Differences in vocabulary growth across groups and individuals

Casey Lew-
Christine E. Potter and Williams

The Oxford Handbook of the Mental Lexicon
Edited by Anna Papafragou, John C. Trueswell, and Lila R. Gleitman

Print Publication Date: Jan 2022 Subject: Linguistics, Psycholinguistics, Semantics
Online Publication Date: Feb 2022 DOI: 10.1093/oxfordhb/9780198845003.013.22

Abstract and Keywords

This chapter describes causes and consequences of individual differences in young children's word learning. For decades, research has documented qualitative and quantitative differences in children's language input, and it has been convincingly demonstrated that across different communities, children's vocabulary growth can be linked to their language experiences. However, children also actively shape their own learning environment, and it is important to consider how their cognitive abilities, as well as their interests, shape their language experiences and their learning. Only by examining children with a wide range of experiences (e.g., children growing up in multilingual communities) and abilities (e.g., children with developmental delays or disorders) will it be possible to develop theories that adequately capture and explain differences in children's word learning and vocabulary growth.

Keywords: language input, word learning, multilingualism, cognitive abilities, language disorders

21.1 Introduction

YOUNG children vary in how they learn words, and developmental scientists vary in how they emphasize individual differences in research on word learning. While the evaluation of variability is built into any empirical study—in the form of statistical tests and conventional reporting of standard deviations and outliers—only a subset of studies examines individual differences as a research question or as a way to interpret data. A common way to motivate developmental science is to focus on average differences *between* samples of children or experimental conditions, but an equally rich approach is to focus on differences *within* a sample of children and to explore relations among different skills. The examination of individual differences is an important device in two primary ways: for understanding the mechanisms of learning, and for making predictions about children's outcomes.

The purpose of this chapter is to examine both causes and consequences of individual differences in children's early vocabulary growth and word learning. We suggest that by testing associations and dissociations between different types of abilities, experiences, and knowledge, it becomes possible to draw key inferences about word learning and child development. In turn, these findings can be used to develop more careful, inclusive, and complete theories of learning across a range of populations.

(p. 439) 21.1.1 Mechanisms of individual differences

Examining relations between children's abilities and outcomes often provides useful insights into developmental mechanisms. For example, a long-standing question in language research is whether or not a particular skill is specific to language. Vocabulary knowledge has been linked to diverse cognitive skills, including attention and memory (e.g., Salley, Panneton, and Colombo, 2013; Swanson, 1996) and even the development of motor skills (Iverson and Wozniak, 2007), suggesting influences of domain-general processes. At the same time, correlations between word knowledge and verbal measures are often more reliable than relations with non-verbal tasks (e.g., Newman, Ratner, Jusczyk, Jusczyk, and Dow, 2006; Rajan, Konishi, Ridge et al., 2019), suggesting there may also be some specialization. Correlational studies cannot provide proof of causal relations between different abilities, but examinations of associations between children's vocabulary knowledge and other skills have challenged notions of modularity and yielded many observations that have helped build comprehensive theories of developmental change (Bates, Dale, and Thal, 1995).

The study of individual differences has also been used to inform discussions about children's use of different mechanisms for learning new words over the course of development. Children are often able to demonstrate comprehension of words before they produce them, and studies that track children's learning over time have highlighted not only the fact that children do not add words to their lexicons at a consistent rate but also that the trajectory of children's learning varies widely (e.g., Fenson, Dale, Reznick et al., 1994). For instance, some children demonstrate sharp growth in their vocabulary after they produce approximately 50 words, a phenomenon termed the "vocabulary spurt" (Nelson, 1973). However, some children's growth rate is steadier, and it has been argued that what appears to be a sudden shift in behavior may actually reflect continuous change (Ganger and Bent, 2004; McMurray, 2007). This incrementality is not always apparent from studies that focus on a group's mean performance, which can make it appear as though a group of children fully possesses or entirely lacks a particular strategy (e.g., McMurray, Samelson, Lee, and Tomblin, 2012; Perry and Kucker, 2019). In other words, while it may appear that older children make use of information that younger children do not, it is likely that differences are a matter of degree (e.g., McMurray, 2007). This viewpoint is also consistent with a growing belief found across a variety of fields that language abilities are best understood as existing on a continuum (e.g., Rescorla, 2009; Tomblin, Zhang, Weiss, Catts, and Weismer, 2004) and underscores the continuous nature

of development (Elman, Bates, Johnson et al., 1996; McMurray et al., 2012; Samuelson and McMurray, 2017).

21.1.2 Predicting long-term outcomes

In addition to offering useful theoretical tools, it is valuable to study individual differences in children's early vocabulary because these differences tend to persist and (p. 440) are often reliable predictors of later language ability and even success in school. Even before they begin producing a single word, infants' demonstrations of preliminary word knowledge predict the size of their vocabulary in subsequent years. For example, infants who show better recognition of familiar word forms in behavioral and neuroimaging tasks have larger vocabularies at two years (Junge, Kooijman, Hagoort, and Cutler, 2012; Newman et al., 2006; Singh, Reznick, and Xuehua, 2012). Likewise, infants who are reported to know more words at one year of age tend to score better on standardized measures of vocabulary knowledge at three years (Lyytinen, Laakso, Paikkeus, and Rita, 2001; Rose, Feldman, and Jankowski, 2009). These relations demonstrate the continuity of infants' learning and knowledge and highlight the value of tracking individual differences from an early age in order to understand later differences.

