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EARLY BILINGUAL
WORD LEARNING*Christopher Fennell*

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Many studies have been published on child language; few on the learning of two languages by small children.

Leopold (1949/1970), p. vii

Some global estimates of the number of bilingual children are as high as 50% (Grosjean, 2010). Yet historically, there has been little research involving word learners acquiring two or more languages. It was not until the mid-1990s that our field rose to the challenge posed by Leopold above. A PsycInfo search revealed that 90% of publications on childhood bilingualism were published in the last 20 years, with 60% in the last 10 years. These studies have primarily addressed the most common question posed to researchers studying bilingual word learning: do bilingual children have a word-learning delay or deficit in the face of more variable input than their monolingual peers?

In this chapter, we review the extant literature of bilingual lexical acquisition in the first years of life. In doing so, we demonstrate that no such general deficit is present in children learning two languages. However, that is not to say that there are no effects engendered by a dual-language environment. When comparing monolingual and bilingual infants and toddlers, researchers need to account for numerous complexities, both in designing experiments and interpreting results. Do we compare total vocabularies across monolingual and bilingual participants, or do we compare bilinguals and monolinguals on vocabulary in just one language (e.g., a bilingual's English vocabulary to the vocabulary of English monolinguals)? Do we consider each vocabulary autonomously? Can we truly compare different types of bilinguals in the first place (e.g., French-English versus Spanish-Basque infants)? Researchers have been aware of these intricacies since the first major scientific treatise on infant bilingualism (Ronjat, 1913), which highlighted issues such as infants' separation of their two languages and the effects of parental bilingual input on vocabulary.

Despite the complexities inherent in measuring the bilingual vocabulary, it is important to establish whether bilinguals and monolinguals reach similar vocabulary levels in toddlerhood in order to inform hypotheses about whether word learning processes would necessarily differ across these populations. If bilinguals and monolinguals have similar vocabularies across the board, there would be little reason to suspect that basic word learning and processing differ depending on the number of languages being acquired. Thus, this review of the early bilingual lexicon unfolds in somewhat of a reverse manner. We begin with an exploration of bilingual vocabulary in the first years of life and then address word learning. Also, as this chapter focuses on early word learning, the studies included herein only involve simultaneous bilingual infants and toddlers, i.e., children learning two languages from birth.

The nature of the initial bilingual vocabulary

The earliest "assessments" of bilingual children's vocabularies were diary studies published by linguists concerning their own bilingual children (Leopold, 1949/1970; Ronjat, 1913). These studies are informative starting points due to their rich detail, although they are necessarily limited in their generalizability—an issue acknowledged by both Ronjat and Leopold. However, to demonstrate the potential validity of these studies, we will tie early diary findings to later research with standardized measures of infant and toddler vocabularies, such as the MacArthur-Bates Communicative Development Inventory (MCDI) (Fenson et al., 1993). The MCDI is a parental report of children's vocabulary comprehension and production that has been used to assess bilinguals' vocabularies in many studies, and it has been adapted to multiple languages and cultures. Although the norms provided by the MCDI are not applicable to bilinguals, as they are based on monolingual samples, one can compare raw scores to a monolingual group of the same age. Further, and more importantly, the MCDI has been found to be a valid and reliable measure of bilingual vocabulary (Marchman & Martinez-Sussman, 2002).

Diary research shows evidence that bilingual infants and toddlers reach developmental milestones at the same time as monolinguals. Ronjat (1913) found that his bilingual son Louis produced words in both French and German starting around 9 months, comfortably inside the average onset age of word production in monolinguals. Leopold's (1949/1970) bilingual daughter, Hildegard, appeared to start comprehending words around 9 months and producing words at 10 months in both English and German. Hildegard produced 377 unique words across both languages by 24 months. If these numbers were treated as MCDI scores—an unorthodox but perhaps informative use of the data—it is interesting to note that Hildegard would be at exactly the 50th percentile based on her total vocabulary, highlighting the lack of a language delay. Indeed, Leopold stressed that "Hildegard's early speaking development was average" (p. 13).

