1990; Gleitman et al. 2005; Hirsch-Pasek, Golinkoff, & Naigles 1996; Landau & Gleitman 1985; Naigles 1990, 1996; Naigles & Kako 1993). At the same time, however, infants' efforts at verb-learning in the laboratory also reveal some striking failures, many of which persist beyond infancy into the preschool years (Imai et al. 2008; see also Kersten & Smith 2002; Meyer et al. 2003). For example, in lab tasks, 3- and 5-year-olds often map novel verbs to categories of objects, rather than events.

How can we reconcile what, until now, has been a large and largely unexplained gap between 24-month-old infants' well-documented ability to acquire verbs in the natural course of their lives and 3- and 5-year-olds' rather surprising failures in many laboratory-based tasks? Waxman and her colleagues designed a task to unravel this mystery (Waxman et al. 2009). They presented 24-month-old infants with dynamic scenes (e.g., a man waving a balloon), and asked (1) whether infants could construe these scenes flexibly, noticing the consistent action (e.g., waving) as well as the consistent object (e.g., the balloon) and (2) whether their construals were influenced by the grammatical form of a novel word used to describe them (verb or noun). See Figure 5.3. In this task, 24-month-olds successfully mapped novel verbs to event categories (e.g., waving events) and novel nouns to object categories (e.g., balloons). Considered in conjunction with other recent work, this outcome beckons the field to move beyond asking *whether* infants can learn verbs (they can), and to consider instead which conditions best support successful verb-learning in infants and young children.

Summarizing to this point, as they learn words, infants attend not only to the novel word itself: They depend crucially on its surrounding linguistic elements (e.g., determiners, arguments). They distinguish among distinct

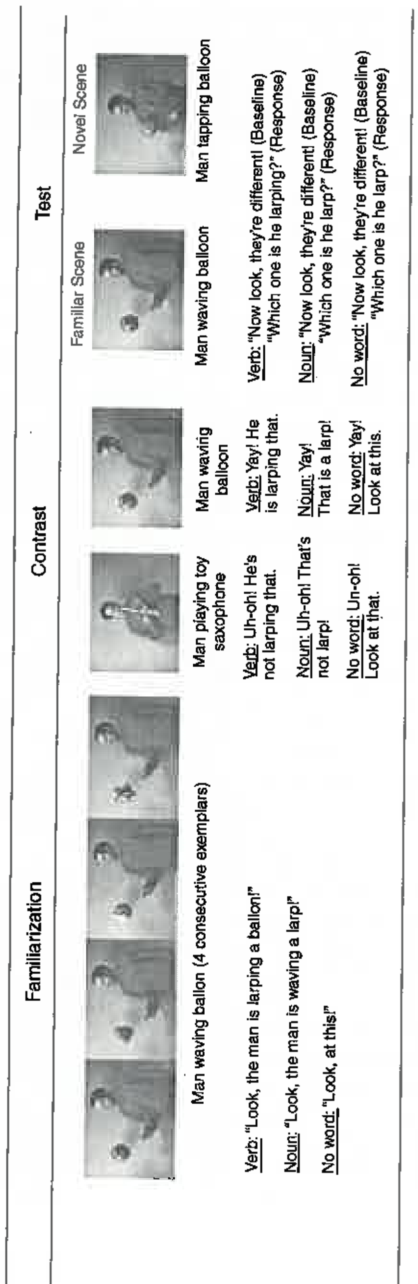

Figure 5.3. Sample set of stimuli and introductory phrases used by Waxman et al. (2009).

kinds of words, and recruit these distinctions precisely in establishing distinct kinds of meaning (e.g., categories of objects, properties, events).

Prelinguistic infants: Effects of naming. In the previous section, we traced the increasingly precise expectations regarding word-to-world mappings of infants as they crossed the important developmental thresholds of producing words on their own, and later combining them. Here, we ask whether words have cognitive consequences for infants who have not yet begun to speak. Surprisingly, the answer is yes. For example, 10-month-old infants look longer at objects that have been named than to objects presented in silence (Baldwin & Markman 1989). But does this increased attention stem from a general attention-engaging function of auditory stimuli, or does it reflect something special about words? And does naming direct infants' attention to the named exemplar only, or does it support categorization, as we have seen in infants at 11 months and older?

To address these questions, researchers have compared the effect of novel words to other kinds of auditory stimuli on infants' categorization behavior. Even for prelinguistic infants, words are indeed special (Balaban & Waxman 1997; Ferry, Hespos, & Waxman 2010). In one task, researchers have assessed 3-, 6-, and 12-month-old infants' categorization when presented with words versus tones in a novelty-preference task. During the familiarization phase, infants saw a sequence of colorful slides, each depicting a different member of a category (e.g., dinosaurs). To examine the influence of words, infants were randomly assigned to either a Word or a Tone condition. For infants in the Word condition, a naming phrase (e.g., "Oh look, it's a *toma*! Do you see the *toma*?") accompanied the familiarization trials. For infants in the Tone condition, a sine-wave tone (matched to the naming phrase in amplitude, duration, and pause length) accompanied the familiarization trials. Infants then viewed a test trial, including (1) a new member of the now-familiar category (e.g., another dinosaur) and (2) an object from a novel category (e.g., a fish). Test trials were presented in silence. If words focus attention on commonalities among objects, then infants in the Word condition should notice the commonalities among the familiarization objects. In that case, the infants should reveal a preference for the novel test object (e.g., the fish). If this effect is specific to words, and not to auditory stimulation more generally, then infants in the Tone condition should be less likely to notice these commonalities and less likely to reveal a novelty preference at test. The results supported this prediction entirely: For infants as young as 3 months of age, there is indeed something special about words. Providing a shared name for distinct individuals highlights commonalities among them.

Naming also helps infants trace the identity of distinct objects over time (Waxman & Braun 2005; Xu & Carey 1996). For example, 10-month-olds can find it taxing to keep track of the unique identities of two distinct objects (e.g., a ball and a duck), especially if these objects are presented in constant motion, with one appearing and disappearing from one side of an opaque screen, and the other appearing and disappearing from the other side (Xu & Carey 1996). However, infants' difficulty in tracking the identity of these distinct objects diminishes dramatically if each is labeled with a distinct name as it emerges from behind the screen.

Together, these results reveal that even before the advent of productive language, naming has powerful cognitive consequences. Naming supports the establishment of a repertoire of object categories and provides infants with a means of tracing the identity of individuals within these categories throughout development (Waxman & Braun 2005).