To understand the emergence of individual differences, longitudinal studies have examined the growth of children's vocabulary knowledge over time and have revealed that the relative size of children's vocabulary typically remains somewhat stable (e.g., Fenson et al., 1994). While there is considerable variability in individual children's trajectories, those children who are classified as "early talkers" at young ages are likely to have advanced vocabularies up to two years later, while those who are identified as "late talkers" disproportionately continue to know fewer words than their peers (Fernald and Marchman, 2012; Thal, Bates, Goodman, and Jahn-Samilo, 1997). There is also burgeoning evidence that these patterns continue into childhood. Recent studies have found that the number of words that children produce at 16 to 24 months can predict the size of their vocabularies up to eight years later (Duff, Reen, Plunkett, and Nation, 2015; Rajan et al., 2019). Similarly, the rate at which children's vocabulary grows between the ages of one and four years is related to their later vocabulary (Rowe, Raudenbush, and Goldin-Meadow, 2012).

These differences are particularly noteworthy because children's vocabulary growth has been linked to their school readiness and even the structure of their brain (Asaridou, Demir-Lira, Goldin-Meadow, and Small, 2017; Rowe et al., 2012). In particular, lexical knowledge is likely to be foundational for children's early reading skills (see Seidenberg, 2017 for discussion of how reading builds on children's prior knowledge of words and the relations among them). Measures of vocabulary in infancy have been shown to be related to reading ability in school-aged children (Duff et al., 2015), and the size of children's vocabulary when they begin school continues to predict their reading skills throughout the elementary school years (Quinn, Wagner, Petscher, and Lopez, 2015). Correlations between young children's vocabulary and their later reading skills have been reported across different cultures, languages, and school systems, including the US, China, and the

Netherlands (e.g., Quinn et al., 2015; Song, Su, Kang et al., 2015; Verhoeven, van Leeuwe, and Vermeer, 2011). These long-term associations underscore the importance of exploring the origins of differences in children's knowledge and suggest that the roots of children's academic success may begin as early as infancy.

While there is converging evidence to support the view that later differences in children's knowledge are related to early variability, it is also important to acknowledge (p. 441) that considerable amounts of variance have yet to be explained. For example, although Thal and colleagues (1997) documented reliable group-level differences in the rate at which children acquired words, they failed to be able to predict trajectories for individual children. Similarly, a number of studies have found that measures of infants' vocabulary cannot reliably be used to determine which children will have diagnosable language delays (e.g., Fernald and Marchman, 2012; Justice, Bowles, Turnbull, and Skibbe, 2009). Infants' early knowledge is a far from a perfect indicator of how quickly and successfully children will add new words to their vocabularies, and more research is still needed in order to find ways to better identify those children at risk for poor outcomes. However, the fact that there are cross-age correlations suggests that a better understanding of how differences in children's vocabularies first emerge can ultimately inform both theories and interventions aimed at improving language and academic outcomes.

21.1.3 Overview

In the current chapter, we do not provide a historical account of how differences have been construed (see Fernald and Weisleder, 2011 for such a review), and we do not fully describe all of the impressive efforts to systematically document the size and composition of children's vocabulary across ages and social groups. Instead, we focus our attention on contemporary perspectives on individual differences and then attempt to unite ideas from studies of typical language development, language disorders, and bilingualism.

In the first section, we discuss the origins and early emergence of individual differences in children's vocabulary knowledge. Current research emphasizes the importance of language input in children's learning and has highlighted striking variability in the language experience of different children, which is particularly apparent when comparing children from different backgrounds. We describe specific features of the input that have been proposed to support children's learning and suggest areas for future research.

In the second section, we note that children play a powerful—and at times overlooked—role in determining their own learning. Children build their knowledge gradually over time, and while the evidence that children's vocabulary knowledge is directly related to the input they receive is compelling, differences in input alone cannot fully explain why some children learn more quickly than others. Thus, rather than conceiving of children as passive recipients of language input, science points toward viewing children as active agents whose knowledge, past experiences, and abilities shape the input they receive *and* the information they extract from it.

In the third section, we focus on differences across different populations of children. We begin by reviewing how vocabulary develops for children learning different languages. We then consider vocabulary development for children with developmental delays and disorders. Finally, we examine the vocabulary knowledge of children (p. 442) learning two languages and use bilingual environments as a case study to understand how experience can influence children's abilities to learn new words.

21.2 Origins of individual differences

Individual differences in children's vocabulary knowledge have been proposed to arise from a variety of sources, including biological and genetic influences (e.g., Oliver and Plomin, 2007), basic cognitive and perceptual abilities (e.g., Tsao, Liu, and Kuhl, 2004), and environmental factors including childhood nutrition, stress, physical environment, and family well-being (e.g., Shonkoff, Garner, Siegel et al., 2012). In recent years, researchers have tended to emphasize that much of the variability in children's knowledge may be related to differences in their language environments, and that children who receive richer input tend to have larger vocabularies (e.g., Hart and Risley, 1995; Hoff, 2003). Recognizing these associations has been important in helping to reconceptualize well-documented differences between the abilities of children from different family backgrounds (Huttenlocher, Waterfall, Vasilyeva, Vevea, and Hedges, 2010; Rowe, 2008) and has yielded crucial insights into learning processes. Other research has revealed that even at very young ages, some children learn words more easily than others, suggesting that differences may emerge quite early (e.g., Samuelson and Smith, 1999). For example, as young as six months of age, some infants show evidence of recognizing some words, while others do not, and those infants who show more recognition of familiar words at young ages know more words at two years (Bergelson and Swingley, 2012; Singh et al., 2012). Thus, early individual differences likely become exacerbated over time, as children's vocabulary continually builds on their past experience and knowledge.