Other diary and small-sample studies further demonstrate that infants learning two languages have similar onsets of receptive and productive vocabularies as infants

learning one language (De Houwer, 1995; Petitto et al., 2001; Quay, 1995; Vihman, 1985; with Yavaş, 1995, as an exception). Further, the language milestone of the lexical spurt, where infants begin learning new words in earnest, appears in bilinguals at the same age as monolinguals: 18–24 months (Pearson & Fernández, 1994). Broadly, these findings suggest that bilinguals do not appear to be delayed or atypical in terms of lexical development (Marchman & Martinez-Sussman, 2002; Patterson, 1998). However, while bilingual infants may acquire their first word and begin an accelerated rate of word learning at approximately the same time as monolinguals, it is still possible that vocabulary size could deviate from monolinguals later in development. Indeed, Pearson and Fernández (1994) found that no child had a lexical spurt in both languages at the same time; one language always preceded the other, and growth was intimately tied to overall exposure to each language. Such differences could have direct ramifications for lexical processing, opening the possibility of weaker processing in the language with the less rich vocabulary.

In early diary studies, researchers saw quantitative differences across the language-specific vocabularies of bilingual infants and toddlers and immediately tied these differences to unequal input across the target languages. Ronjat (1913) reported that Louis had a larger initial vocabulary in German due to greater overall input in that language; however, changes in location and input (e.g., spending time with French family members) affected his language dominance. Leopold (1949/1970) reported that the relative percentage of German and English words in Hildegard's vocabulary shifted depending on her amount of German and English input (e.g., a trip to Germany increasing the proportion of German words). Other diary studies demonstrated that bilinguals' vocabularies were matched to the distribution of input. Vihman (1985) reported that Raivo, who was learning Estonian and English, spent 24% of his waking hours exposed to English, and one-quarter of his vocabulary consisted of English words. Quay's (1995) analyses of the vocabulary of an infant acquiring English and Spanish also showed tight correspondence to exposure (50% English exposure resulting in 50% English words).

Again, researchers using standardized measures with larger samples confirmed 1) different vocabulary scores across the two languages of many young bilingual children, and 2) the tight relationship between language exposure and the nature of the bilingual vocabulary (e.g., Pearson & Fernández, 1994; Pearson et al., 1993; Silvén et al., 2014; Thordardottir et al., 2006; Umbel et al., 1992). Pearson, Fernández, Lewedeg, and Oller (1997) discovered a strong positive correlation between bilingual infants' Spanish and English exposure and the presence of words from those languages in their nascent vocabularies (see also Hoff et al., 2012; Marchman & Martinez-Sussman, 2002; Place & Hoff, 2011). Spanish exposure explained nearly 70% of the variance in children's Spanish vocabulary size, which was also the case in English. This concordance between input and vocabulary matches monolingual findings: monolingual infants with higher maternal speech input have larger vocabularies (e.g., Hart & Risely, 1995), and there are relationships between types of speech input and the corresponding parts of the young child's vocabulary (e.g., mental state language, Taumoepeau & Ruffman, 2008).

Young bilinguals thus have vocabularies that are tied to input in each language, but what of the overlap between the two vocabularies? Hildegard possessed translation equivalents, i.e., words across a bilingual's languages that refer to the same concept, such as *dog* and *Hund* (Leopold, 1949/1970). Vihman (1985) reported that translation equivalents comprised 34% of Raivo's vocabulary by age 2. Similar levels were reported in a study of a Spanish-English toddler (40%; Quay, 1995) and an ASL-English toddler (37%; Brackenbury et al., 2006). Large-sample research again confirmed these levels of translation equivalents amongst bilingual infants and toddlers, with translation equivalents across studies accounting for an average of 25% of total vocabulary (Mancilla-Martinez et al., 2011), ranging from 15% (Marchman et al. 2010; Core et al., 2013) to 50% (Frank & Poulin-Dubois, 2002; Houston-Price et al., 2010; Junker & Stockman, 2002). Thus, translation equivalents are present in the vocabularies of bilingual children from the onset of their vocabulary development and comprise a sizeable proportion of words.