The evidence from early word-learning provides considerable support for Waxman's proposal that even before infants begin to speak, they are sensitive to a broad initial link between words (independent of their grammatical form) and a wide range of commonalities among named objects and events. By roughly 14 months, this general expectation had become more fine-tuned. Infants distinguish nouns from adjectives, and treat this distinction as relevant to establishing the meaning of novel words; they map nouns specifically to category-based (and not property-based) commonalities. Yet discovering the specific links between adjectives and properties of objects emerges later, toward the end of the second year of life. At this point, infants also successfully link verbs to event categories. In essence, then, there is a developmental cascade: Some word-world links emerge first, and others follow. At the same time, there is substantial developmental continuity. From infancy, words are powerful engines, promoting conceptual development, advancing us beyond our initial groupings, and fueling the acquisition of the rich relations that characterize our most powerful concepts.

Implications for Education

From infancy through adulthood, language and conceptual organization are intricately and powerfully linked. Language is a prime conduit for communicating our own knowledge and intentions, and conveying this information to others. As a result, language is essential not only to conceptual development in infants and preschool-aged children, but also to education. The results of the work described in this section will advance our efforts to promote positive development outcomes for the ever-increasing number of infants and young children who enter classrooms having acquired languages other than the language of the classroom. This work will also set the stage for examining infants growing up bilingual, and identifying the consequences of processing two languages in the first years of life. Finally, this basic research can also serve as a springboard for developing targeted interventions for young children diagnosed with language delay and impairments.

Learning How Words Sound

As they learn the meaning of novel words, infants also learn about the sounds of words in their language. Earlier in this chapter, we saw also that newborns prefer to listen to human speech, particularly infant-directed speech, rather than to other sources of auditory stimulation. The rhythmical and melodic contours of infant-directed speech appear to have a specific language-learning function, for example in word boundary segmentation. Infant-directed speech (IDS) emphasizes prosodic cues: Pitch is typically heightened, duration is increased, and rhythm and intonation are exaggerated. These features are found in IDS across the world's languages (Fernald et al. 1989). So the acoustic features that are important for phonological acquisition seem to be similar across languages.

Child phonologists propose that infants learn language-specific "phonotactic templates" (Vihman & Croft 2007). A phonotactic template is basically a phonological pattern. Each template contains variations in sound intensity, pitch, duration, and rhythm which together constitute a unit, usually of meaning. For spoken English, a common template is a bi-syllabic pattern with stronger first syllable stress (a strong – weak stress template). In the English template, the "strong" first syllable is typically louder, longer, and higher in pitch than the second syllable. Early acquired words that follow this pattern are "Mummy," "Daddy," and "baby." This rhythmic pattern is so strong in English that caregivers frequently change the words that they use with babies and young children to fit the pattern ("milkie," "doggie"). Developmental phonologists such as Vihman and Croft (2007) have shown that babies' own babbling also conforms to these rhythmic patterns. Babies do not babble single-syllable words. So, both auditory perception and spoken language production appear to converge onto these rhythmic templates.

These first acquisitions have been termed "prosodic structures" by the linguist Pierrehumbert (2003). Of course, typical prosodic structures or phonotactic templates vary across languages. In French, the dominant prosodic pattern depends on lengthening the final syllable, whereas Hungarian utilizes first-syllable stress. Prosody is a term used in linguistic theory to cover all aspects of grouping, rhythm, and prominence, from subparts of the syllable up through the organization of words in the phrase (Lehiste 1977; Pierrehumbert 2003). Prosody and speech rhythm are intimately linked, and languages conform to different rhythm "types." English is a stress-timed language. It has a rhythm determined by the stressing of syllables that occur at roughly equal intervals in speech. French and Hungarian are syllable-timed languages. They have rhythms determined by stressing particular syllables in particular words. The phonotactic templates that organize a preliterate child's phonological development will therefore differ across languages. This will naturally have implications for learning to be literate.

Cross-Language Similarities

Despite these differences in prosodic organization, there is widespread agreement among linguists that the syllable is the primary perceptual phonological unit across languages. Young children can be asked to reflect on their knowledge of spoken language by asking them to perform "phonological awareness" tasks. Phonological awareness tasks are performed most easily at the syllable level. For example, young children can be asked to tap once with a wooden dowel for each syllable in a word (e.g., butterfly = 3 taps), to put out a counter for each syllable in a word (e.g., president = 3 counters), or to make "same–different" judgments about words (e.g., whether "repeat" and "compete" share a syllable). High levels of performance are found across languages in tasks measuring children's awareness of syllabic structure, from age 3 to 4 years (e.g., Liberman et al. 1974; Treiman & Zukowski 1991). When Treiman and Zukowski used a same–different judgment task to measure syllable awareness, 100% of 5-year-olds, 90% of 6-year-olds, and 100% of 7-year-olds made accurate same–different judgments about syllables. Similar performance levels have been reported for Turkish kindergartners (age 6) (Durgunoglu & Oney 1999), who tapped out 94% of syllable structures correctly, Norwegian kindergartners (age 6), who counted out 83% of syllable structures correctly (Hoien et al. 1995), and German kindergarten children (age 6), who performed at 81% correct in a syllable counting task (Wimmer et al. 1991). Clearly, when pre-reading children are asked to reflect on the phonological structure of spoken language at the syllable level, they perform extremely well regardless of language.

Cross-Language Differences

Despite the ubiquity of the syllable as a perceptual linguistic unit across languages, structural elements of the syllable appear to vary across languages. Different factors that vary systematically across languages include the number of sound elements within syllables (syllable complexity – a consonant-vowel or CV syllable is "simple," a CCVCC syllable is "complex"), the types of sound elements within syllables ("sonority profile"), and phonological "neighborhood density" (the number of similar-sounding syllables to a particular target syllable in a given language). All of these factors affect the development of well-specified phonological representations of words and the development of phonological awareness skills by young children.

Syllable complexity. A simple syllable is a CV syllable, comprising a consonant sound and a vowel sound. Strikingly, most world languages have syllables with a simple CV structure. Logically, it should be easier to become "phonologically aware" of the individual sound elements in syllables that have this simple CV structure. Developing an awareness of these individual sound elements is an integral part of learning to read. However, despite its prominence as a written world language, English has primarily complex syllables. The primary syllabic structure in English is CVC. For single-syllable words (of which English has more than most languages), this structure accounts for 43% of monosyllables (e.g., "cat," "dog," "soap," "look"; see De Cara & Goswami 2002). English also has many CCVC syllables (15% of monosyllables, e.g., "trip," "plan," and "spin"), CVCC syllables (21% of monosyllables, e.g., "fast," "pant," and "jump"), and some CCVCC syllables (6%, e.g., "crust"). Only 5% of monosyllabic words follow the CV pattern ("sea," "go," "do"). Because children find it perceptually challenging to segment a complex syllable such as "pant" into four distinct elements, they often omit sounds such as the penultimate consonant sound when they learn to spell (e.g., writing PAT for "pant," or JUP for "jump"; Treiman 1998). The dominant phonological CVC template in English does not necessarily correspond to a CVC spelling pattern, however – "coat," "book," and all "magic E" words such as "make" and "time" follow a CVC phonological pattern but are spelled with more than three letters.

