23

Vocabulary Learning in Bilingual First-Language Acquisition and Late Second-Language Learning

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Even though grammar may be the quintessential component of language, vocabulary is beyond doubt the most indispensable one. This contribution discusses aspects of the acquisition of vocabulary in two very different populations of learners. The first part discusses stages of lexical development in monolingual and bilingual infant first language (L1) learners, focusing on the bilingual case. The stages covered are the development of sublexical knowledge structures and complete word forms, and the association of word form to word meaning. The second part discusses vocabulary acquisition in late second language (L2) learners. Themes that are covered are the stages and methods of acquisition and the effects of various word characteristics on acquisition. Due to the many differences between these two populations of learners that are correlated with the age difference between them, for instance differences in brain size, general cognitive skills, and extant knowledge structures, vocabulary learning differs considerably between them. One specific difference between L1 and L2 vocabulary learning will be highlighted: the fact that L1 vocabulary learning involves the learning of both word form and word meaning, whereas in L2 vocabulary learning the targeted L2 meanings are already largely in place in the form of lexical concepts in the learners' L1.

The Genesis of Vocabulary in Monolingual and Bilingual First Language Acquisition

Monolingual first language acquisition: phonemes and phonotactics

First-language vocabulary learning starts well before the glorious moment a toddler produces its first words around 12 months of age. During the months prior to this

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first overt sign of a rudimentary lexicon, infants' impressive perceptual skills have led to the build-up of sublexical knowledge structures, phonemes, and phoneme clusters, thus paving the way to this milestone event. Because words are composed of phonemes, the acquisition of a language's phonemes can be regarded a preliminary step in, or even a component part of, vocabulary learning. The acquisition of the phonemes of the ambient language – the native language(s) – starts immediately at birth, proceeding in parallel to a decreasing perceptual sensitivity to innate nonnative phonetic categories and contrasts. During the first 5 or 6 months of life infants can discriminate both native and nonnative minimal phonetic contrasts. In other words, they can perceive small acoustic differences between pairs of speech sounds that represent different phonemes in the ambient language ("native contrasts") as well as acoustically equally small differences between pairs of speech sounds that represent different phonemes in certain nonnative languages but not in the native language ("nonnative contrasts"). After about 6 months of age the ability to perceive nonnative phonetic contrasts starts to decline (Werker & Tees, 1984). At the same time language-specific perception of speech sounds has started to emerge. By the time infants are about 11 months of age, they have largely lost the ability to discriminate nonnative phonetic contrasts, although some of these continue to be perceived (Best & McRoberts, 2003; Best, McRoberts, & Sithole, 1988; Tees & Werker, 1984) and a lost contrast may not be lost forever but be restored through relevant language exposure (Kuhl, Tsao, & Liu, 2003). As stressed by a number of authors (Kuhl, 2004; Kuhl et al., 2003; Sebastián-Gallés & Bosch, 2005), rather than pointing at perceptual loss, this reduced perceptual sensitivity to nonnative speech sounds in fact indexes growth in phonetic development, resulting from perceptual reorganization processes caused by exposure to the ambient language.

The way phonemes combine into phoneme sequences within words is subject to language-specific sequential and positional constraints. For instance, the phoneme strings /str/ and /spr/ occur in English but only at the beginning of a word, not the end, and /ʦ/ can occur in initial position in German but not in English. Just as vocabulary acquisition involves the learning of the language's phoneme inventory, it requires the development of knowledge regarding these constraints on the sequencing and positioning of phonemes within words. There is some evidence to suggest that this knowledge, known as "phonotactic" knowledge, becomes manifest during the second half of the first year: Jusczyk, Friederici, Wessels, Svenkerud, and Jusczyk (1993) presented English and Dutch word lists to American and Dutch 9-month-old infants, each list containing words of one language only. The majority of the English words violated the phonotactic constraints of Dutch, containing sound sequences that do not occur in Dutch. Conversely, the majority of the Dutch words violated the phonotactic constraints of English. It was found that the American infants listened significantly longer to the English lists than to the Dutch lists, whereas the Dutch infants showed the opposite pattern. These results suggest that the previous 9 months of exposure to the ambient language had sensitized the infants to the phonotactics of their native language. In a further experiment testing

American 6-month-olds the language effect did not materialize. These combined findings suggest that sensitivity to the ambient language's phonotactics develops between 6 and 9 months.

Two studies by Saffran and her colleagues (Saffran, 2001; Saffran, Aslin, & Newport, 1996) provided relevant information regarding a cognitive mechanism that might underlie this ability of infants to discover the phonotactics of the surrounding language(s). In addition, these studies provided an answer to the question how infants learn to segment continuous speech into sound patterns that correspond to single words. This ability is a further necessary preliminary step in the development of a lexicon. Saffran et al. (1996) first familiarized a group of American 8-month-olds with 2 minutes of fluent synthesized speech. The speech stream consisted of four three-syllabic nonsense "words" (*pabiku, tibudo, golatu, daropi*), repeated in a random order. There were no physical boundaries between the successive words (e.g., *tibudodaropipabikutibudogolatudaropigolatupabiku* . . .) nor did the speech stream contain any prosodic cues to the word boundaries. During a subsequent test phase the infants were presented with repetitions of two of the four "words" presented during training (e.g., *pabiku* and *tibudo*) and with repetitions of two syllable triads that were created by joining the final syllable of one of the words onto the first two syllables of a second word (e.g., *tudaro* and *pigola*, called "part-words" in Saffran, 2001). The crucial difference between these two types of syllable triads was that the sequential (or "transitional") probability between the first, second, and third syllable was always 1.0 within the words whereas it was less (.33) for one of the syllable transitions within the part-words (notice that also the part-words occurred as such in the speech stream; see the example above). If the infants' listening times at test would be different for the words and part-words, this would indicate the infants had extracted from the input the relative frequencies of the transitions between the syllables (high within words; lower within part-words). A difference in listening time for words and part-words was indeed obtained. Accordingly, Saffran and her colleagues concluded that infants possess a statistical learning device that detects sequential probabilities of syllables in speech and that this tool helps them to develop a lexicon by suggesting where the word boundaries are in continuous speech: a syllable sequence of high sequential probability is likely to be a word and one of low sequential probability presumably contains a word boundary somewhere in the middle. This statistical learning device can similarly account for the above finding (Jusczyk et al., 1993) that at 9 months infants can discriminate between the phonotactic patterns of the ambient language and uncommon phonotactic patterns because what distinguishes the two is the sequential probability of the constituent phonemes. Furthermore, just like the sequential probabilities of syllable sequences, the sequential probabilities of phoneme sequences plausibly provide information on word boundaries: a familiar phonotactic pattern is likely to be a sublexical unit of one and the same word, whereas an uncommon phoneme sequence presumably marks a boundary between two words.