Bilinguals' potentially unequal vocabularies across their languages (i.e., dominance) and the fact that translation equivalents usually comprise less than half of their vocabulary have ramifications for vocabulary assessment. Comparing bilinguals' performance in only one language to monolingual learners of that language fails to account for concepts known only in their other language, especially if the vocabulary in question is their non-dominant language. Indeed, the majority of bilingual work demonstrates that young bilingual children have significantly lower vocabularies in their non-dominant language when compared to monolinguals of that language (Junker & Stockman, 2002; Patterson, 1998; Pearson & Fernández, 1994; Thordardottir et al., 2006; Umbel et al., 1992). While some large-sample studies reveal parity between the dominant language of young bilinguals and that of monolinguals of that language (e.g., Junker & Stockman, 2002; Patterson, 1998; Pearson & Fernández, 1994; Pearson et al., 1993), others continue to find smaller vocabularies even in bilinguals' stronger language (Mancilla-Martinez & Vagh, 2013; Thordardottir et al., 2006). These differences highlight the problem of using only one language as the central measure of bilingual word knowledge. Unfortunately, this is, even today, a misguided but common practice in clinical language assessment.

Thus, Pearson and her colleagues, who pioneered large-sample vocabulary assessments of bilingual infants, advocated two alternate and more representative measures of bilingual lexical knowledge: total vocabulary (i.e., adding all words across the two languages), and total conceptual vocabulary, or TCV (e.g., Pearson & Fernández, 1994; Swain, 1972). This latter measure counts translation equivalents across the two languages as only one "word," so that only words reflecting unique concepts comprise infants' vocabulary. The argument for using TCV is that the large amount of vocabulary overlap (i.e., translation equivalents) may be acting as an inflationary factor for a total vocabulary measure.

In Pearson's work, bilingual infants' total vocabularies were the same size as monolinguals' vocabularies from 8 to 30 months of age, in both production and comprehension (Pearson & Fernández, 1994; Pearson et al., 1997; Pearson et al., 1993, see also Core et al., 2013; Hoff et al., 2012; Patterson, 1998). Other research has

shown that the mean total vocabulary size of bilingual infants actually exceeds that of monolinguals (Bosch & Ramon-Casas, 2014; Junker & Stockman, 2002; Silvén et al., 2014). Many bilingual studies, including Pearson's work above, indicate that the TCV measure is also the same size as monolinguals' total vocabulary (Bosch & Ramon-Casas, 2014; Junker & Stockman, 2002; Silvén et al., 2014). However, Core et al. (2013) found that bilingual English-Spanish toddlers' TCV fell below monolingual values (see also Mancilla-Martinez & Vagh, 2013; Thordardottir, et al, 2006). Core and her colleagues criticized TCV by arguing that reducing translation equivalents from two vocabulary entries to one misrepresents the complexity of the bilingual lexicon. After all, the child still needs to learn two phonological forms. Further, translation equivalents are rarely truly equivalent: there is imperfect semantic overlap across the languages for the same "words." Nevertheless, while total vocabulary size may sometimes overestimate bilingual children's vocabulary size and TCV may sometimes underestimate it, it is important to note that the majority of research shows parity between these measures of bilingual vocabulary and monolingual norms.

The above findings inform hypotheses about the word learning processes underlying lexical acquisition and vocabulary development. Bilingual children appear to possess the same *general* word learning capabilities as monolinguals, despite the complexities inherent in their language environments. The evidence for this is the similarly sized vocabularies between bilinguals and monolinguals, and the similarly timed language milestones between these groups. Bilinguals are not delayed; but they also do not initially possess a super-vocabulary, double that of monolinguals. However, because bilinguals' two languages unfurl at different rates depending on exposure to each language, this may indicate that lexical processing efficiency may differ across dominant and non-dominant languages. With these hypotheses in mind, we now turn to an exploration of lexical processes in young bilinguals.