Sonority profile. There is also variation across languages in the types of sound elements that comprise syllables. This variation is described by the linguistic term "sonority profile." Vowels are the most sonorant sounds that the vocal tract can make, followed in decreasing order by glides (e.g., /w/), liquids (e.g., /l/), nasals (e.g., /n/), and obstruents or plosive sounds (e.g., /p/, /d/, /t/). Linguists have investigated whether there is an optimal sonority profile that is frequently represented across languages because it is easy to produce (e.g., Clements 1990). Theoretically, more sonorant sounds should be nearer to the vowel (we say "tra" but not "rta"). The majority of syllables in English end with plosive or non-sonorant sounds (such as "dog" and "cat" – around 40%). In contrast, the majority of syllables in French either end in liquids or have no consonant coda (almost 50%). To date, the effects of sonority profile have not been investigated systematically across languages with respect to the development of phonological awareness. Nevertheless, it seems likely that sonority profile will affect children's ability to segment syllables into smaller elements of sound.

Phonological neighborhood density. Phonological neighborhood density is an interesting structural factor for an incremental learning approach to child phonology. It was originally proposed by psycholinguists (e.g., Landauer & Streeter 1973; Luce & Pisoni 1998) as a metric for describing similarities and differences between words in terms of shared single sound elements or phonemes (a "phoneme" corresponds to the sounds made by single letters or letter clusters, such as the sound /f/, which corresponds to F and PH). However, phonological neighborhood density analyses for spoken English turned out to highlight the perceptual salience of phonological similarity at the level of rhyme rather than the phoneme (De Cara & Goswami 2002). In these phonological neighborhood density analyses, phonological "neighbors" are defined as words that sound similar to each other. The classical linguistic definition of a phonological neighborhood is the set of words generated by the addition, deletion, or substitution of one *phoneme* to the target (e.g., Landauer & Streeter 1973; Luce & Pisoni 1998). For example, the neighbors of the target *tin* would include *tint*, *in*, *tip*, and *tan*. When many words resemble the target, the neighborhood is said to be dense. When few words resemble the target, the neighborhood is said to be sparse. Developmental psycholinguists have also argued that a phonological neighborhood density metric based on the phoneme was unsatisfactory. For example, Dollaghan (1994) reported that the one-phoneme-different criterion led to many intuitively dissatisfying exclusions when she was calculating children's phonological neighborhoods. In particular, the one-phoneme different criterion excluded many rhyme neighbors, such as *clock* and *sock* (you cannot create *clock* by adding or substituting a single phoneme of *sock*).

De Cara and Goswami (2002) provided empirical data that supported Dollaghan's view. They carried out statistical neighborhood analyses for all monosyllabic English words in the CELEX corpus (4086 words; Baayen, Piepenbrock, & van Rijn 1993), as well as for a number of smaller English lexica controlled for age of acquisition. These statistical analyses demonstrated that most phonological neighbors in English are rhyme neighbors (e.g., *clock/sock*). This means that the phonology of English is rhyme-based, at least at the monosyllabic level. A good example of a dense phonological neighborhood in English is words that rhyme with *fair*. A good example of a sparse phonological neighborhood in English is words that rhyme with *moth*. In later work (Ziegler & Goswami 2005), we carried out similar statistical analyses for German, French, and Dutch. The German and Dutch analyses were based on the monosyllabic words in the CELEX database (Baayen et al. 1993), and the French analyses were based on the monosyllabic words in BRULEX (Content, Mousty, & Radeau 1990). The analyses showed that rhyme neighbors predominate in French, Dutch, and German phonology as well. In all of these languages, the percentage of rhyme neighbors in the monosyllabic lexicon is between 40% and 50%. The phonological neighborhood density structure of different European languages may explain why rhyme awareness is also an early emerging skill.

Changes in Phonological Representation as Literacy Is Learned

Once reading skills are acquired, the way in which the brain represents phonology changes. As Port (2007, p. 143) commented, once we are literate "speech [seems to present] itself to our consciousness in the form of letter-like symbolic units." The ease or difficulty with which the spelling system of a language supports the development of these "letter-like symbolic units" (classically, these units are called *phonemes*) will play a role in literacy acquisition in different languages, and in the transfer of literacy skills between languages. This factor is called *orthographic consistency* or *orthographic transparency*.

We have provided detailed analyses elsewhere to demonstrate that the orthographic consistency of different European languages has dramatic effects on how rapidly children learning those languages develop an awareness of phonemes (Ziegler & Goswami 2005). We have also shown how differences in orthographic consistency are related systematically to how rapidly children learning different languages become efficient at single-word reading (Ziegler & Goswami, 2005, 2006). Our analyses demonstrate that children acquiring reading in languages with high orthographic consistency, that is mainly one-to-one mappings between letters and sounds, learn about phonemes more rapidly. In languages such as Finnish, Greek, German, Spanish, and Italian, a letter corresponds consistently to one phoneme, and children acquire phoneme awareness rapidly. In languages such

Table 5.1. Illustrative Data (% correct) from Studies Comparing Phoneme Counting, Simple Word Reading and Nonword Reading in Different Languages in Kindergarten or Early Grade 1

Language	% phonemes counted correctly	% familiar real words read correctly[8]	% simple nonwords read correctly[8]
Greek	98[1]	98	97
Turkish	94[2]	-	-
Italian	97[3]	95	92
German	81[4]	98	98
Norwegian	83[5]	92	93
French	73[6]	79	88
English	70[7]	34	41

Notes: 1 = Harris & Giannoulis 1999; 2 = Durgunoglu & Oney 1999; 3 = Cossu et al. 1988; 4 = Hoien et al. 1995; 5 = Wimmer et al. 1991; 6 = Demont & Gombert 1996; 7 = Liberman et al. 1974; 8 = Seymour, Aro, & Erskine 2003 (familiar real words = content and function words, nonwords = monosyllabic items only).

as English, French, Portuguese, and Danish, there is a one-to-many mapping between letters and phonemes, and children acquire phoneme awareness more slowly (see Ziegler & Goswami 2005, 2006, for more detailed evidence). English has a particularly high level of orthographic inconsistency. Many letters or letter clusters can be pronounced in more than one way. Examples include *O* in "go" and "do," *EA* in "bead" and "bread," and *G* in "magic" and "bag" (see Berndt, Reggia, & Mitchum 1987; Ziegler, Stone, & Jacobs 1997). Hence children who are learning to read in English show particularly slow acquisition of phoneme awareness.