In a later study, Saffran (2001) put forward the important argument that only if infants treat the familiar syllabic patterns they have extracted from the speech input as potential words (and not as patterns that are merely familiar to them but are not assigned a special linguistic status), it is legitimate to conclude that this statistical learning device bootstraps vocabulary acquisition. She examined this issue using a modified procedure. Following the same familiarization procedure as used in Saffran et al. (1996), at test the words and part-words were embedded in either an English context (e.g., word: *I like my pabiku*; part-word: *What a nice tudaro*) or in a nonsensical context (word: *Zy fike ny pabiku*; part-word: *Foo day miff tudaro*). A significant listening time difference between words and part-words was obtained when they were embedded in an English context but not when they were embedded in nonsense. Accordingly, the author concluded that "infants are not just detecting the statistical properties of sound sequences. Instead, they are using the statistical properties of sound sequences to acquire linguistic knowledge: possible words in their native language" (Saffran, 2001, p. 165).

The studies by Saffran and her colleagues have thus revealed an important learning mechanism of infants, one that is sensitive to the frequency and internal structure of recurrent patterns in the speech input. The learning process involved, coined "statistical learning" by these authors, does not only start off vocabulary acquisition but is assumed to bootstrap learning in other language domains as well, specifically, the learning of grammar and phonology (see Saffran, 2001, for a review). In its turn, this evidence that statistical learning plays a pivotal role in language learning in general challenges theories of language acquisition that assume it to be largely driven by innate linguistic universals (see Saffran, 2003, for a review).

Bilingual first language acquisition: phonemes and phonotactics

The above description of precursors of vocabulary development was based on studies that examined infants exposed to monolingual input. But of course, many children grow up with two languages either from birth ("simultaneous bilingualism" or "bilingual first language acquisition"), or are exposed to a second language soon after a period of exclusive exposure to the first ("early sequential bilingualism"). This situation gives rise to the question whether and how the above skills and types of knowledge structures develop differently in monolingual-to-be (henceforth: "monolingual") and bilingual-to-be (henceforth: "bilingual") children. There is no reason to believe that the word segmentation procedure described above is operative at different moments in bilingual and monolingual infants, but plausibly language-specific phonological and/or phonotactic knowledge emerges later, or follows a different developmental trajectory, in bilingual infants.

Bilingual infants are exposed to two different speech systems that may contain different numbers of phonemes, different phonetic contrasts, and differences between the prototypical values of shared phonemes. A consequence of these differences between the phonological systems of a bilingual infant's two languages is the occurrence of cross-language distributional overlap of speech sounds that instantiate phonemes belonging to the different languages. For example, the /e/

phoneme in the one language may be realized in speech the same way as the /ɛ/ phoneme in the other language. Maye, Werker, and Gerken (2002) have shown that 6- and 8-month-old monolingual infants exploit distributional information of speech sounds in the language input to develop phoneme categories. Specifically, they found that their infant participants built a single phonetic category when the majority of the speech sounds presented to them clustered around one central value on a particular acoustic dimension (voiced–voiceless) but formed two categories if the presented speech sounds were grouped around two more peripheral values on the phonetic dimension. This finding suggests that bilingual infants, experiencing cross-linguistic distributional overlap of speech sounds, may be hindered in developing the phoneme categories of their two languages, exhibiting a delay as compared with monolingual children and/or perhaps following a different trajectory towards the targeted phonemes.

A second reason for a relatively late emergence of phoneme categories in bilingual infants might be that the language input they receive is divided between their two languages. As a consequence, bilingual infants will be exposed to exemplars of one and the same phoneme less frequently than monolingual infants. Presumably, frequency of exposure to a particular phoneme determines how rapidly it is acquired, thus favoring monolingual infants. For the same reason, the phonotactic development in the two separate languages may be delayed in bilingual infants: a bilingual child will hear a particular phoneme sequence, common in one of his languages, less often than a child exclusively exposed to this language and, plausibly, it will therefore take the bilingual child relatively long to develop the associated knowledge structure.

Among the paucity of studies that examined the developing speech system in bilingual infants there is one that suggests that, despite the complexity of the linguistic input they are exposed to, bilingual infants develop some knowledge of the sublexical elements in their two languages at a very early age: Bosch and Sebastián-Gallés (2001) discovered that Catalan–Spanish 4-month-olds discriminated between Catalan and Spanish speech passages even though Catalan and Spanish belong to the same rhythmical class of languages and an interpretation in terms of perceived rhythm differences cannot therefore account for this result. Although it remains possible that less salient prosodic differences between these two languages enabled them to do so, an equally plausible alternative is that at 4 months bilingual infants have already developed the rudimentary beginnings of the sublexical elements in both their languages.