Lexical processes in bilingual infants and toddlers

To successfully learn a word and build a vocabulary, an infant must acquire and refine both the form of the word and the concept to which it refers. The extant literature on early bilingual word learning and recognition primarily focuses on the former over the latter. Most studies examining lexical processes in young bilingual children investigated their ability to learn and/or recognize words in the face of changes to the acoustic form, especially phonological contrasts (i.e., sounds that denote lexical changes, like /b/ and /p/ in English: *bat* versus *pat*). This approach stems from literature indicating that bilingual infants may have developmentally transient difficulties in perceiving some acoustically close phonological contrasts, especially if learning related languages (e.g., Spanish-Catalan; Bosch & Sebastián-Gallés, 2003). The explanation for these difficulties is that the variation present in bilinguals' language environments may promote a greater acceptance of acoustic variation in phonemes. Small changes are normal and therefore not surprising due to the higher probability of hearing accented speech in comparison to monolinguals and the presence of cognates in the input of many bilingual infants. Thus, it logically

follows that research on early bilingual lexical processing has focused on phonological changes in word forms.

Word segmentation

The only two studies exploring bilingual infants' word segmentation and recognition both examined issues relating to phonological detail (Singh & Foong, 2012; Vihman et al., 2007). Before or during attaching a meaning to a word, infants must extract the acoustic word-form candidate from continuous speech (see Chapter 2). In one study, English-learning 7.5-month-olds listened longer to passages containing word forms heard during a learning phase (e.g., *bike*) over those with phonetically similar forms (e.g., *gike*; Jusczyk & Aslin, 1995). This suggests that English-learning infants recognize familiar words in fluent speech by 7.5 months and encode word forms in sufficient detail to detect phonemic mispronunciations.

Bilingual exposure does affect word segmentation. However, the specific effects appear to depend on the languages being acquired. Singh and Foong (2012) found that Mandarin-English bilingual infants were sensitive to a phonological change present in only one of their languages (Mandarin tone changes) at 7.5 and 11 months. At 9 months, however, they appeared to generalize words across differences in lexical tone. These data mirror the U-shaped developmental pattern seen in some bilingual phoneme discrimination work that also tests infants on phonological changes unique to one of their languages (see Byers-Heinlein & Fennell, 2014, for a review). This supports the hypothesis that bilingual infants may go through a period of accepting phonemic substitutions that should signal a change in a word's meaning due to the variability present in their input.

However, Vihman et al. (2007) found that exposure to a more "stable" phonological system actually enhanced bilinguals' attention to phonological changes in comparison to their monolingual peers. In Welsh, words undergo consonant mutation for a variety of morphological and syntactic reasons. For example, the word *pont* (bridge) could be produced as /pont/, /bont/, or /font/ depending on the grammatical context. English-learning infants of 11 months preferred listening to frequent words over phonetically similar infrequent words. But Welsh-learning infants did not show the same preference until 12 months, perhaps due to their more variable phonological environments. However, bilingual Welsh-English infants recognized frequent words in Welsh one month earlier than their Welsh-learning peers (their performance in English matched their English peers). Thus, the bilinguals' exposure to English, a more phonologically "stable" language, supported their ability to recognize words in the comparatively more "unstable" Welsh (Vihman et al., 2007). These studies highlight the need to take language characteristics into account when interpreting bilingual performance.

Word learning

A fundamental aspect of lexical acquisition that we would expect to be similar across bilinguals and monolinguals is the ability to contemporaneously link a word form

to a concept, which undergirds all word learning. Byers-Heinlein, Fennell, and Werker (2013) tested this skill in 12- and 14-month-old monolingual and bilingual infants using the Switch task. In this procedure, infants are habituated to two distinct auditory word-object combinations and then receive two test trials: a "same" trial where they experience one of the word-object combinations from habituation (e.g., Word A–Object A), and a "switch" trial where a word and object from habituation are incorrectly paired (e.g., Word A–Object B). If infants map the words to the objects, they should react with surprise to the incorrect pairing and look longer on the "switch" versus the "same" trials. While infants begin acquiring word-object correspondences in natural settings earlier in life (e.g., Bergelson & Swingley, 2012), monolingual infants usually do not succeed in this controlled laboratory task until 14 months (Werker et al., 1998). Byers-Heinlein et al. (2013) replicated that monolingual finding and extended it to bilinguals: both groups succeeded in learning the words at 14 months, but not at 12 months. As predicted, basic word learning does not appear to differ in bilingual infants.