A table based on studies using the phoneme-counting task, which shows cross-language variation in the development of phoneme awareness, is provided as Table 5.1. Very similar differences between languages are found if children are asked to read aloud simple words and nonwords (i.e., if grapheme-phoneme recoding to sound is the dependent variable). For example, Seymour, Aro, and Erskine (2003) reported large differences in reading achievement during the first year of literacy instruction in 14 European Community languages. This was demonstrated using simple measures of word and nonword reading (and importantly, the word and nonword items used in the study were matched for difficulty across languages). As an example, whereas Finnish children were reading 98% of simple words accurately, English children (in Scotland) were reading only 34% of matched items correctly. Whereas Italian children were reading 95% of items correctly, French children were reading 79% of items correctly. These data are also included in Table 5.1.

According to the theoretical analysis provided here, these cross-language differences in the development of phoneme awareness and simple reading skills are a product of *both* phonological factors and orthographic factors. Children learning to read in languages such as Finnish, Italian, and Spanish are not only learning orthographically consistent languages, they speak languages with predominantly CV syllables. This simplifies the segmentation problem considerably. However, children who are learning to read in languages such as English not only have to acquire an orthographically inconsistent language, they also have a spoken language with predominantly complex syllables. The effects of both phonological and orthographic complexity on learning to be literate are considerable. As shown by the cross-language comparisons in Table 5.1, it takes children longer to learn about phonemes and to become efficient in simple reading skills for languages such as English and French compared to languages such as Finnish, Italian, and Spanish. It should also be noted that another factor that is likely to be important for cross-language differences in phonological development is morphology (Goswami & Ziegler 2006). Morphological or meaning-based changes are frequently signaled by small phonological differences. For example, in Turkish *evim* means "in my house' and *evin* means "in your house." This single phoneme change (/m/ to /n/) is critical for language comprehension. Therefore, it is a priori likely that Turkish morphology affects how rapidly Turkish children become aware of phonemes (Durgunoglu 2006). However, the cross-language database on how morphological differences affect phonological development is currently too small to attempt a systematic analysis.

Educational Difficulties in Learning to Read

So far, we have seen that the child's brain develops phonological "representations" of words in response to spoken language exposure and learning to speak. Extensive cross-language research has shown that the quality of these phonological representations then determines literacy acquisition (see Ziegler & Goswami 2005, for a detailed analysis). When phonological representations are impaired, children will struggle to acquire functional literacy skills across languages. For example, cognitive studies demonstrate that children with developmental dyslexia in all languages so far studied have difficulties with phonological awareness tasks. They find it difficult to count syllables, they find it difficult to recognize rhyme, they find it difficult to decide whether words share phonemes, and they find it difficult to substitute one phoneme for another (e.g., Kim & Davis 2004, *Korean*; Wimmer 1996, *German*; Porpodas, Pantelis, & Hantziou 1990, *Greek*; Share & Levin

1999, *Hebrew*). Numerous studies in English in particular have shown that children with developmental dyslexia remain poor at tasks such as deciding whether words rhyme (Bradley & Bryant 1978). They remain poor at making accurate judgments in counting or same–different judgments (Swan & Goswami 1997), at making oddity judgments about phonemes (Bowey, Cain, & Ryan 1992), and at phoneme swapping tasks (Landerl, Wimmer, & Frith 1997). These difficulties persist into the teenage years (e.g., Bruck 1992).

However, for dyslexic children who are learning to read transparent orthographies, reading has an impact on phonological awareness. Learning consistent letter–sound relationships appears to help children to specify phonological similarities and differences between words. For example, German dyslexic children show age-appropriate phonological skills in some phonological awareness tasks (those that can be solved using letters) by the age of 10 years. A Spoonerism task is an example of a phonological awareness task that can be solved using letter–sound knowledge. In Spoonerism tasks, the child has to swap the beginning sounds in words (like Reverend Spooner, who told students "You have hissed all my mystery lectures"). For example, the child may have to say "Dob Bylan" instead of "Bob Dylan". German dyslexic children eventually became able to do such tasks as well as typically developing control children (Wimmer 1993). However, when German dyslexic children are compared to age-matched English dyslexic children, the Germans perform much better in Spoonerism tasks because of their more transparent spelling system (Landerl et al. 1997).

Despite measurable phonological difficulties in children with developmental dyslexia across languages, for most of the world's languages, differences in the *accuracy* of decoding is only found in the very earliest stages of reading. Studies of young German and Greek children who later turned out to have specific reading difficulties showed that word and nonsense word reading was significantly poorer than that of age-matched controls in the first year of reading instruction, but this difference soon disappeared (Porpodas 1999; Wimmer 1993). Although difficulties with phonology remain for children learning to read transparent orthographies, these difficulties do not impede reading accuracy; rather, they impede reading *speed* and *spelling* accuracy. Developmental dyslexia in most languages other than English is usually diagnosed on the basis of extremely slow and effortful reading, and strikingly poor spelling.

For English children, however, developmental dyslexia is characterized by both inaccurate and effortful reading and by inaccurate spelling. Even dyslexic adults in English remain poor at decoding words accurately (Bruck

1992). Hence the same cognitive phonological deficit can manifest differently in different languages. In fact, English children with developmental dyslexia perform significantly more poorly in tasks such as nonsense word reading compared to German children with developmental dyslexia, even when they are trying to read the same items (e.g., nonsense words such as "grall"; see Landerl et al., 1997). This demonstrates the pervasive effects of learning to read an inconsistent orthography on reading development. The consequences of having a phonological deficit are more profound in developmental terms for literacy in English.

Implications for Education: Phonological Interventions

Current early screening tools for identifying developmental dyslexia are relatively ineffective, generating many false positives. However, we know that effective interventions for developmental dyslexia are based on phonology. The most effective interventions are thus likely to be *generic* interventions that develop excellent phonological skills in *all* children during the early years. Such generic intervention can then be followed by differentiated interventions for those most at risk. For example, teachers can be trained to recognize children who are unresponsive to generic enrichment, thereby identifying those with likely learning difficulties. These children could then receive more specific interventions such as individualized treatments. For phonological difficulties and literacy, early generic intervention with later individualized and differentiated intervention seems likely to offer the highest return on educational investment.