Still, a further study by these same researchers indicates that at least some phonemes develop later in bilingual infants than in age-matched monolingual controls. Bosch and Sebastián-Gallés (2003a) compared the development of a vowel contrast that exists in Catalan but not in Spanish in Catalan and Spanish monolingual infants and Catalan–Spanish bilingual infants. The vowel contrast under study concerned the vowels /e/ (as in *bait*) and /ɛ/ (as in *bet*). The Spanish phonetic system only contains /e/, which acoustically overlaps with both Catalan /e/ and /ɛ/ and whose prototypical exemplar is intermediate between those of the two Catalan vowels. Two age groups were tested: 4-month-olds and 8-month-olds. Half of the participants in each bilingual and monolingual age group were first familiarized with /e/ exemplars whereas the remainder half were first familiarized with /ε/ exemplars. In a subsequent test phase all participants heard exemplars of both the category they had heard during familiarization ("same") and the other category ("different"). The question of interest was which of the infant groups could hear the difference between same and different exemplars, as indicated by different listening times for these two types of stimuli.

In agreement with the common observation that during the first months of life infants are sensitive to both native and nonnative contrasts, all three groups of 4-month-olds, also the Spanish monolingual group, perceived the Catalan contrast. Furthermore, in agreement with the established view that language-specific perception develops in the second semester of life, the Catalan monolingual 8-month-olds still perceived the contrast whereas the Spanish 8-month-olds failed to discriminate between /e/ and /ε/ exemplars. Interestingly, despite the fact that the bilingual 8-month-olds had been exposed to the contrast from birth, albeit on average less frequently than their Catalan peers, they failed to perceive it, behaving like the Spanish 8-month-olds. A follow-up experiment testing 12-month-old Catalan–Spanish infants showed that by that age the sensitivity to the Catalan contrast had been restored. The authors concluded that due to the overlapping distributions of exemplars of Spanish /e/ and Catalan /e/ and /ε/, the bilingual infants had first developed a single extended phoneme category encompassing all three vowels and therefore failed to discriminate them (cf. Maye et al., 2002; see above). They suggested that this one category is ultimately separated into three (Catalan /e/ and /ε/ and Spanish /e/), presumably as a result of extended exposure to both languages. In a second study, the authors replicated part of this bilingual developmental pattern, now testing infants' ability to discriminate between the fricatives /s/ and /z/, which, again, are contrastive in Catalan but not in Spanish (Bosch & Sebastián-Gallés, 2003b): At 4 months infants from monolingual Catalan, monolingual Spanish, and Catalan–Spanish bilingual homes all discriminated between these fricatives when they occurred in word-initial position of monosyllabic stimuli. At 12 months only the Catalan monolingual infants were sensitive to this contrast. No older age groups were tested so that it is impossible to tell when exactly sensitivity to this contrast is restored again in the bilinguals.

The studies by Bosch and Sebastián-Gallés (2003a, 2003b) suggest that cross-language distributional overlap of the speech sounds in bilingual infants' dual language input delays the building of language-specific contrastive phonetic categories. It was already mentioned above that the lower average frequency of exposure to each separate phonetic element might be a further cause of this developmental delay. That exposure frequency indeed plays a role in the development of phonetic categories was suggested by Sundara, Polka, and Molnar (2008). These authors argued that if infants are sensitive to the frequency of occurrence of the phonetic elements in the speech input (which the statistical learning device described above suggests is the case), a high frequency of occurrence might counteract the adverse

Pr

effect of cross-language distributional overlap in the development of specific phonetic categories in bilingual infants.

They tested this hypothesis by comparing the ability of monolingual French, monolingual English, and bilingual French–English 6–8- and 10–12-month-olds, six groups in all, to discriminate between exemplars of French /d/ (articulated dentally) and English /d/ (articulated at the alveolar ridge). Exemplars of French and English /d/ show considerable acoustic overlap and French adults fail to distinguish between them. English adults, however, can hear the difference between them, possibly because French dental /d/ is perceptually similar to English /ð/. Importantly, both French /d/ and English /d/ occur very frequently in their respective languages. As hypothesized by the authors, despite the distributional overlap of French and English /d/, English–French bilingual infants might therefore remain sensitive to this contrast. In a habituation procedure similar to the one employed by Bosch and Sebastián-Gallés (2003a) they found that all three groups of 6–8-month-olds succeeded in discriminating between French and English /d/. The monolingual English and French 10–12-month-olds behaved like adult speakers of these languages, the English monolinguals still discriminating French and English /d/ but the French monolinguals failing to do so. Interestingly, the French–English bilingual 10–12-month-olds also perceived the contrast, exhibiting the same response pattern as the English monolingual infants this age. These findings warrant the conclusion that, in addition to the distributional pattern of speech sounds, their occurrence frequency determines whether or not bilingual infants lag behind their monolingual peers in developing phonetic categories.

As described earlier, at 9 months monolingual infants recognize the difference between sound sequences that occur in their native language and those that do not, thus showing that phonotactic knowledge has emerged (Jusczyk et al., 1993). Sebastián-Gallés and Bosch (2002) provided a first indication that growing up bilingual does not inevitably delay phonotactic development. They presented Catalan monolingual, Spanish monolingual, and Catalan–Spanish bilingual 10-month-olds with lists of nonwords that all had a CVCC structure. Catalan contains consonant clusters in word-final position but Spanish does not. Half of the presented lists consisted of nonwords with legal Catalan end clusters (e.g., *birt* and *kisk*) whereas the nonwords on the other half of the lists contained end clusters that do not occur in Catalan (e.g., *ketr* and *datl*). Given the absence of consonant clusters in word-final position in Spanish, all nonwords were illegal in Spanish. The Catalan monolinguals listened longer to lists of words with legal consonant clusters than to those with illegal consonant clusters, thus demonstrating sensitivity to the phonotactics of their native language and corroborating the results obtained by Jusczyk et al. (1993). The Spanish monolinguals listened equally long to both types of word lists, a finding that agrees with the fact that the words of both lists were illegal in Spanish, so there was no ground to discriminate between them. The pattern of results obtained for the bilingual infants depended upon the relative dominance of their two languages: a subgroup of Catalan-dominant bilinguals (exposed to Catalan and Spanish 60% and 40% of the time, respectively) exhibited an equally

Pr

large difference in listening time to the legal and illegal word lists as their Catalan monolingual peers. In contrast, a much smaller and statistically nonsignificant list-type effect was observed for a subgroup of Spanish-dominant bilinguals (exposed to Catalan and Spanish 40% and 60% of the time, respectively). These results suggest that the development of phonotactic knowledge is not linearly related to the amount of exposure to the phoneme sequences in question because if it were, the Catalan monolinguals should have shown a larger list-type effect than the Catalan-dominant bilinguals. Nevertheless, the statistical null-effect observed for the Spanish-dominant bilinguals indicates that some minimum amount of exposure to the common phoneme sequences of a language is required for phonotactic knowledge to develop and that exposure alone does not suffice for bilingual phonotactic development to keep pace with monolingual phonotactic development. A more general conclusion to draw from the results obtained for the Catalan-dominant bilingual infants is that growing up with two languages does not inevitably delay the development of language-specific phonotactic knowledge.