21.2.1 Associations between caregivers' language input and children's vocabulary

At a superficial level, it is obvious that children can only learn the words that they hear, so their vocabularies must be in some way related to their language and communicative experience. It has become increasingly clear that children receive different amounts and types of experience with language and that these differences, to paraphrase the seminal work by Hart and Risley (1995), are meaningfully related to their language knowledge and development. Furthermore, when children encounter words in different contexts, they have more opportunities to determine what the words mean (Trueswell, Medina, Hafri, and Gleitman, 2013; Smith and Yu, 2008), as well as to enrich their understanding of those words (Sloutsky, Yim, Yao, and Dennis, 2017; Wojcik and Saffran, 2015), and to use the words they know to continue learning (p. 443) additional words (Samuelson, 2002; Smith, Jones, Landau, Gershkoff-Stowe, and Samuelson, 2002). Thus, it may be unsurprising that children whose parents talk to them more during the first years of life are likely

to have larger vocabularies across ages (Hart and Risley, 1995; Hoff, 2003; Huttenlocher, Haight, Bryk, Seltzer, and Lyons, 1991; Newman, Rowe, and Ratner, 2016; Rowe, 2008; Weisleder and Fernald, 2013). In fact, one way to understand these effects is to view children's input as the "corpus" of data that they can use to learn words; when children have access to larger, richer datasets, learning is likely to be more successful.

Critically, and unfortunately, links between language input and language knowledge have been consistently demonstrated by comparing children from backgrounds of high- and low-socioeconomic status (SES). Typically, children from higher-SES families hear more speech, and the speech that they hear contains more unique words, offering them a rich corpus of data from which to learn (Hart and Risley, 1995; Huttenlocher et al., 2010; Rowe, 2008). Because children in lower-SES homes tend to be exposed to less language, differences in children's early language environments have been proposed to explain SES-related discrepancies in early vocabulary growth (Hoff, 2003; Huttenlocher et al., 2010; Rowe, 2008; Weisleder and Marchman, 2018). Importantly, although children from low-SES families hear less language *on average* than their high-SES peers do, there is also considerable variability in language use by families of approximately the same SES. The key message from this research is that across the SES spectrum, children's language development relates to their parents' speech (Rowe, 2008; Schwab, Rowe, Cabrera, and Lew-Williams, 2018; Weisleder and Fernald, 2013). Therefore, both researchers and policy makers have begun to emphasize the importance of encouraging parents, especially in lower-SES communities, to engage in rich dialogue with their children in the hopes of reducing disparities (e.g., Ridge, Weisberg, Ilgaz, Hirsh-Pasek, and Golinkoff, 2015; Suskind, Leffel, Graf et al., 2016).

21.2.2 Important features of language input

While the sheer number of words that children hear may be useful as a global measure of their language experience, newer research has sought to tease apart more nuanced relations between properties of the input and children's learning. For example, Newman and colleagues (2016) reported that infants whose parents often repeat words tend to have larger vocabularies. This relation makes sense; children may find it easier to learn the meaning of a word after repeated exposure (Schwab and Lew-Williams, 2016). However, other research suggests that as children get older, their vocabulary growth is *negatively* correlated with parents' use of repetition (Schwab et al., 2018), and instead, the diversity of caregivers' speech predicts both receptive and productive vocabulary (Hoff and Naigles, 2002; Huttenlocher et al., 2010). While these findings may at first appear incongruous, they can be reconciled by the proposal that children benefit from exposure to input that is tailored to their present knowledge (Rowe, 2008; Rowe and Leech, 2018; Schwab et al., 2018). In other (p. 444) words, it is not uniformly the case that simplicity or variability supports children's learning. When children know very few words, they may accumulate information gradually and need more experience with each individual item. However, as their vocabularies grow, they can draw on prior knowledge and experience, allowing them to benefit from more complexity in the input. Therefore, caregivers who

provide input that reflects their children's current abilities are most likely to be able to continue to support their children's subsequent learning.

Moreover, it is not only language input that can be tailored for a child. As in speech, parents adjust their gestures and actions when interacting with young children and provide input that is simpler, more enthusiastic, and more repetitive, offering infants potentially useful cues for learning (Brand, Baldwin, and Ashburn, 2002; Fernald and Simon, 1984), and non-verbal information has been shown to help children learn new words. Differences in parents' early use of gesture relate to children's later vocabulary (Rowe and Goldin-Meadow, 2009), and similarly, parents who are more engaged with their children may be able to direct their children's attention more effectively, which in turn could help children to learn the names of objects more easily (Yu, Suanda, and Smith, 2018). In fact, it has been shown that when parents provide clear cues to a word's referent in their spontaneous interactions with their infants, the same children have larger vocabularies even years later (Cartmill, Armstrong, Gleitman et al., 2013). In addition, children whose language experience is more interactive (as measured by conversational turn-taking) not only show enhancements in vocabulary knowledge but also show different patterns of neural activity, even after controlling for SES and the overall quantity of input that they receive (Romeo, Leonard, Robinson et al., 2018). Combined, these studies suggest that children's learning can be systematically influenced by interactions with their parents and support the view that early experience has long-lasting consequences for the words that children know.

As a result of recent research that has quantified and delved into different aspects of children's experience, individual differences in children's knowledge are now widely interpreted to reflect children's experience, rather than other factors, such as genetics. This perspective has led to a significant focus on input as a target for intervention in low-SES communities. However, the exact nature of the association between input and outcomes is still poorly understood. Existing research cannot satisfactorily explain why some parents talk to their children more than others, and there has been little research examining the input that children receive from individuals other than their parents, such as teachers, siblings, or peers. Likewise, it is likely that different types of input may support different aspects of learning, but direct associations between children's experience and their learning of different types of words, for example, have yet to be explored. To fully understand how children's experience can (or perhaps cannot) determine the trajectory of their vocabulary growth, future research will need to test specific relations between different aspects of children's language environment and the words that they know.

(p. 445) 21.3 How children construct their knowledge of words

As learners gain experience with language, they become sensitive to different cues in the environment, and even when presented with identical input, individual learners do not necessarily extract the same information (Potter, Wang, and Saffran, 2017). Moreover,

children's knowledge, interests, and attention all affect the input they receive, and individual differences in abilities such as memory, executive function, and temperament have been shown to relate to language knowledge (e.g., Slomkowski, Nelson, Dunn, and Plomin, 1992; Swanson, 1996; Zelazo, Anderson, Richler et al., 2013), suggesting that children's cognitive skills may also affect the rate and manner in which their vocabularies grow. Therefore, it is important to consider that children play an active and integral role in constructing their knowledge of words.