Targeted phonological interventions that include teaching children about letters across languages generally are effective in improving developmental dyslexia (mean effect size 0.67, Bus & van IJzendoorn 1999). Many interventions considered by Bus and van IJzendoorn were for school-aged children, but they reported greater effects for preschool children. The effects can be considerable. For example, a successful generic phonology-based intervention in German with younger pre-reading children (the 20-week program "Hearing, Listening, Learning" developed by Schneider and his colleagues, which is delivered by German kindergarten teachers), reported an effect size of 0.57 for spelling development by Grade 2, with a smaller effect size for reading (0.26; see Schneider, Roth, & Ennemoser 2000). Further studies by Schneider and his colleagues have revealed similar enhancement of reading and spelling following phonological training for migrant children from other language backgrounds, and also for children with spoken language difficulties. Importantly, the phonological training for the migrant children was delivered in the mother tongue (e.g., Turkish migrant children received oral language interventions in Turkish, and this had an impact on learning to read in German). Phonological interventions with older at-risk children in English also show large effect sizes (0.69), which translate into gains of around 7 standardized score points in reading (Hatcher et al. 2006). These studies suggest that phonological interventions that link phonological training to letter–sound relations offer an important tool for early educational intervention.

Parents and the home environment also play a crucial role in literacy development. Connor et al. (2004) estimated that the family environment was the major source of the variability in children's literacy skills at school entry. The learning environment provided by the home influences both phonological development (e.g., via oral language practices in the home such as nursery rhymes and singing) and how much exposure to print the child receives (e.g., the number of books in the home, parental valuation of literacy, etc.). Unsurprisingly, therefore, interventions that are designed to introduce books into the home and to demonstrate optimal "shared reading" practices are also effective in fostering early literacy skills (e.g., Whitehurst et al. 1994). Typical effect sizes are about 0.50, which is medium to large. Interventions that involve shared reading enhance the spoken language that caregivers use with young children as well as providing exposure to print. The spoken language input is important, as overall language skills (vocabulary development and use of complex language) as well as phonological awareness and letter knowledge are extremely strong predictors of later literacy. Effective shared reading program also teach caregivers to use books as a starting point for dialogue. The books thereby increase the complexity of the language used with the child and also make the parent more responsive to the interests of the child ("responsive contingency," Bornstein & Tamis-LeMonda 1989). Responsive contingency is also an important predictor of later independent learning. Hence, interactions around books affect more than the developmental trajectory for later literacy learning: These interactions also affect memory and conceptual development, and the development of social cognition and reasoning skills, as well as the child's ability to manage his or her own behavior.

Chapter Conclusion

The research reviewed here illustrates some of the developmental trajectories that make early language acquisition so critical for later school achievement. Word learning (vocabulary development) is exponential in early childhood. Using the "Child Language Checklist" (now translated into 12 languages), Fenson et al. (1994) showed that median English spoken vocabulary size was 55 words by 16 months of age, 225 words by 23 months, 573 words by 30 months, and 6000 words by age 6. Comprehension vocabulary at age 6 is around 14,000 words (Dollaghan 1994). However, the developmental range can be enormous. For example, at 2 years, the range in word production was from 0 words to more than 500 words (Fenson et al. 1994). New-word learning is extremely rapid, with around 10 new words acquired daily at age 2. Clearly, talking to children and enriching their language experiences via books and other media can play an important role in enhancing later achievement. Most important of all, language is symbolic. This symbolic system enables children to detach themselves from the immediate situation, enabling cognition itself to become the object of thought and reflection. The long-lasting and pervasive effects on memory, reasoning, self-regulation, and theory of mind mean that enhancing early language enhances the child's entire cognitive repertoire.

Acknowledgments

Preparation of this chapter was supported by grants from the National Institute of Health (HD030410 to Waxman) and the Medical Research Council (G0400574 to Goswami). We are indebted to the parents who agreed to have their infants and children participate in the experiments we have described and to the members of our respective labs for their dedication and discoveries. Finally, thanks to Erin Leddon and Jennifer Woodring for editorial assistance.

REFERENCES

Ahn, W. & Luhmann, C. C. (2004). Demystifying theory-based categorization. In L. Gershkoff-Stowe & D. Rakison (Eds.), *Building object categories in developmental time* (pp. 277–300). Mahwah, NJ: Lawrence Erlbaum Associates.

Akhtar, N. & Tomasello, M. (1996). Two-year-olds learn words for absent objects and actions. *British Journal of Developmental Psychology*, **14**, 79–93.

Arunachalam, S. & Waxman, S.R (2010). Meaning from syntax: Evidence from 2-year-olds. *Cognition*, **114**(3), 442–446.

Baayen, R. H., Piepenbrock, R., & van Rijn, H. (1993). *The CELEX lexical database (CD-ROM)*. Philadelphia: Linguistic Data Consortium, University of Pennsylvania.

Baillargeon, R. (2000). How do infants learn about the physical world? In D. Muir & A. Slater (Eds.), *Infant development: The essential readings. Essential readings in development psychology* (pp. 195–212). Malden, MA: Blackwell.

Balaban, M. T. & Waxman, S. R. (1997). Do words facilitate object categorization in 9-month-old infants? *Journal of Experimental Child Psychology*, **64**(1), 3–26.

Baldwin, D. A. & Baird, J. A. (1999). Action analysis: A gateway to intentional inference. In P. Rochat (Ed.), *Early social cognition: Understanding others in the first months of life* (pp. 215–240). Mahwah, NJ: Lawrence Erlbaum Associates.

Baldwin, D. A. & Markman, E. M. (1989). Establishing word-object relations: A first step. *Child Development*, **60**(2), 381–398.

Barsalou, L. W., Santos, A., Simmons, W. K., & Wilson, C. D. (2008). Language and simulation in conceptual processing. In M. De Vega, A. M. Glenberg, & A. C. Graesser (Eds.). *Symbols, embodiment, and meaning* (pp. 245–283). Oxford: Oxford University Press.

Berndt, R. S., Reggia, J. A., & Mitchum, C. C. (1987). Empirically derived probabilities for grapheme-to-phoneme correspondences in English. *Behavior Research Methods, Instruments, & Computers*, **19**, 1–9.

Booth, A. E. & Waxman, S. R. (2009). A horse of a different color: Specifying with precision infants' mappings of novel nouns and adjectives. *Child Development*, **80**(1), 15–22.