Word-form recognition and linking word to meaning

The discussion so far has concerned the development of the building blocks of words, the phonemes and common phoneme sequences they consist of. In addition, a statistical learning device was described that presumably plays an important role in this development and that also enables infants to detect the words' sound patterns in fluent speech. A next issue to address is how many months of naturalistic language exposure it takes before infants, exploiting this learning device, actually start recognizing the phonological forms of complete words in connected speech. To become familiar to the infant, a word's sound pattern must probably be encountered a minimum number of times, and reaching this minimally required number of encounters presumably takes longer than the time it takes a language's typical sublexical phoneme sequences to become familiar to the infant. The ground for this claim is that a particular sublexical pattern occurs across a number of different words and is therefore encountered more often than the sound pattern of a complete word. In general, the larger a particular linguistic unit, the less often it is encountered as such in speech. Furthermore, because children growing up with two languages will on average encounter each separate word less often than their monolingual peers, word recognition is plausibly delayed in bilingual children. A further question is at what age infants start to discover the referential nature of words and begin to establish connections between their phonological forms and meanings. If word-form recognition is delayed in bilingual children, then this component process of word knowledge, namely, the linking of word form to word meaning, will also develop later in bilingual infants.

A small number of bilingual studies have addressed the above questions by examining the development of word-form recognition and word-to-meaning linkage in bilingual infants and toddlers between the ages of 9 and 22 months and comparing their performance to age-matched monolingual controls. Vihman, Thierry, Lum, Keren-Portnoy, and Martin (2007) studied word-form recognition in separate groups of 9-, 10-, 11-, and 12-month-old monolingual infants from English-speaking Welsh families and in one group of English–Welsh bilingual 11-month-olds. (In fact, Welsh "monolingual" infants were also tested but their data will be ignored here because there was reason to believe they had been exposed to English as well, to a degree that complicated the interpretation of the data.) For each language, Welsh and English, two sets of words were created, one set (called "unfamiliar") containing words that were presumably all unknown to all of the subjects, the second (called "familiar") containing a number of words (about 35%) likely to be known by the infants. The known–unknown judgments were based on Welsh and English versions of the MacArthur Communicative Development Inventory (CDI; e.g., Fenson et al., 2000), lists of words that the participants' families checked off, indicating which ones they thought their child understood.

The study consisted of two parts, one in which behavioral data were gathered, the second involving the registration of event-related potentials (ERPs). In the behavioral part of the study two loudspeakers were mounted on a wall, on either side of the child, and on every single trial one of them played the words from one of the word-sets for a given language. Across trials, presentation side (right or left) and type of word-set played (familiar or unfamiliar) were randomized. The time the infant looked in the direction of the loudspeaker currently emitting a word-set was registered as the infants' listening time. The bilinguals were tested in both languages, the English monolinguals obviously only on the English materials. In the second part of the study ERPs to the same stimulus materials were collected. The questions of interest were whether the infants' listening time differed for the familiar and unfamiliar word sets and whether familiar and unfamiliar words would give rise to different ERP patterns. Affirmative answers to these questions would suggest that word-form recognition had emerged (in fact confirming the parents' subjective judgments that their child knew at least some of the words).

The 11-month-old English monolinguals, but not the younger ones, listened significantly longer to the familiar English word-set than to the unfamiliar set. The bilingual infants, all 11 months of age, also showed a reliable familiarity effect, in both languages, and the size of this effect was comparable to that observed for the monolinguals. These findings indicate that word-form recognition emerges around 11 months and that it is not noticeably delayed in bilinguals. However, the ERP data suggested a revision of this conclusion, exhibiting a familiarity effect – and, thus, word-form recognition – already at 10 months. This first evidence of word-form recognition at 11 months only in the behavioral data but already one month earlier in the brain data corroborates an observation by previous authors (e.g., Rivera-Gaxiola, Silva-Pereyra, & Kuhl, 2005) that ERPs provide a more sensitive marker of the (emergence of) cognitive skills than behavioral measures do (see McLaughlin, Osterhout, & Kim, 2004, for a similar demonstration in the domain of adult L2 word learning). Because no 10-month-old bilinguals were tested, it is impossible to tell whether they also would have shown the effect as early as at 10 months. Still, on the basis of the available data, it can be concluded that, if word-form recognition is delayed at all in bilingual infants, the delay is a modest one.