21.3.1 Cumulative effects of learning over time

Children's early experience with language sets the stage for future learning because early differences are likely to become exaggerated over time. Children who hear more *and* more rich language early in life not only have more opportunities to learn the meanings of words but also—critically—to develop learning strategies that make use of their prior knowledge. Children's growing knowledge of their native language changes the way they interpret the input around them, and they use words that they already know to inform their learning of new words, as well as to process information more efficiently. Thus, early experience not only provides a corpus of data from which to learn words but also influences the way that children approach new input, which in turn shapes their subsequent learning.

The cumulative influence of children's learning is clearly illustrated in the domain of speech perception; as infants' vocabulary size increases, the sound structure of their native language exerts greater influence over their learning (Graf Estes, Edwards, and Saffran, 2011). Infants who know more words have a better understanding of the common sound patterns in their native language, and they pay more attention to distinctions that are important in their language and less attention to those that are not meaningful (e.g., Kuhl, Stevens, Hayashi et al., 2006, see Creel, this volume). For instance, infants who know more words are better able to understand speakers with different types of accents, suggesting that they can use their knowledge to overcome the challenge of unfamiliar pronunciations (Mulak, Best, Tyler, Kitamura, and Irwin, 2013). Consequently, as children's vocabulary size increases, they are more likely to infer that words that differ in only a single sound refer to distinct objects, supporting their ability to learn challenging new words (Law and Edwards, 2015). When children know more words, their representations of the sounds and words in their language become more (p. 446) refined, allowing them to exploit that knowledge to make sense of new information (see Swingley, this volume).

Differences in the number of words that children already know are also related to their ability to accumulate additional word knowledge. Children with larger vocabularies and more robust word knowledge show more successful learning of new words across a variety of paradigms (e.g., Bion, Borovsky, and Fernald, 2013; Ferguson, Graf, and Waxman, 2018; Jones, 2003; Lany, 2018). Why might this be? One possibility is that children who know more words process language more efficiently, thereby supporting their ability to encode and remember new words (Fernald and Marchman, 2012; Lany, 2018; Rajan et al.,

2019). In one study by Fernald and colleagues (2008), children who responded more quickly to words in the middle of a sentence such as *There's a blue cup on the deebo* showed better learning of the novel words that occurred later in the sentence. Other evidence also suggests that children who recognize words more easily at young ages show more rapid growth in their vocabularies (Fernald and Marchman, 2012; Lany, Giglio, and Oswald, 2018; Weisleder and Fernald, 2013), demonstrating how efficient processing of familiar words can support subsequent learning.

A second possibility is that children with larger vocabularies can leverage their greater knowledge to determine the meanings of new words. Several studies have shown that children can use their understanding of familiar verbs to infer the meaning of new nouns. For instance, children can deduce that an unknown word must refer to an edible referent when they hear sentences such as *Do you want to eat the artichoke?*, and children who know more verbs are better able to learn new words in these types of contexts (Ferguson, Graf, and Waxman, 2014; Ferguson et al., 2018; Goodman, McDonough, and Brown, 1998). Likewise, children can use other parts of speech, such as adverbs, to inform their learning of verbs under otherwise-challenging circumstances (Syrett, Arunachalam, and Waxman, 2014). Children may also make use of their existing knowledge via mutual exclusivity, the tendency to map a new label onto a novel object when viewing one novel object and one or more familiar objects (Markman and Wachtel, 1988). Over time, this approach can only be realistic and useful if children already know the names of a sufficient number of objects; indeed, children who know more words show more evidence of using mutual exclusivity to learn new labels (Bion et al., 2013; Law and Edwards, 2015). When viewing multiple objects at once, with no clear referential cues, children may also be able to leverage their word knowledge to gradually rule out incorrect mappings (Smith and Yu, 2008; Stevens, Gleitman, Trueswell, and Yang, 2017). For instance, a child might see several toys on the floor, and she will more easily be able to figure out which one is the *xylophone* and which one is the *slinky* if she already knows the word for *puzzle*. Because children's ability to learn new words often relies on their existing word knowledge, small differences in early experience and vocabulary size have the potential to compound over time.

Just as both the quantity and quality of children's language experience shape language outcomes, the size and composition of children's vocabulary can influence later learning. Both behavioral studies and computational models have shown that children are more likely to learn words that are related to words that they already know (p. 447) (Borovsky, Evans, Ellis, and Elman, 2016; Hills, Maouene, Maouene, Sheya, and Smith, 2009). As many parents can attest, a child who can identify a *velociraptor* and a *triceratops* may quickly learn to recognize a *brachiosaurus,* while another child who knows the words *bulldozer* and *backhoe* may have an easier time learning *excavator.* Moreover, the structure of children's vocabulary also influences more general strategies in word learning. When children know words from categories that are organized by shape, they are more likely to generalize a novel label to another object of the same shape instead of an object made of the same material (e.g., Samuelson and Smith, 1999). This is a useful insight, as shape is often an indicator of category membership. Importantly, it has been shown that children's

vocabulary develops more quickly once they acquire this bias to make generalizations based on shape (Samuelson, 2002; Smith et al., 2002), and children with vocabulary delays show a reduced bias (Jones, 2003; Perry and Kucker, 2019). In addition, children's knowledge of grammatical patterns grows along with their learning of individual words (De Carvalho, He, Lidz, and Christophe, 2019; Devescovi, Caselli, Marchione et al., 2005; Marchman and Bates, 1994). As children learn more about the structure of language, they are increasingly able to take advantage of relations among words (e.g., Gertner, Fisher, and Eisengart, 2006; Gleitman, 1990; Naigles, 1990; Wojcik and Saffran, 2015; Yuan, Fisher, and Snedecker, 2012, see Lidz, this volume). This research highlights that children do not learn words in isolation, and that vocabulary development is a process of building networks of interconnected knowledge that depend on the specific words and experiences of the individual child (Borovsky and Peters, 2018; Hills et al., 2009; Wojcik, 2017).