Bornstein, M. & Tamis-LeMonda, C. S. (1989). Maternal responsiveness and cognitive development in children. In M. H. Bornstein (Ed.), *Maternal responsiveness, characteristics and consequences*. San Francisco: Jossey-Bass.

Bornstein, M. H., Cote, L. R., Maital, S., Painter, K., Park, S.-Y., & Pascual, L. (2004). Cross-linguistic analysis of vocabulary in young children: Spanish, Dutch, French, Hebrew, Italian, Korean, and American English. *Child Development*, **75**(4), 1115–1139.

Bowey, J. A., Cain, M. T., & Ryan, S. M. (1992). A reading-level design study of phonological skills underlying fourth grade children's word reading difficulties. *Child Development*, **63**, 999–1011.

Bradley, L. & Bryant, P. E. (1978). Difficulties in auditory organization as a possible cause of reading backwardness. *Nature*, **271**, 746–747.

Bruck, M. (1992). Persistence of dyslexics' phonological awareness deficits. *Developmental Psychology*, **28**, 874–886.

Bunger, A. & Lidz, J. (2004). Syntactic bootstrapping and the internal structure of causative events. Proceedings of the 28th Annual Boston University Conference on Language Development. Somerville, MA: Cascadilla Press.

Buresh, J., Wilson-Brune, C., & Woodward, A. L. (2006). Prelinguistic action knowledge and the birth of verbs. In K. Hirsh-Pasek & R. M. Golinkoff (Eds), *Action meets word* (pp. 208–227). Oxford: Oxford University Press.

Bus, A. G. & vanIJzendoorn, M. H. (1999). Phonological awareness and early reading: A meta-analysis of experimental training studies. *Journal of Educational Psychology*, **91**(3), 403–414.

Casasola, M. & Cohen, L. B. (2000). Infants' association of linguistic labels with causal actions. *Developmental Psychology*, **36**(2), 155–168.

Clements, G. N. (1990). The role of the sonority cycle in core syllabification. In J. Kingston & M. E. Beckman (Eds.), *Papers in laboratory phonology 1: Between the grammar and physics of speech* (pp. 283–333). Cambridge: Cambridge University Press.

Connor, C. M., Morrison, F. J., & Katch, L. E. (2004). Beyond the reading wars: Exploring the effect of child-instruction interactions on growth in early reading. *Scientific Studies of Reading*, **8**(4), 305–336.

Content, A., Mousty, P., & Radeau, M. (1990). BRULEX: A computerized lexical data base for the French language/BRULEX. *Une base de donnees lexicales informatisee pour le francais ecrit et parle. Annee Psychologique*, **90**(4), 551–566.

De Cara, B. & Goswami, U. (2002). Statistical analysis of similarity relations among spoken words: Evidence for the special status of rimes in English. *Behavioural Research Methods and Instrumentation*, **34**(3), 416–**423**.

Dollaghan, C. A. (1994). Children's phonological neighbourhoods: Half empty or half full? *Journal of Child Language*, **21**, 257–271.

Durgunoglu, A. Y. (2006). Learning to read in Turkish. *Developmental Science*, **9**, 437–438.

Durgunoglu, A. Y. & Oney, B. (1999). A cross-linguistic comparison of phonological awareness and word recognition. *Reading & Writing*, **11**, 281–299.

Fennell, C. & Waxman, S. R. (2010). What paradox? Referential cues allow for infant use of phonetic detail in word learning. *Child Development*, **81**(5), 1376–1383.

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D., & Pethick, S. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development*, **59**(5), Serial no. 242.

Fernald, A., Taeschner, T., Dunn, J., Papousek, M., Boysson-Bardies, B., & Fukui, I. (1989). A cross-language study of prosodic modifications in mothers' and fathers' speech to preverbal infants. *Journal of Child Language*, **16**, 477–501.

Fernandes, K. J., Marcus, G. F., DiNubila, J. A., & Vouloumanos, A. (2006). From semantics to syntax and back again: Argument structure in the third year of life. *Cognition*, **100**, B10–B20.

Ferry, A. L., Hespos, S. J., & Waxman, S. R. (2010). Categorization in 3- and 4-month-old Infants: An advantage of words over tones. *Child Development*, **81**, 472–479.

Fisher, C. (2002). Structural limits on verb mapping: The role of abstract structure in 2.5-year-olds' interpretations of novel verbs. *Developmental Science*, **5**, 56–65.

Fisher, C., Hall, G., Rakowitz, S., & Gleitman, L. (1994). When it is better to receive than to give: Structural and cognitive factors in acquiring a first vocabulary. *Lingua*, **92**, 333–376.

Gelman, S. A. (2006). Early conceptual development. In K. McCartney & D. Phillips (Eds.), *Blackwell handbook of early childhood development* (pp. 149–166). Malden, MA: Blackwell.

Gelman, S. A. & Kalish, C. W. (2006). Conceptual development. In W. Damon & R. M. Lerner (Series Eds.), & D. Kuhn & R. S. Siegler (Vol. Eds.), *Handbook of child psychology: Vol. 2 cognition, perception, and language* (6th ed., pp. 687–733). Hoboken, NJ: Wiley.

Gentner, D. & Namy, L. (1999). Comparison in the development of categories. *Cognitive Development*, **14**, 487–513.

Gergely, G., Nádasdy, Z., Csibra, G., & Bíró, S. (1995). Taking the intentional stance at 12 months of age. *Cognition*, **56**, 165–193.

Gertner, Y., Fisher, C., & Eisengart, J. (2006). Learning words and rules: Abstract knowledge of word order in early sentence comprehension. *Psychological Science*, **17**, 684–691.

Gleitman, L. (1990). The structural sources of verb meanings. *Language Acquisition: A Journal of Developmental Linguistics*, **1**(1), 3–55.

Gleitman, L. R., Cassidy, K., Nappa, R., Papafragou, A., & Trueswell, J. C. (2005). Hard words. *Language Learning and Development*, **1**(1), 23–64.

Golinkoff, R. M. & Hirsh-Pasek, K. (2006). Introduction: Progress on the verb learning front. In K. Hirsh-Pasek & R. M. Golinkoff (Eds.), *Action meets word: How children learn verbs* (pp. 3–28). NewYork: Oxford University Press.

Gomez, R. (2002). Variability and detection of invariant structure. *Psychological Science*, **13**, 431–436.

Goswami, U. & Ziegler, J. C. (2006). Fluency, phonology and morphology: A response to the commentaries on Becoming Literate in Different Languages. *Developmental Science*, **9**, 451–453.