In an English–Spanish study Conboy and Mills (2006) also examined bilingual infants' brain responses to known and unknown words, but this study differed crucially from the one by Vihman et al. (2007) in one respect, namely, the age of the participating infants: they were between 19 and 22 months with an average of 20 months. This means that Conboy and Mills' subjects were all presumably long beyond the stage of mere word-form recognition – the developmental stage examined by Vihman and colleagues – and had begun to treat words as meaning-bearing entities with a referential function. This is, for instance, suggested by the fact that 19-month-old monolingual toddlers exhibit an N400-like semantic incongruity effect in the ERP when they listen to words that are either congruent or incongruent with the content of simultaneously presented pictures (Friedrich & Friederici, 2004). That infants this age process the meanings of words is also suggested by the fact that the average monolingual 18-month-old exhibits a sudden growth in productive vocabulary, the so-called "vocabulary spurt," after gingerly having started to produce his first words around 12 months. Nazzi and Bertoncini (2003) hypothesized that this vocabulary spurt reflects a qualitative shift from an "associative" to a "referential" mode of word acquisition and that these two acquisition modes are effectuated by two different lexical acquisition mechanisms. In the first word-acquisition stage an associative mechanism links phonetically underspecified sound patterns to specific objects. In the second stage a referential mechanism pairs phonetically specified sound patterns with categories of objects rather than with specific objects. Nazzi and Bertoncini regard the word-meaning connections resulting from the first stage as "proto-words" and those resulting from the second, the referential stage, as genuine words. The referential acquisition mode allows an increase in cognitive economy and, as a consequence, a reduction in cognitive load: if a particular sound pattern is connected to a whole category of objects, far fewer word–meaning pairings have to be learned than when words are paired with individual objects. The vocabulary spurt observed around 18 months may be the direct effect of this increase in cognitive economy. In addition, the reduced cognitive load would allow the infants to attend to the words' phonological forms more carefully than before, thus gradually replacing the phonetically underspecified word forms by more precisely specified ones. In terms of this model of vocabulary acquisition, and assuming that bilingual infants will not lag substantially behind their monolingual peers, the participants in Conboy and Mills have all presumably reached the associative, and possibly the referential, stage of vocabulary acquisition and the results of that study must be interpreted in that light.

Conboy and Mills (2006) divided their participants in subgroups depending upon their total conceptual vocabulary (TCV) scores, a measure of the total number of concepts, not words, mastered by the child, and examined each child's brain responses to stimuli in both his dominant and the weaker language (as determined by the parents' assessments of how many words their child knew in each language). Their reason for doing so was to determine the effect of differential language experience in the two languages – relatively more and less in the dominant and the weaker language, respectively – on the brain responses to known and unknown words. In their data analysis the investigators focused on three negative components in the ERP signal, between 200–400, 400–600, and 600–900 ms following word onset (and on an early positive component, the P100, to be ignored here). Clear effects of the known–unknown word manipulation were observed, which were qualified by language dominance and TCV and explained in terms of differential meaning processing of these two word types. The high TCV group exhibited an effect of word type in all three time windows and in both the dominant and the weaker language, with the known words eliciting more negative ERP amplitudes than the unknown words in all cases. In the low TCV group these effects occurred only for the dominant language, whereas in the weaker language the known–unknown word effect was only observed in the 600–900 ms time window. Comparing the ERP components' latency and distribution of these bilingual data with those observed in comparable studies testing monolingual infants (e.g., Mills, Coffey-Corina, & Neville, 1997), the authors concluded that in some respects the ERP patterns of both the high and the low TCV bilinguals (all around 20 months of age) resembled those of 13–17-month-old normally developing monolinguals and 20-month-old monolingual late talkers. This suggests that word acquisition is somewhat delayed in bilingual infants. In addition, the different response patterns for the dominant and the weaker language within the low TCV group indicate that the amount of language experience affects brain processes, corroborating similar evidence obtained in functional magnetic resonance imaging studies on adult bilinguals (see e.g., Abutalebi, Cappa, & Perani, 2005; Steinhauer, White, & Drury, 2009).

Three further studies examined the development of word-to-meaning linkage in monolingual (Werker, Cohen, Lloyd, Casasola, & Stager, 1998; Werker, Fennell, Corcoran, & Stager, 2002), and bilingual (Fennell, Byers-Heinlein, & Werker, 2007) toddlers using a behavioral research method. Across these three studies, different age groups were first familiarized with two word–object pairs (Word A – Object A; Word B – Object B), with the (toy) object of each pair shown on a video screen and the (nonsense) word played repeatedly from a speaker just below the screen. The age groups in Werker et al. (1998) concerned infants of 8, 10, 12, and 14 months, whereas the age groups in the remaining two studies concerned toddlers of 14, 17, and 20 months. In Werker et al. (1998) the two words were totally dissimilar (*lif* and *neem*), whereas in the remaining two studies they were similar (*bih* and *dih*). After familiarization – which lasted between about 5 and 10 minutes – the participants were tested on "same" and "switch" trials (e.g., Word A – Object A, vs. Word A – Object B). The researchers argued that if the infants had learned the associative links between the words and the paired objects, the incorrect pairings in the switch trials should surprise them, resulting in longer looking times for the switch trials. In contrast, equally long looking times for both types of trials would suggest they had not learned the word–object links.

The 14-month-olds in Werker et al. (1998; dissimilar words, monolinguals), but not the younger age groups, showed longer looking times for the switch trials than the same trials. Werker et al. (2002; similar words, monolinguals) observed equally long looking times for same and switch trials in the 14-month-olds and different ones in two groups of 17- and 20-month-olds. Finally, Fennell et al. (2007; similar words, bilinguals) found equally long looking times for same and switch trials in both a group of 14-month-olds and a group of 17-month-olds, whereas a group of 20-month-olds exhibited different looking times for the two types of trials. These results indicate that 14-month-old monolingual toddlers are able to simultaneously attend to the sound pattern of a word and an object associated with this sound, while at the same time establishing a link between the two. Within a short time span of about 5 to 10 minutes they can do so for (at least) two word–object pairings, on condition that the two words have dissimilar phonological forms. According to the authors, this finding challenges the standard view that "prior to the vocabulary spurt, it is a very slow and laborious process for infants to learn to associate new words with objects" (Werker et al., 1998, p. 1301). The authors furthermore argued that earlier evidence suggesting that this skill might already be in place before 14 months (Woodward, Markman, & Fitzsimmons, 1994) probably had to do with the fact that learning and testing took place in a contextually rich, interactive setting instead of under tightly controlled circumstances without any assistance of adults or other contextual support. The equally long looking times of the monolingual 14-month-olds in same and switch trials in Werker et al. (2002) suggest that the mental resources – attentional, perceptual, and memorial – of 14-month-olds do not yet suffice for the component processes to be executed successfully in parallel, if the two words to pair with their respective objects are very similar and thus require very detailed perceptual analysis. Three months later, at 17 months, the monolinguals but not the bilinguals manage to perform the task successfully with a pair of similar words. Finally, at 20 months, bilinguals catch up with their monolingual peers. In conclusion, it appears that attending to the phonetic details of words while at the same time linking these words to objects develops somewhat more slowly in children growing up bilingual. As however noted by Fennell et al. (2007), this may not noticeably delay word learning in children growing up bilingual, because the initial lexicon of infants still contains very few similar-sounding words.