Would these comparable results hold for bilingual infants in a more challenging word learning task? One such task is a variation of the Switch procedure where infants are required to learn two similar-sounding words (i.e., a minimal pair) rather than two distinct words. If a bilingual infant is habituated to Object A being called '/kem/' and Object B called '/gem/', they may not react with surprise to Object A receiving the label '/gem/' at test. After all, in their environment, words can undergo such changes (i.e., cognates). Indeed, Fennell, Byers-Heinlein, and Werker (2007) found that bilingual infants did not react to a minimally different mislabeling of the objects at test until 20 months of age, whereas monolinguals reacted to the switch in labels at 17 months. On the surface, it would appear that variation in the bilinguals' language environments led them to learn words in either a less detailed manner, or to disregard small changes in word forms.

Yet, a similar word-learning study demonstrated opposing results, casting doubt on bilinguals' purported holistic processing of word details. Mattock et al. (2010) tested French-English bilingual, English monolingual, and French monolingual infants of 17 months in the minimal pair Switch task. Although the minimal pair was the same across conditions (/bos/-/gos/), the words were either produced in a French or English manner. Monolingual infants only reacted to a violation in the learned word-object pairings when hearing native productions (e.g., French monolinguals hearing words produced in a French manner). They failed with non-native productions (e.g., French monolinguals hearing words in an English manner) or when hearing an interleaved mix of the two productions. In contrast, Mattock et al. (2010) found that bilingual infants in the mixed-production condition succeeded in noticing word-object violations. The researchers hypothesized that, compared to monolinguals, bilingual infants are better able to process a diverse array of tokens based on the phonetic variability in their environment.

However, a recent study indicates that bilingual infants do not fundamentally differ from monolinguals in these challenging word-learning tasks; both groups react to changes prevalent in their language environment. Note that bilingual infants who

failed to notice a change in the target words in Fennell et al. (2007) only heard words produced by a monolingual speaker, and the successful bilingual infants in Mattock et al. (2010) heard bilingual-accented tokens. Even highly proficient simultaneous bilinguals possess slightly different accents in their native languages relative to monolinguals of those languages (Antoniou et al., 2010). Bilingual and monolingual infants may simply prefer their "native" accents, meaning that bilinguals possess neither an enhanced acceptance of variation nor impoverished word representations. Indeed, Fennell and Byers-Heinlein (2014) found that 17-month-old bilinguals succeeded in distinguishing a minimal pair when hearing a bilingual adult produce the tokens, but failed when hearing a monolingual adult, with monolingual infants showing the opposite pattern. Monolingual and bilingual infants therefore follow the same pattern of development: both groups succeed with minimal pairs at 17 months when listening to a speaker who sounds like people in their environment.

All of the word learning studies discussed above examined bilinguals' reactions to a phonological change that occurred in both of their languages. Would young bilingual learners react appropriately to a phonological change that occurs in only one of their languages, similar to their sensitivity to such changes in early segmentation (Singh & Foong, 2012)? Mandarin-English bilingual 2-year-olds successfully detect changes in lexical tone in newly learned words (tone is phonological in Mandarin, but not in English). Importantly, bilinguals acquiring English and a non-tonal language treat tone as non-phonemic at 2 years, thereby treating a word that changes in tone as a new word (Singh et al., 2014). So, the variable nature of the bilingual environment does not engender broader acceptance of non-native phonological categories. Rather, bilinguals, like monolinguals, are attuned to the possible phonemes in both their languages. This again shows that bilingual infants are as detailed in their lexical acquisition as monolinguals.