21.3.2 Children are not passive recipients of language input

To fully understand how children's past experience and learning shape their later vocabularies, it is important to consider the fact that children themselves play a role in determining the input that they receive. Caregiver speech, infant language skills, and later vocabulary have all been shown to be interrelated (Bornstein, Tamis-LeMonda, and Haynes, 1999; Newman et al., 2016), and transactional models of development suggest that is impossible to isolate the influences of the child's individual abilities from the social context, as different children elicit different input from the speakers around them (Sameroff and Chandler, 1975; Slomkowski et al., 1992).

Parents have been shown to adjust their speech to make it easier for children to comprehend (Arunachalam, 2016), and they are likely to direct simpler speech to children who do not yet demonstrate understanding of many words and to direct more complex speech to children who can understand and respond appropriately (Huttenlocher et al., 2010; Schwab et al., 2018). Parents may also be more inclined to label and talk about objects that consistently attract their children's attention (Suanda, Geisler, Smith, and Yu, 2014), which could further support children's processing of familiar items and their (p. 448) learning of new, related words (Borovsky et al., 2016). To illustrate, parents might be more likely to both read animal books and go to the zoo if they have an animal-loving child, which in turn would support children's learning of less common animal words like *sloth*, *mammal*, and *herbivore*. Therefore, the input that children receive on a daily basis can be viewed as both an origin and outcome of individual differences in their current language knowledge.

21.3.3 Influences of cognitive abilities

Language is, of course, just one aspect of cognitive functions and processes—intertwined with many others—and studying language alone would be limited in scope. Improvements in infants' understanding of language are related to their growing knowledge of the world around them, as language and cognitive abilities can be mutually reinforcing (see Perszyk

and Waxman, 2018 for review). Being able to track regularities in the environment, attend to the most relevant cues, remember salient information, and integrate learning over time are all likely to facilitate the acquisition of new words (e.g., Konishi, Stahl, Golinkoff, and Hirsch-Pasek, 2016; Saffran, 2003; Smith and Yu, 2008; Swanson, 1996). Across many studies, children who perform better on tasks that assess abilities such as working memory, cognitive control, and attentional flexibility tend to have larger receptive and productive vocabularies (e.g., Reuter, Emberson, Romberg, and Lew-Williams, 2018; Swanson, 1996; Zelazo et al., 2013). In addition, measures of early infant cognition, such as visual attention and memory, can predict individual differences in vocabulary not only in infancy, but also later in life (Rose et al., 2009; Salley et al., 2013; Yu et al., 2018). These associations underscore the importance of recognizing that individual children process information differently and suggest that differences in domain-general cognitive skills may also help explain differences in children's vocabulary, further demonstrating that children build, and do not simply absorb, their knowledge.

21.4 Vocabulary development across different populations

21.4.1 Cross-linguistic research

Research on children's early language learning has focused excessively on children who are learning English, and patterns of vocabulary development may not be identical across languages. Languages, of course, vary in many structural dimensions. But of equal importance is that children growing up in different societies are exposed to varying amounts and types of speech, and different cultures vary in the importance they (p. 449) place on language (Casillas, Brown, and Levinson, 2020; Cristià, Dupoux, Gurven, and Stieglitz, 2019; Weber, Fernald, and Diop, 2017). Differences in how parents choose to engage with their children can reflect personal or community attitudes (Johnston and Wong, 2002; Schieffelin and Ochs, 1986; Simmons and Johnston, 2007; see Kuchirko and Tamis-LaMonda, 2019 for recent review of similarities and differences in how parents interact with children in different communities), and the quantity, acoustic properties, and contents of parents' speech differ across languages and cultures (Au, Kit-Fong, Dapretto, and Song, 1994; Fernald and Morikawa, 1993; Schneidman and Goldin-Meadow, 2012; Tardif, Shatz, and Naigles, 1997). Nevertheless, studies that include samples of children learning different languages typically emphasize similarities in the size and growth of children's early vocabulary (*Italian*: Caselli, Casadio, and Bates, 1999; *Korean*: Choi and Gopnik, 1995; *Spanish*: Jackson-Maldonado, Thal, Marchman, Bates, and Gutierrez-Clellen, 1993; *Hebrew*: Maital, Dromi, Sagi, and Bornstein, 2000; *Icelandic*: Thordardottir and Ellis Weismer, 1996). Likewise, relations between children's early and later vocabulary have been reported in a number of languages, including in communities that place less emphasis on speaking directly to young children (Guiberson, Rodríguez, and Dale, 2011; Lyytinen,

Laakso, Poikkeus, and Rita, 1999; Scheidman and Goldin-Meadow, 2012), suggesting commonalities in how children learn words across languages.

However, there are reports that languages with particularly complex structure may be learned more slowly (*Danish*: Bleses, Vach, Slott et al., 2008; *Greek*: Papaeliou and Rescorla, 2011; *Polish*: Rescorla, Constants, Białecka-Pikul, Stępień-Nycz, and Ochał, 2017), indicating that there may be some cross-language variability. For example, it has been proposed that the sound system of Danish makes it especially hard for children to identify word boundaries in speech, which in turn impedes their ability to learn new words (Trecca, Bleses, Madsen, and Christiansen, 2018). Similarly, the grammar of Polish requires words to be marked with a variety of prefixes, suffixes, and interfixes, and these added challenges seem to lead Polish children to learn words more slowly (Rescorla et al., 2017; Smoczyńska, Krajewski, Łuniewska et al., 2015). Thus, the specific characteristics of different languages appear to influence the rate at which children acquire their vocabularies, highlighting the importance of studying different populations before drawing conclusions about universal patterns of development.