In the above comparison of monolingual and bilingual first-language vocabulary acquisition a number of differences have been identified. The perception of a number of phonetic contrasts (Bosch & Sebastián-Gallés, 2003a, 2003b) and referential word use (Conboy & Mills, 2006; Fennell et al., 2007) was shown to be delayed in bilingual infants and toddlers by a couple of months. But equally noteworthy is the fact that in some cases bilinguals kept pace with their monolingual peers. Sebastián-Gallés and Bosch (2002) found this to be the case for phonotactic development in bilinguals' dominant language and Vihman et al.'s (2007) data indicate it might also hold for word-form recognition. Three of the above studies that *did* point at a delayed development in bilinguals used stimuli that required a very careful perceptual analysis of the presented stimuli (Bosch & Sebastián-Gallés, 2003a, 2003b), presenting pairs of notoriously confusable phonemes or two very similar words (Fennell et al., 2007). These types of stimuli are known to cause lasting discriminative problems in late nonnative speakers of a language (e.g., Broersma, 2006; Weber & Cutler, 2004) and have led to the counterintuitive conclusion that, despite the fact that the nonnative lexicon typically contains fewer lexical elements overall than the native lexicon, more lexical elements compete for selection during nonnative language speech perception than during native language speech perception. That bilingual infants caught up with their monolingual peers after just a few more months of exposure to their two languages testifies to the excellent auditory perceptual skills of infants. The same can be said of the finding that a high frequency of exposure to confusable phonetic items can prevent a delayed development in bilingual infants (Sundara et al., 2008).

All in all, the above experimental studies point at the conclusion that in some ways the development of sublexical and lexical knowledge is slightly delayed in bilingual children as compared with their monolingual age-mates, but that in other respects bilingual children keep pace with their monolingual age-mates. The second part of this conclusion is corroborated by studies that examined lexical development in (Spanish–English) bilingual infants and toddlers (between 8 and 30 months of age) as assessed by means of the MacArthur Communicative Development Inventory rather than experimentally (Pearson & Fernández, 1994; Pearson, Fernández, & Oller, 1993). Perhaps the most noteworthy finding in these (and many other) studies is the wide range of vocabulary sizes exhibited by normally developing children. But of special interest here is the finding that the bilingual children's productive vocabulary in *the two languages together* equaled that of their monolingual age-mates and, moreover, that their receptive vocabulary in *each of their languages* was comparable to that of their monolingual peers. In addition, the Pearson and Fernández study indicated that the vocabulary spurt occurs around the same age in bilingual children as in age-matched monolingual children. Similar findings were obtained in a study that compared vocabulary knowledge in 24- to 27-month-old German–English toddlers and German and English monolingual age-mates (Junker & Stockman, 2002). In conclusion then, all of the above evidence suggests that the relative complexity of the linguistic input to which children growing up to become bilingual are exposed does not appreciably delay their vocabulary development.

Vocabulary Acquisition in Late Second Language Learners

Vocabulary acquisition in late L2 learning differs considerably from vocabulary learning in monolingual and bilingual L1 acquisition, and in a couple of respects late L2 learners clearly have an advantage over L1 learners despite the fact that, perhaps as a consequence of neural commitment of brain tissue to the native language (e.g., Ellis & Lambon Ralph, 2000; Rivera-Gaxiola et al., 2005), they have a lesser aptitude for language learning than young children. Late L2 learners have already figured out how language "works," being aware of the fact that continuous speech is built up from smaller linguistic units with a referential function. In addition, late L2 learners dispose of a larger variety of learning strategies, more cognitive resources, and, perhaps most importantly, a large stock of lexical concepts, namely, the meaning representations of the words they already master in their L1. To the extent that L1 and L2 have lexicalized the same or very similar concepts – in other words, to the extent that L1 words are approximately translatable into single words in the L2 – these L1 meaning representations can serve the L2 as well: an L2 word can be assigned the meaning of its closest word translation in L1. So whereas L1 word learning requires the learning of both form and meaning (in addition to forming a connection between them), at the onset of L2 vocabulary acquisition the targeted L2 meanings are already largely in place. As a consequence, it initially suffices to learn the new forms and to link them onto the meaning representations of the corresponding L1 words. In other words, it initially suffices to merely re-label extant lexical concepts. Because the two terms in a word–translation pair seldom share all aspects of meaning, this parasitic use of the L1 word meanings in L2 word learning inevitably leads to a semantic "accent" in the L2, an overextended and underextended use of words that, for different reasons, also characterizes young L1 users. Through extensive subsequent naturalistic exposure to written and spoken L2, the L1-specific aspects of the inherited L2 meanings can subsequently be chipped off from them and the L2-specific components added onto them. Arguably, this advantage late L2 learners have over L1 learners outweighs a clear disadvantage, namely, the fact that to properly perceive and produce the phonological forms of the L2 words, they will have to relearn lost nonnative contrasts, an undertaking that is often not completely successful (as is, for instance, suggested by a wealth of studies showing age-of-acquisition effects on L2 pronunciation; see also the studies by Broersma, 2006, and Weber and Cutler, 2004, mentioned above).

Methods of second language vocabulary learning

The L1 word meanings already present in memory can most readily be exploited if the forms of the L1 words are present in the L2 learning environment, because through these the extant L1 meanings immediately become available. In naturalistic communication settings this condition will generally not be fulfilled, because the learner does not usually carry a bilingual dictionary around with him, nor is he accompanied by a teacher (perhaps in the form of a bilingual friend) who helps him make the connection with the stored L1 knowledge by providing him with an unknown L2 word's translation in L1 (cf. Sternberg, 1987). In contrast, in the L2 classroom it is a common practice to use methods that directly provide the relevant L1 words.