The literature reviewed above has shown that monolingual and bilingual word learning processes are highly concordant. However, this is not necessarily the case for a word learning constraint known as mutual exclusivity: the idea that monolingual children assume that objects should have one basic-level label (Markman & Wachtel, 1988; see Chapter 3 for in-depth discussions of word learning constraints). Strong adherence to this mutual exclusivity constraint would derail bilingual acquisition. If a French-English bilingual infant possesses *chien* as the word for the category dog, she must also be able to efficiently attach the word *dog* to that same category. The presence of large numbers of translation equivalents in bilinguals' early vocabularies suggests a relaxed mutual exclusivity constraint.

In one study on mutual exclusivity, Au and Glusman (1990) tested Spanish-English bilingual 3- to 5-year-olds. An English-speaking experimenter labeled an animal from a novel category (a lemur) with a novel name (*mido*). When presented with another lemur along with two individual animals from another novel category (seals), children selected another lemur when the English experimenter asked for another *mido*. A Spanish-speaking experimenter then asked the children to show her a *theri*, and interestingly, children were random in their choices: *theri* could equally be the Spanish word for lemur or seal (see also Davidson & Tell, 2005; but

see Frank & Poulin-Dubois, 2002, for comparable results across monolinguals and bilinguals).

Two more recent studies have confirmed that infant multilinguals do not readily apply mutual exclusivity to word learning. Using English as the testing language, Houston-Price et al. (2010) showed that 17- to 22-month-old bilinguals learning English and another language did not look reliably longer to a novel object over a familiar object after hearing a novel label (*dax*), whereas monolinguals did. Byers-Heinlein and Werker (2009) showed comparable results. Monolingual 18-month-olds looked significantly longer to a novel object over a familiar one after hearing a novel label, whereas bilingual infants approached but failed to reach significance. Trilingual infants failed to show any evidence of mutual exclusivity. Further, bilingual infants with more translation equivalents in their vocabularies appear to have weaker adherence to mutual exclusivity, demonstrating an influence of the structure of the bilingual lexicon (Byers-Heinlein & Werker, 2013). Collectively, it appears that greater experience with multiple labels for a single word or category reduces the role of mutual exclusivity from the beginnings of word learning.

Word recognition

Word recognition skills may not fundamentally differ across young bilinguals and monolinguals, but may be subject to the intricacies of dual-language input. Bilingual infants' vocabularies in each of their languages are tied to exposure to each language, and non-dominant languages are more deviant from monolingual norms than dominant languages. Thus, one strong prediction would be that bilingual infants' and toddlers' word processing and recognition skills would be comparable to monolinguals in their dominant language but weaker in their non-dominant language (i.e., similar to monolinguals with low total vocabulary).

Marchman et al. (2010) investigated how Spanish-English bilingual 2-year-olds' vocabularies relate to their real-time language processing skills. Specifically, they sought to understand whether bilinguals' speed of processing familiar words is similar across their two languages, or whether processing speed in each language is tied specifically to vocabulary in each language. Participants were Spanish-English bilingual 30-month-olds with a range of exposure to each language. As in previous studies with bilinguals, vocabulary size in one language was not closely related to vocabulary size in the other language (Pearson et al., 1993), but interestingly, this was also the case for real-time processing speed. Young bilingual children's processing speed in Spanish was tied to vocabulary knowledge in Spanish, and processing speed in English was tied to vocabulary knowledge in English; neither was linked to processing speed or vocabulary in the other language.

Parra, Hoff, and Core (2011) found comparable within-language relations in 2-year-old Spanish-English bilinguals. Data were collected on children's household language exposure, vocabulary knowledge, grammatical knowledge, and ability to repeat novel words produced by an experimenter. While some evidence of language-general skill was found for phonological memory, the central finding was that exposure

to each language accounted for significant variance in phonological memory skill in that language, and—in turn—phonological memory skill in each language predicted vocabulary and grammar in that language. Thus, in young bilingual children, there may be two independent tracks of cascading effects between language exposure and later language growth. Together with the study by Marchman et al. (2010), we can conclude that exposure, vocabulary, and processing travel together, such that (for example) lower vocabulary predicts slower processing, as in studies with monolingual children (e.g., Hurtado et al., 2007). Critically, this also parallels the robust finding that children who hear less language in the household show lower vocabulary (Hart & Risley, 1995) and slower language processing (Weisleder & Fernald, 2013).