Furthermore, counts of the total size of children's vocabulary may obscure subtle differences in knowledge about types of words. In particular, there has been debate about whether the dominance of nouns in children's early vocabulary is universal or reflects the unique statistics of English (Bornstein, Cote, Maital et al., 2004; Caselli, Bates, Casadio et al., 1995; Choi and Gopnik, 1995; Gentner and Boroditsky, 2001). Languages such as Korean and Mandarin contain more balanced use of nouns and verbs than English, and children learning these languages have been shown to learn verbs more quickly and nouns more slowly than children learning noun-heavy English (Choi and Gopnik, 1995; Tardif, 1996), revealing language-specific influences on word learning. Similarly, it has been reported that even when early vocabularies may be skewed toward nouns across languages, there are still different patterns in how quickly (p. 450) children learn other word types, including verbs and adjectives (Bornstein et al., 2004; Tardif et al., 1997). Thus, it seems likely that differences in the structure and frequency of words in children's native language affect the words they learn most easily, in addition to other linguistic and cultural factors.

21.4.2 Vocabulary development for children with developmental delays and disorders

Thus far, we have focused on the variability in children's vocabulary that exists among children who are typically developing, but variability is perhaps more pronounced for children whose development is not typical. Vocabulary delays are commonly found in children with many different types of developmental delays, and in some cases, these delays may be diagnostic. Importantly, just because children with different types of developmental disorders display comparable deficits in their vocabulary growth does not mean that their difficulties stem from the same processes, and closer examination of the relative

strengths and weaknesses of their knowledge can yield insight into underlying mechanisms, as well as potential targets for interventions.

21.4.2.1 Late talkers

Language delays are often co-morbid with broader developmental disorders, but some children without another diagnosis still fall behind their peers in learning language. Because there is so much variability in children's early vocabulary, it is difficult to accurately distinguish those children who will later have language delays and academic difficulties from those who simply wait longer to begin speaking. Current approaches to studying language disorders emphasize that children's abilities exist along a continuum, and language delays are best understood as the lower portion of a normal distribution (McMurray, Samelson, Lee, and Tomblin, 2010; Rescorla, 2009; Tomblin et al., 2004). Consistent with this perspective, there is considerable heterogeneity among late talkers (Fernald and Marchman, 2012; Perry and Kucker, 2019; Rescorla, 2009). While some late-talking children are later diagnosed with language and learning difficulties, most eventually have language skills that fall within the normal range (Dale, Price, Bishop, and Plomin, 2003; Justice et al., 2009). Therefore, early delays in children's expressive vocabulary are not necessarily indicative of long-term problems with language, and researchers continue to try to find ways to separate young children who are merely slow to begin talking from those who would benefit from early interventions and services (Fernald and Marchman, 2012; Justice et al., 2009).

While most late talkers do not ultimately meet clinical criteria for language delays, it is important to note that they may still show some deficits in some areas of language later in life (Rescorla, 2009). Longitudinal work has shown that children who were classified as late talkers at two years but scored in the typical range as adolescents still had language skills that were lower than an SES-matched comparison sample, suggesting that (p. 451) slow growth in early vocabulary may have long-term consequences. Children who know fewer words also seem to have impoverished semantic representations of the words that they know (McGregor, Oleson, Bahnsen, and Duff, 2013), supporting the idea that children need a strong foundation of early vocabulary to support the incremental growth of a rich network of word knowledge.

In addition, recent studies have found differences in the structure of late talkers' vocabularies, as well as in their learning of new words. Compared to typically developing children who know a similar total number of words, late talkers' vocabulary is not as well-matched to the typical patterns of children's input (Beckage, Smith, and Hills, 2011). Late talkers' early vocabularies contain proportionally fewer nouns and verbs, and the words that they know are less related to one another in meaning, revealing that their semantic networks may not have the same organization. Possibly due to this atypical organization, late talkers show less consistent use of word learning strategies that are built on their prior knowledge, such as making generalizations based on shape (Perry and Kucker, 2019). As reviewed earlier, the shape bias emerges as children learn more words from shape-based categories, which in turn boosts subsequent learning, so decreased use of this strategy may both reflect and contribute to existing differences. It may also be that

children who talk less at young ages elicit different input than their typically developing peers (Beckage et al., 2011), offering another illustration of the cascading effects of early experience and abilities. While early measures of children's vocabulary size cannot fully explain which children will go on to have language delays, the development of late talkers' vocabulary still provides robust support for the view that early differences affect the long-term trajectory of children's language knowledge.

21.4.2.2 Children with developmental disorders

Difficulties with many aspects of language, including vocabulary, are common for both children and adults with autism spectrum disorders (ASD) and are often among the earliest symptoms observed (Luyster, Kadlec, Carter, and Tager-Flusberg, 2008; Mitchell, Brian, Zwaigenbaum et al., 2006). Language outcomes are highly variable for children with ASD, and as in other populations, the size of children's vocabulary at young ages is related to their language skills in later childhood (Kjelgaard and Tager-Flusberg, 2001). In addition, vocabulary growth for children with ASD is negatively correlated with the severity of other autism symptoms, including difficulty with social interaction (Charman, Baron-Cohen, Swettenham et al., 2003; Ellis Weismer and Kover, 2015), highlighting the variety of influences on language development for children with developmental delays. Interestingly, compared to children with other types of developmental delays, toddlers and children with ASD show greater impairments in receptive vocabulary than in their expressive abilities (Ellis Weismer, Lord, and Esler, 2010; Kover, McDuffie, Hagerman, and Abbeduto, 2013).