Two well-known methods of this type are the keyword method and paired-associate learning that both involve an L1 word as a component part of each learning event. Both are so called "direct" methods of L2 vocabulary learning, that is, methods in which the learner's attention is explicitly focused on the individual words to acquire (rather than on the meaning of a text or discourse as a whole, as in so-called "context" methods; see below). L2 word learning by means of the keyword method involves three stages. In the first stage the learner is told an L1 word's name in the L2, for instance, that the French word for *fish* is *poisson* or that the Italian word for *night* is *notte*. In the next step, the learner is provided with (or encouraged to come up with) an L1 word with a similar, or the same, sound as the L2 word (e.g., English *poison* and *naughty*, respectively). This same or similar sounding L1 word is the eponymous keyword. In the final stage, he is asked to create, or is provided with, a mental image in which the meanings of keyword and L1/L2 word interact (e.g., he is asked: "Imagine poisoning your pet fish" or "Imagine having a naughty night out"; the examples are from Beaton, Gruneberg, Hyde, Shufflebottom, & Sykes, 2005). When at some later point the learner encounters the new L2 word (*poisson* or *notte*), it will evoke the keyword (*poison* or *naughty*), which, in turn, will arouse the interactive image of the keyword and L1/L2 word from which the L2 word's meaning can subsequently be read off. At that point the native word associated with this meaning (*fish*, *night*) can also be retrieved. It may be obvious from this description that both learning by means of the keyword method and subsequent retrieval of the learned words are complex processes. Still, the method has been shown to be highly effective, although its efficacy relative to other methods depends on a number of variables, such as the interval between learning and testing, the mode of testing (receptive or productive), and learner characteristics such as the age of the learners and whether or not the learners have substantial prior experience with foreign language learning (see de Groot, in press, and de Groot & van Hell, 2005, for details).

Of the second of the above-mentioned direct methods of L2 vocabulary acquisition, the paired-associate method, two versions are often used: picture–word association and word–word association. In the picture–word version, pairs of stimuli are presented during learning, each pair consisting of the L2 word to acquire and a picture depicting its meaning. In the word–word version the paired terms presented during learning are two words: the L2 word and its translation in L1. The use of the picture–word association method is limited by the fact that it is relatively difficult to draw pictures that unambiguously depict abstract words. As a consequence, studies that have employed the picture–word method have typically confined themselves to examining the acquisition of concrete L2 words. The use of the keyword method described above is limited for a different reason: it is unsuitable for learning cognates, that is, words that share orthography and/or phonology, with their L1 translation (e.g., English *chair* and French *chaise*). The reason is that the L1 cognate form itself (*chair*) will generally be more similar in form to the corresponding L2 word (*chaise*) than any other L1 word that could serve as keyword (*champion*). Therefore, the most straightforward way to learn cognates is to create a direct link between the L1 and L2 cognate forms using the word–word association technique. The use of the word–word association method is not limited to specific subsets of words and can be applied to cognates as well as noncognates and to abstract as well as concrete words.

As mentioned, simply adopting the L1 words' meaning to also serve the L2 leads to overextended and underextended usage of the L2 words, which through extensive subsequent naturalistic exposure to, and use of, the L2 should gradually be refined to come to resemble native-like referential use of the L2 words. In addition to refining the referential meaning of L2 words, subsequent L2 exposure and use should also lead to a native-like "intensional" meaning of each L2 word (that is, a "word web" within the L2 lexicon which connects the L2 word with related L2 words, such as its antonyms, synonyms, and hyponyms; see Henriksen, 1999). Furthermore, subsequent L2 exposure and use should gradually lead towards fluency in using the L2 words. This aspect of L2 word learning is as important as acquiring native-like meaning (and form) representations because, even with the targeted lexical structures fully in place, L2 communication will break down if access to and retrieval of these structures consume more mental resources than the processing system has to spare. Finally, subsequent L2 exposure and use is needed to acquire all the L2 words that were not first learned directly in the curriculum. In fact, many have claimed that by far the majority of L2 words are learned from "context" (that is, from naturalistic L2 exposure and use), even though learning from context is a far less effective method to learn *specific* L2 vocabulary than learning through direct instruction. The ground for the claim that nevertheless most vocabulary is learned from context is that formal instruction time in the classroom is far too limited to teach more than a basic vocabulary directly.

That learning from context is a relatively ineffective way to acquire specific L2 vocabulary has been repeatedly demonstrated in studies that compared the recall of specific L2 words after a text containing these words had just been read for general comprehension, with recall of these same L2 words after the participants had been engaged in vocabulary-centered activities or had just simply been given the L2 target words' translation in L1 (e.g., Hulstijn, Hollander, & Greidanus, 1996; Laufer, 2003). Merely reading the text led to extremely poor recall scores, while adding the target words' L1 translations in the text's margin significantly improved recall (Hulstijn et al., 1996). Even an explicit instruction to the participants to infer the target words' meaning from context leads to very poor recall, except when the inferred meanings are subsequently verified and memorized (Mondria, 2003). The reason the "context method" is as ineffective as it is presumably is that it does not exploit the fact that the learner already has (approximations of the) meanings of the L2 words to learn in memory (namely, the meanings of their translations in L1). In addition to learning the new L2 words' forms, the learner must therefore also figure out their meanings from context, while all the while these meanings are just sitting there in memory. In Sternberg's (1987) words: "If one has definitions available, then learning from context is not so efficient. Why waste a good definition?" (Sternberg, 1987, p. 95).