One final line of research on bilinguals' word recognition skills returns to the focus on bilingual phonology: testing mispronunciations of known words. In these tasks, infants see two side-by-side pictures (e.g., a doll and a car) and a target object is either named correctly (e.g., *doll*) or incorrectly (e.g., *goll*). Monolinguals as young as 11 months showed reduced looking to the target when hearing mispronunciations relative to correct pronunciations, suggesting phonologically rich lexical encoding (Swingley, 2005). However, Spanish-Catalan bilingual 17- to 24-month-olds did not detect a mispronunciation in familiar words when the vowel change corresponded to the Catalan-specific /e/-/ε/ contrast, unlike same-age Catalan monolinguals. Bilinguals looked to the target object equally regardless of correct or incorrect pronunciation (Ramon-Casas et al., 2009). This was not due to a general inability to hear the distinction, as early discrimination problems resolve by 12 months. Their failure, however, does seem to be restricted to the Catalan-specific contrast, since mispronunciations consisting of contrasts common to both Spanish and Catalan hindered word recognition. Further, Ramon-Casas and Bosch (2010) noted that this study only used cognate words, which may have driven bilinguals' acceptance of mispronunciations. Indeed, they found that Spanish-Catalan bilinguals of the same age detected /e/-/ε/ mispronunciations when target words were not cognates (see Chapter 5 for further discussions of phonological encoding, including effects of input variability).

Conclusion

Research on bilingual lexical acquisition reveals striking similarities between bilingual and monolingual infants and toddlers. In the face of more variable input, infants acquiring multiple languages still reach similar milestones, have similar sized total vocabularies, and learn word-concept pairings in similar ways as their monolingual peers. Further, although input affects lexical processes in both populations, this link is more clearly revealed in bilingual infants due to the presence of two languages. The few discrepancies between the populations are primarily attributable to the presence of multiple labels for individual concepts, which increases children's willingness to map two words onto one object and engenders a greater acceptance of certain mispronunciations. Critically, these conclusions may shift as the field makes progress in understanding the intricacies of bilingual word learning.

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10

ERP INDICES OF WORD LEARNING

What do they reflect and what do they tell us about the neural representations of early words?

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Introduction

At a certain point in development, infants' mental representations of word meanings shift from low-level visual-auditory associations to higher-level connections that referentially bind word forms with semantic representations. This view of a representational transition from so-called "proto-words" to "genuine words" (Nazzi & Bertoncini, 2003) is widely accepted, but how such a change happens has been largely unknown. Does a particular state of brain maturation have to be achieved before elementary semantic representations can be established? Do genuine words develop from first-established proto-words? Do proto-words and genuine words develop independently at successive developmental stages, or does the emergence of genuine words begin parallel to the further establishments of proto-words? Until recently, it has not been investigated on which factors the transition from proto-words to genuine words depends. Moreover, even though the shift from perceptual-associative to referential semantic representations was claimed to underlie changes in infants' behavioral development, such as the emergence of the fast mapping ability or the onset of the vocabulary spurt (e.g., Nazzi & Bertoncini, 2003), it has been unknown when exactly the supposed transition in infants' word representations occurs.

The presence of genuine words is hard to prove. Behavioral methods cannot directly differentiate between knowledge based on perceptual memory and knowledge based on semantic memory. In behavioral measures, a distinction between perceptual and semantic memory can only be made by varying the kind of knowledge, e.g., by testing concrete vs. abstract words (e.g., Bergelson & Swingle, 2013). However, this kind of dissociation of proto-words and genuine words involves an interference with the developmental trajectory of the acquisition of concrete and abstract knowledge.