Like children with ASD, children with Down syndrome (DS) seem to have particular trouble with language, even compared to children with other types of developmental delays (Roberts, Martin, Moskowitz et al., 2007), and their early knowledge of words is related to later abilities (Chapman, Hesketh, and Kistler, 2002). (p. 452) It has long been suggested that parents may use simpler speech when interacting with children with DS; for example, they may give relatively more instructions and ask fewer questions (Buium, Rynders, and Turnure, 1974; Cardoso-Martins and Mervis, 1985), and as with typically developing children, the language skills of children with DS are also related to the input their parents provide (Crawley and Spiker, 1983; Sterling and Warren, 2014). Children with DS also display slower vocabulary growth than typically developing children, even when they are matched for non-verbal mental age (Hick, Botting, and Conti-Ramsden, 2005). However, in contrast to children with ASD, children with DS have greater difficulty with expressive language, compared to comprehension (Laws and Bishop, 2003). The differences between these two populations suggest that there are multiple causes of children's difficulties that are not yet well understood.

Even in cases where children's language abilities are considered to be relatively spared, children with developmental delays often differ from typically developing children (Karmiloff-Smith, Brown, Grice, and Paterson, 2003). Individuals with Williams syndrome (WS, a genetic disorder with distinct cognitive, physiological, and neuroanatomical traits) have language skills that are stronger than their non-verbal cognitive abilities might suggest (Bellugi, Bihrle, Jernigan, Trauner, and Doherty, 1990; Brock, Jarrold, Farran, Laws,

and Riby, 2007). While children with WS tend to have larger expressive vocabularies than children with DS, they also show delays in infancy, and their vocabularies still do not equal those of typically developing children in either size or composition (Mervis and John, 2008; Mervis and Robinson, 2000). For example, children with WS have better knowledge of concrete words and less understanding of relational associations (Mervis and John, 2008). These differences in their vocabularies may be related to other skills, such as the ability to understand social cues and to appropriately engage in shared attention (John, Rowe, and Mervis, 2009; John, Dobson, Thomas, and Mervis, 2012), again suggesting that the process by which children with WS learn may differ from both typically-developing children and children with other types of delays (Nazzi and Karmiloff-Smith, 2002).

The experiences and abilities of children with developmental delays vary widely, and deficits in language occur in conjunction with other conditions, making it hard to identify the origin of the difficulty. Nevertheless, comparisons of the skills of children with different types of delays do suggest some important underlying commonalities. Across populations, vocabulary knowledge seems to be related to non-verbal skills, and for children with delays, social abilities and attention may be especially important. In addition, as with typically developing children, early vocabulary knowledge appears to arise in part from input quality/quantity and predicts their later vocabulary outcomes. These relations leave open a key question: can the same interventions span multiple populations or should interventions be heavily tailored to a specific population? It is safe to conclude that early experiences are important for promoting the best possible outcomes, yet there is no one-size-fits-all description of vocabulary-related difficulties within or across populations.

(p. 453) 21.4.3 Bilingual populations

Despite the global prevalence of multilingual environments, research has overwhelmingly focused on monolingual children’s learning. In the past decade, researchers have begun to rectify this lack of information, and there has been a dramatic increase in interest in children’s learning of two language simultaneously (Fennell and Lew-Williams, 2018). This research is important because it is not clear that standards based on monolingual children’s knowledge are appropriate for evaluating bilingual children, and as a result, bilingual children may be both over- and under-diagnosed as having language delays (Bedore and Peña, 2008). In addition, the study of individual differences in bilingual children’s knowledge affords the unique opportunity to separate language-specific experience from domain-general processes because the same child has different experience with each of two languages. For example, a Spanish-English bilingual toddler who loves Oreos might respond more quickly when offered a *galleta* than a *cookie* because of differences in familiarity with the words. Scrutinizing bilingual children’s knowledge in each of their languages allows us to test how exposure to a particular language affects the words that children know, as well as to observe the impact of multilingual experience on children’s learning strategies.

21.4.3.1 Learning two languages

By definition, bilingual children must learn more words than their monolingual peers—a child learning both English and Spanish will ultimately need to know both *dog* and *perro* to be able to communicate effectively in each language. This added challenge leads many parents to express concern that the presence of two languages will impede their children's language development, and it is true that when young bilinguals are compared to monolinguals, they typically know fewer words in the language of comparison (Byers-Heinlein and Lew-Williams, 2013; Pearson, Fernández, Lewedeg, and Oller, 1997). However, estimates that take into account their knowledge of the two languages combined tend to show that monolingual and bilingual children learn their first words at a similar rate (e.g., Core, Hoff, Rumiche, and Señor, 2013; Pearson, Fernández, and Oller, 1993). That is, young English-Spanish bilinguals may know fewer English words than their monolingual peers, but they know a similar total number of words when their English and Spanish vocabularies are counted together. Overall, both the trajectory and heterogeneity of bilingual children's early vocabulary growth appear to be similar to those of monolinguals, and as with monolinguals, individual differences in bilingual children's early vocabularies are correlated with the number of words that they know at later ages (Conboy and Thal, 2006; Hurtado, Grüter, Marchman, and Fernald, 2014), providing additional evidence for the persistence and continuity of differences in children's learning.

While global estimates of bilingual children's vocabulary size are useful in highlighting parallels between monolinguals and bilinguals, it is also informative to examine the growth of bilingual children's vocabulary in each language separately. (p. 454) Bilinguals' knowledge is not evenly distributed across their two languages, and children's vocabularies grow more quickly in the language to which they receive more exposure (e.g., Potter, Fourakis, Morin-Lessard, Byers-Heinlein, and Lew-Williams, 2019). In addition, while there are correlations between children's early and later vocabulary within a language, the number of words that children know in one language is largely unrelated to their knowledge of the other language (e.g., Conboy and Thal, 2006; Hurtado et al., 2014). In other words, children's later vocabulary in English is highly related to how many English words they knew in infancy, but not to the number of Spanish words that they know. This dissociation underscores the complexity of predicting children's development and emphasizes that each child's vocabulary reflects their own unique experiences.