Harris, M. & Giannouli, V. (1999). Learning how to read and spell in Greek: The importance of letter knowledge and morphological awareness. In M. Harris & G. Hatano (Eds.), *Learning to read and write: A cross-linguistic perspective* (pp. 41–70). Cambridge: Cambridge University Press

Hart, B. H. and Risley, T. R. 1995. *Meaningful differences in the everyday experience of young American children.* Baltimore, MD: Paul H. Brookes.

Hatcher, P. J., Hulme, C., Miles, J. N. V., Carroll, J. M., Hatcher, J., Gibbs, S., Smith, G., Bowyer-Crane, C., & Snowling, M. J. (2006). Efficacy of small-group reading intervention for beginning readers with reading delay: A randomized controlled trial. *Journal of Child Psychology & Psychiatry*, **47**, 820–827.

Hirsh-Pasek, K., Golinkoff, R., & Naigles, L. (1996). Young children's use of syntactic frames to derive meaning. In K. Hirsh-Pasek & R. M. Golinkoff (Eds.), *The origins of grammar.* Cambridge, MA: MIT Press.

Hoien, T., Lundberg, L., Stanovich, K. E., & Bjaalid, I. K. (1995). Components of phonological awareness. *Reading & Writing*, **7**, 171–188.

Huttenlocher, J., Vasilyeva, M., Cymerman, E., & Levine, S. (2002). Language input and child syntax. *Cognitive Psychology*, **45**, 337–374.

Imai, M., Lianjing L., Haryu, E., Okada, H., Hirsh-Pasek, K., Golinkoff, R. M., & Shigematsu, J. (2008). Novel noun and verb learning in Chinese-, English-, and Japanese-speaking children. *Child Development*, **79**, 979–1000.

Jaswal, V. K. (2004). Don't believe everything you hear: Preschoolers' sensitivity to speaker intent in category induction. *Child Development*, **75**, 1871–1885.

Jusczyk, P. & Aslin, R. N. (1995). Infants' detection of the sound patterns of words in fluent speech. *Cognitive Psychology*, **29**(1), 1–23.

Keates, J. & Graham, S. A. (2008). Category labels or attributes: Why do labels guide infants' inductive inferences? *Psychological Science*, **19**, 1287–1293.

Kemler Nelson, D. G., Hirsh-Pasek, K., Jusczyk, P. W., & Cassidy, K. W. (1989). How the prosodic cues in motherese might assist language learning. *Journal of Child Language*, **16**(1), 55–68.

Kersten, A. W. & Smith, L. B. (2002). Attention to novel objects during verb learning. *Child Development*, **73**(1), 93–109.

Kim, J. & Davis, C. (2004). Characteristics of poor readers of Korean Hangul: Auditory, visual and phonological processing. *Reading and Writing*, **17**(1–2), 153–185.

Landau, B. & Gleitman, L. (1985). *Language and experience: Evidence from the blind child.* Cambridge, MA: Harvard University Press.

(1994). Object shape, object name, and object kind: Representation and development. In D. L. Medin (Ed.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 31, pp. 253–304). San Diego, CA: Academic Press.

Landauer, T. K., & Streeter, L. A. (1973). Structural differences between common and rare words: Failure of equivalence assumptions for theories of word recognition. *Journal of Verbal Learning and Verbal Behaviour*, **12**, 119–131.

Landerl, K., Wimmer, H., & Frith, U. (1997) The impact of orthographic consistency on dyslexia: A German-English comparison. *Cognition*, **63**, 315–334.

Landry, S. H. (2005). *Effective early childhood programs: Turning knowledge into Action.* University of Texas Houston Health Science Center, Houston, Texas.

Lehiste, I. (1977) *Suprasegmentals.* Cambridge, MA/London: M.I.T. Press.

Leslie, A. M. & Keeble, S. (1987). Do six-month-old infants perceive causality? *Cognition*, **25**, 265–288.

Liberman, I. Y., Shankweiler, D., Fischer, F. W., & Carter, B. (1974). Explicit syllable and phoneme segmentation in the young child. *Journal of Experimental Child Psychology*, **18**, 201–212.

Luce, P.A., & Pisoni, D. B. (1998). Recognising spoken words: The neighbourhood activation model. *Ear & Hearing*, **19**, 1–36.

Macnamara, J. (1994). Logic and cognition. In J. Macnamara & G. E. Reyes (Eds.), *The logical foundations of cognition. Vancouver studies in cognitive science*, Vol. 4 (pp. 11–34). New York: Oxford University Press.

Markman, E. M. (1989). *Categorization and naming in children: Problems of induction.* Cambridge, MA: MIT Press.

Meyer, M., Leonard, S., Hirsh-Pasek, K., Imai, M., Haryu, E., Pulverman, R., & Addy, D. (2003). *Making a convincing argument: A crosslinguistic comparison of noun and verb learning in Japanese and English.* Paper presented at the 28th Annual Boston Conference on Language Development. Boston University, Boston, MA.

Morgan, J. L. & Demuth, K. (Eds.). (1996). *Signal to syntax: Bootstrapping from speech to grammar in early acquisition.* Mahwah, NJ: Lawrence Erlbaum Associates.

Murphy, G. (2004). *The big book of concepts.* Cambridge, MA: MIT Press.

Naigles, L. (1990). Children use syntax to learn verb meanings. *Journal of Child Language*, **17**, 357–374.

(1996). The use of multiple frames in verb learning via syntactic bootstrapping. *Cognition*, **58**, 221–251.

Naigles, L. & Kako, E. (1993). First contact in verb acquisition: Defining a role for syntax. *Child Development*, **64**, 1665–1687.

Pauen, S. & Träuble, B. (2009). How 7-month-olds interpret ambiguous motion events: Category-based reasoning in infancy. *Cognitive Psychology*, **59**(3), 275–295.

Piccin, T. B. & Waxman, S. R. (2007). Why nouns trump verbs in word learning: New evidence from children and adults in the Human Simulation Paradigm. *Language Learning and Development*, **3**(4), 295–323.

Pierrehumbert, J. (2003). Phonetic diversity, statistical learning and acquisition of phonology. *Language & Speech*, **46**, 115–154.

Porpodas, C. D., Pantelis, S. N., & Hantziou, E. (1990). Phonological and lexical encoding processes in beginning readers: Effects of age and word characteristics. *Reading and Writing*, **2**, 197–208.