Word-type effects in L1–L2 word-association learning

As mentioned, the word–word association method (and also the keyword method) *does* provide definitions of the L2 words to acquire in the form of their L1 translations and is therefore an effective method to acquire specific L2 vocabulary. It enables the learner to focus on form learning. Interestingly, the ease with which L2 words (in the narrow sense of new labels for old lexical concepts) are learned by means of this method depends on a number of characteristics of both the new labels to learn (the L2 words' forms) and the L1 words and concepts that are already in place. One common finding is that L2 words are easier to learn if the corresponding L1 words have concrete referents than when they have abstract referents (e.g., de Groot, 2006; van Hell & Candia Mahn, 1997). A second is that L2 words are easier to learn when they have a phonotactic structure typical of L1 words than when they have a phonotactic structure atypical of the learner's L1 (e.g., Ellis & Beaton, 1993; de Groot, 2006). A third is that L2 words with a cognate translation in the L1 are easier to learn than those with a noncognate L1 translation. A final finding is that it is easier to learn L2 words if the corresponding L1 words occur frequently in L1 use than when the latter are infrequent, but this effect is less robust than the other three (de Groot, 2006; de Groot & Keijzer, 2000; Lotto & de Groot, 1998).

Of these four word-type effects, those of cognate status and phonotactical typicality are intuitively the most obvious, because both concern aspects of the new forms to learn: the orthographic and/or phonological form similarity between the L2 words and the corresponding L1 translations (cognate status) and whether or not the new forms have a sound structure that is familiar to the learner. That also L1 word concreteness and word frequency exert an effect on L2 labeling is more surprising, because typically the L2 word forms paired with concrete and frequent L1 words during learning do not systematically differ from those paired with abstract and infrequent L1 words, respectively. This suggests that the representations of the L1 words with which the new L2 forms are paired during learning must somehow cause the effects of L1 concreteness and frequency.

The effect of phonotactical typicality probably partly results from the fact that the learning of L2 words requires the rehearsal of their phonological forms in working memory (e.g., Gathercole & Thorn, 1998). This rehearsal process is hindered if the phonological forms of the new vocabulary are atypical. A further reason is that phonological structures in long-term memory similar to the phonological forms of the L2 words to learn are known to be recruited during learning and to facilitate the learning process (e.g., Service & Craik, 1993). For phonotactically typical L2 words, but not for phonotactically atypical ones, such supporting structures exist in long-term memory. For the same reason cognate translations of L1 words may be easier to learn than noncognate translations. After all, by definition, a cognate L2 word closely resembles at least one other structure in long-term memory, namely, the form of its L1 translation. A further source of the cognate effect is likely facilitated retrieval due to the fact that upon the presentation of a written or spoken word, the memory representations of words with a similar form, be they similar words in the same language or actual cognates or "pseudocognates" in another language (e.g., Hall, 2002), are automatically activated. (A pair of pseudocognates – also called "false cognates" or "accidental cognates" – consists of two words belonging to different languages that share form but not meaning across these languages. Notice that the keyword method discussed above exploits this same process of automatic triggering of similar memory representations: what was called a "keyword" there is a "pseudocognate" in the present terminology.) In other words, if, following training, one element of a cognate translation pair is presented as the recall cue, this stimulus automatically reminds of the other element in the pair.

Regarding the concreteness effect on L2 vocabulary acquisition, de Groot and Keijzer (2000) hypothesized that it might result from different amounts of information stored for concrete and abstract L1 words in memory, on the assumption that the more information stored for the L1 words the easier it is to link their new names, the L2 words, onto them. Two versions of this view were considered, one in terms of Paivio's (1986) "dual coding" theory, which holds that concrete words but not abstract words are represented in memory by means of both an image representation and a verbal representation whereas for abstract words only a verbal representation exists. The second view does not distinguish between verbal and image representations in memory but assumes that all stored knowledge is built from "amodal" information units. In addition, it assumes that the (meaning) representations of concrete words consist of a larger number of these information units than those of abstract words, possibly because only the former have referents that can be experienced by one or more senses: they can be observed and felt, sometimes heard and tasted. These perceptual experiences will lead to the storage of meaning elements that the representations of abstract words lack (see, e.g., de Groot & Keijzer, 2000; de Groot & van Hell, 2005, for more details and supporting evidence). In various publications (e.g., Lotto & de Groot, 1998) it was suggested that the (smaller and less robust) effect of L1 word frequency can also be explained in terms of differential information density of memory representations, those representing frequently used words containing more information units than those representing less frequently used words.

Conclusion

In a way, this review started where a previous review of vocabulary-acquisition studies (de Groot & van Hell, 2005) ended. That earlier review exclusively concerned late L2 vocabulary learning and ended with the statement that the learning processes involved in late L2 vocabulary acquisition and early bilingual vocabulary acquisition "differ crucially because, in early bilingual vocabulary acquisition . . . the acquisition of word form and word meaning proceed in parallel, whereas in late FL [foreign language] vocabulary acquisition, a meaning for the new word to be learned is already in place" (de Groot & van Hell, 2005, p. 25). It then continued stating that future reviews of studies on foreign language (FL = L2 in the present terminology) vocabulary learning might shift the focus to this neglected issue. This is exactly what was done above. This exercise has hopefully convinced the reader that vocabulary acquisition in monolingual and bilingual L1 acquisition and late L2 vocabulary learning involve very different processes that exploit different skills and knowledge structures. The difference stressed in this review was the presence of approximate

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meanings of the vocabulary to acquire in late L2 learners' memory but not in L1 learners' memory. In our earlier review we mentioned a second neglected issue, namely, the role of typological distance between L1 and L2 in late L2 vocabulary learning, noting that "the larger the distance between L1 and the FL to be learned . . . the more alien the meanings of the FL words will be to the learner" (p. 25). This implies that in cases of distant L1–L2 language pairs, L2 vocabulary acquisition methods that exploit the L1 meaning representations in the learning process are less effective and it might make sense to shift the balance in the initial stages of learning towards a stronger role for contextual learning. With such a shift to contextual learning, late L2 vocabulary learning would more closely resemble L1 vocabulary learning than when it can maximally exploit extant L1 lexical concepts.

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