21.4.3.2 Bilingual input

Recent studies have also consistently shown that bilingual children's vocabulary in a given language depends on the quantity and quality of input that they receive in that language (Hurtado et al., 2014; Marchman, Martínez, Hurtado, Grüter, and Fernald, 2017; Place and Hoff, 2011). This research is an important complement to studies showing links between parents' language use and monolingual children's vocabulary; examining bilingual children's vocabulary separately in two languages can help to disentangle the direct effects of input in one particular language from other potential influences such as genetics, SES, or global parenting strategies. Children's vocabulary in each language can be predicted by both early patterns of exposure (Hurtado et al., 2014) and the concurrent

balance of language use in their environments (Marchman et al., 2017; Place and Hoff, 2011). Children's processing is also more efficient in the language with which they have more experience (Hurtado et al., 2014), and they show different neural responses to words in the language they hear more frequently (Conboy and Mills, 2006). Bilingual children are also better able to recognize words in challenging contexts (such as sentences with language mixing; e.g., *Do you like the* perro?) if the key words appear in the language they hear more frequently (Potter et al., 2019). These findings provide additional evidence for the view that bilingual children's vocabulary in each language depends on their specific experience with that language.

Importantly, bilingual children not only tend to receive unequal amounts of exposure to each language, but their social experience with each language can also differ in ways that affect learning. For example, children may interact with more native speakers in just one of their languages, and more non-native speakers in the other, and experience with native speakers tends to better support vocabulary growth (Place and Hoff, 2011). In addition, there are often differences in the perceived status of each language in society, which likely has consequences for parents' and children's language use. This can mean that children's skills in their community's majority language improve at the expense of their skills of their other language. For instance, in the English-dominated United States, the development of children's vocabulary in English has been shown to be negatively related to their vocabularies in Spanish (Duursma, Romero-Contreras, Szuber et al., 2007; Hoff, Rumiche, Burridge, Ribot, and Welsh, 2014). Likewise, Inuit children (p. 455) in Canada who receive more instruction in a majority language (French or English) show weaker knowledge of their heritage language (Wright, Taylor, and Macarthur, 2000). Conversely, increased exposure to the minority language does not appear to be associated with weaker knowledge of the majority language (Cha and Goldenberg, 2015). Complex social factors, combined with the prevalence of the language in children's experience, contribute to the ease with which children learn language. These findings showing the independence of bilingual children's knowledge across their two languages allow us to examine the influences of specific experiences and to isolate these effects from child-specific factors, such as general cognitive abilities, as we attempt to understand variation in children's vocabulary.

21.4.3.3 Consequences of bilingual experience on learning

Though monolinguals and bilinguals may acquire their vocabularies at a similar rate, the different nature of their experience means that there may still be differences in the processes by which they learn. For instance, bilingual infants who are exposed to similar-sounding languages may be sensitive to cues in both the auditory and visual input that help separate their two languages, such as speakers' mouth movements (Birulés, Bosch, Brieke, Pons, and Lewkowicz, 2019; Bosch and Sebastián-Gallés, 2003). Bilingual infants can also learn that pitch contours of otherwise identical words can be used to distinguish possible referents, while monolingual infants learning a non-tonal language do not, suggesting that bilingual experience informs the cues to which infants attend (Graf Estes and Hay, 2015; Hay, Graf Estes, Wang, and Saffran, 2015). Other studies have shown differ-

ences in how monolinguals and bilinguals learn new words. Unlike monolinguals, bilinguals regularly encounter multiple words for the same object, and therefore do not appear to assume that each object should have a unique label. As a result, they are more likely to accept multiple labels for the same object and less likely to assume that a novel label must refer to a novel object (Byers-Heinlein, 2017; Byers-Heinlein and Werker, 2009; Kandhadai, Hall, and Werker, 2017). This research comparing bilinguals and monolinguals highlights yet another way that children's experience with language changes how they learn words.

21.5 Conclusions

In recent decades, research on language development has increasingly emphasized the importance of understanding how differences in children's early experiences influence their long-term outcomes. In this chapter, we have reviewed evidence for a number of main conclusions. First, across different communities and cultures, children's vocabulary knowledge is directly related to the quality of their language input. However, much of this evidence consists of somewhat coarse descriptions, such as the total number of words that children hear in particular contexts. Second, we have argued that language input cannot be treated as an independent force. Children play an active role in shaping (p. 456) their input; they vary in what information they extract from their input; and individual differences in vocabulary growth reflect children's own abilities, interests, and prior experience. Third, learning effects are cumulative. Children use their prior knowledge to learn new words, and they are more likely to elicit rich, complex input when they are able to demonstrate understanding. Thus, by continuing to explore reciprocal influences of children's knowledge and experience with language, we will have the opportunity to understand why and how early experiences may have such sizable effects on children's development.

Finally, we have attempted to illustrate both the theoretical and practical value of examining individual differences in children's learning among different populations and contexts. As developmental science increasingly recognizes the need to examine development in diverse environments, we will have the opportunity to test claims about similarities and differences across languages and developmental contexts, as well as to generate predictions about a wider range of language-related phenomena. In particular, our final section suggests that the independence with which bilingual children learn each of their languages provides powerful support for the view that children's experiences, rather than their innate capacities, can explain differences in the success with which they learn words.

A deeper understanding of links between input and learning will be essential for developing complete theories of vocabulary development that capture the experiences of children from diverse populations, as well as for designing interventions that reduce input-related disparities and support the skills of children with developmental delays.

Christine E. Potter

Christine E. Potter is Assistant Professor in the Department of Psychology at The University of Texas at El Paso. Her research explores the role of experience in language learning, with an emphasis on learning across different communities and environments.

Casey Lew-Williams

Casey Lew-Williams is Professor in the Department of Psychology at Princeton University. He works with postdocs, graduate students, and undergraduates in the Princeton Baby Lab to study how young children learn, and his research focuses in particular on language learning. He is a Chief Editor of *Frontiers for Young Minds* and a Co-founder of ManyBabies.