Porpodas, C. D. (1999). Patterns of phonological and memory processing in beginning readers and spellers of Greek. *Journal of Learning Disabilities*, **32**, 406–416.

Port, R. (2007). How are words stored in memory? Beyond phones and phonemes. *New Ideas in Psychology*, **25**, 143–170.

Pruden, S. M., Hirsh-Pasek, K., Maguire, M. J., & Meyer, M. A. (2004). Foundations of verb learning: Infants form categories of path and manner in motion events. In A. Brugos, L. Micciulla & C. E. Smith (Eds.), *Proceedings of 28th annual Boston University Conference on language development* (pp. 461–472). Somerville, MA: Cascadilla Press.

Pulverman, R., Hirsh-Pasek, K., Pruden, S., & Golinkoff, R. M. (2006). Precursors to verb learning: Infant attention to manner and path. In K. Hirsh-Pasek & R. M. Golinkoff (Eds.), *Action meets word: How children learn verbs* (pp. 134–160). New York: Oxford University Press.

Schneider, W., Roth, E., & Ennemoser, M. (2000). Training phonological skills and letter knowledge in children at-risk for dyslexia: A comparison of three kindergarten intervention programs. *Journal of Educational Psychology*, **92**, 284– 295.

Seymour, P. H. K., Aro, M., & Erskine, J. M. (2003). Foundation literacy acquisition in European orthographies. *British Journal of Psychology*, **94**, 143–174.

Share, D. & Levin, I. (1999). Learning to read and write in Hebrew. In M. Harris & G. Hatano (Eds.), *Learning to read and write: A cross-linguistic perspective* (pp. 89–111). New York: Cambridge University Press.

Shi, R. & Werker, J. F. (2003). The basis of preference for lexical words in 6-month-old infants. *Developmental Science*, **6**(5), 484–488.

Sommerville, J. A., Woodward, A. L., & Needham A. (2005). Action experience alters 3-month-old infants' perception of others' actions. *Cognition*, **96**, B1–B11.

Spelke, E. S. (2000). Nativism, empiricism, and the origins of knowledge. In D. Muir & A. Slater (Eds.), *Infant development: The essential readings. Essential readings in development psychology* (pp. 36–51). Malden, MA: Blackwell.

Swan, D., & Goswami, U. (1997). Phonological awareness deficits in developmental dyslexia and the phonological representations hypothesis. *Journal of Experimental Child Psychology*, **66**(1), 18–41.

Treiman, R. (1998). Beginning to spell in English. In C. Hulme & R. M. Joshi (Eds.), *Reading and spelling: Development and disorders* (pp. 371–393). Mahwah, NJ: Lawrence Erlbaum Associates.

Treiman, R. & Zukowski, A. (1991). Levels of phonological awareness. In S. Brady & D. Shankweiler (Eds.), *Phonological processes in literacy*. Hillsdale, NJ: Erlbaum.

Vihman. M. & Croft, W. (2007). Phonological development: Towards a "radical" templatic phonology. *Linguistics*, **45**, 683–725.

Wagner, L. & Carey, S. (2005). 12-month-old infants represent probable endings of motion events. *Infancy*, **7**(1), 73–83.

Waxman, S. R. & Booth, A. E. (2001). Seeing pink elephants: Fourteen-month-olds' interpretations of novel nouns and adjectives. *Cognitive Psychology*, **43**(3), 217–242.

(2003). The origins and evolution of links between word learning and conceptual organization: New evidence from 11-month-olds. *Developmental Science*, **6**(2), 130–137.

Waxman, S. R. & Braun, I. E. (2005). Consistent (but not variable) names as invitations to form object categories: New evidence from 12-month-old infants. *Cognition*, **95**, B59–B68.

Waxman, S. R. & Gelman, S. A. (2009). Early word-learning entails reference, not merely associations. *Trends in Cognitive Sciences*, **13**(6), 258–263.

Waxman, S. R. & Lidz, J. (2006). Early word learning. In D. Kuhn & R. Siegler (Eds.), *Handbook of child psychology*, Vol. 2 (6th ed.). Hoboken, NJ: John Wiley & Sons.

Waxman, S. R. & Markow, D. B. (1995). Words as invitations to form categories: Evidence from 12- to 13-month-old infants. *Cognitive Psychology*, **29**(3), 257–302.

(1998). Object properties and object kind: Twenty-one-month-old infants' extension of novel adjectives. *Child Development*, **69**(5), 1313–1329.

Waxman, S. R., Lidz, J. L., Braun, I. E., & Lavin, T. (2009). 24-month-old infants' interpretations of novel verbs and nouns in dynamic scenes. *Cognitive Psychology*, **59**(1), 67–95.

Welder, A. N. & Graham, S. A. (2006). Infants' categorization of novel objects with more or less obvious features. *Cognitive Psychology*, **52**, 57–91.

Werker, J. F., Lloyd, V. L., Pegg, J. E., & Polka, L. (1996). Putting the baby in the bootstraps: Toward a more complete understanding of the role of the input in infant speech processing. In J. L. Morgan & K. Demuth (Eds.), *Signal to syntax: Bootstrapping from speech to grammar in early acquisition* (pp. 427–447). Mahwah, NJ: Lawrence Erlbaum Associates.

Whitehurst, G. J. et al. (1994). A picture book reading intervention in day care and home for children from low-income families. *Developmental Psychology*, **30**, 679–689.

Wimmer, H. (1993). Characteristics of developmental dyslexia in a regular writing system. *Applied Psycholinguistics*, **14**, 1–33.

(1996). The nonword reading deficit in developmental dyslexia: Evidence from children learning to read German. *Journal of Experimental Child Psychology*, **61**, 80–90.

Wimmer, H., Landerl, K., Linortner, R., & Hummer, P. (1991). The relationship of phonemic awareness to reading acquisition: More consequence than precondition but still important. *Cognition*, **40**, 219–249.

Xu, F. & Carey, S. (1996). Infants' metaphysics: The case of numerical identity. *Cognitive Psychology*, **30**(2), 111–153.

Ziegler, J. C. & Goswami, U. (2005). Reading acquisition, developmental dyslexia and skilled reading across languages: A psycholinguistic grain size theory. *Psychological Bulletin*, **131**(1), 3–29.

(2006). Becoming literate in different languages: Similar problems, different solutions. *Developmental Science*, **9**, 429–453.

Ziegler, J. C., Stone, G. O., & Jacobs, A. M. (1997). What's the pronunciation for -OUGH and the spelling for /u/? A database for computing feedforward and feedback inconsistency in English. *Behavior Research Methods, Instruments, & Computers*, **29**, 600–618.