J. Child Lang. **38** (2011), 69–74. © Cambridge University Press 2010
doi:10.1017/S0305000910000449

Interactions between lexical and phonological development: cross-linguistic and contextual considerations – a commentary on Stoel-Gammon's 'Relationships between lexical and phonological development in young children'*

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Stoel-Gammon (this issue) provides a welcome addition to the phonological acquisition literature, bringing together insights from long-standing and more recent research to address the relationship between the developing phonological system and the developing lexicon. A growing literature on children's early use of words across languages and phonological contexts provides additional insight into the nature of the interactions between phonological and lexical development, suggesting that learners' knowledge and connection of the two may develop much earlier than often thought. This commentary highlights some of these exciting results from recent cross-linguistic research on development between the ages of 1 and 3.

As Stoel-Gammon notes, both phonotactic probability and neighborhood density play a role in understanding the nature of the developing lexicon. This is part of a more general phenomenon that relates the characteristics of the developing lexicon to several levels of phonological structure. This is easier to see from a cross-linguistic perspective, where learners' patterns of both syllable structure and lexical development appear to be closely tied to the frequency of the syllable structure and prosodic word shapes in the ambient language. For example, Levelt, Schiller & Levelt (2000) showed that Dutch-speaking children's development of syllable structure correlated with the frequency of syllable structures in child-directed speech. Thus, one might expect learners of languages with complex syllable structures to acquire CVC and CCVCC word structures earlier than children learning a language where such structures are less frequent. It is therefore interesting that there have been anecdotal reports of CVC structures as early as the late

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https://doi.org/10.1017/S0305000910000449 Published online by Cambridge University Press

states of babbling in English and German. In contrast, Lleó & Prinz (1996) note the late acquisition (around age 2;3) of CVC syllable structures in Spanish. These patterns of development appear to reflect characteristics of the ambient language, where English child-directed speech has coda consonants in 60% of syllables, whereas Spanish child-directed speech has codas in only 25% (Roark & Demuth, 2000). Thus, although there may be some children who avoid attempting words with low-frequency segmental and prosodic structures, there is also ample evidence that children also attempt words they cannot accurately produce, resulting in the frequently heard modified/truncated forms.

Other research demonstrates that word length and prosodic factors interact with frequency effects to determine how and when syllable structure and lexical form are acquired. For example, Demuth & Tremblay (2008) and Demuth, Culbertson & Alter (2006) found that French- and English-speaking children use coda consonants in monosyllabic words several months before they use codas in disyllabic words. In a study with nonce words, Kirk & Demuth (2006) further showed that English-speaking two-year-olds were more likely to produce coda consonants when these occurred in either stressed or final syllables. They suggested that this is due to the fact that these contexts are longer in duration, providing the child with more time to produce more complex syllable structures. Similarly, in a study of Catalan-speaking children, Prieto (2006) noted that metrical factors play an important role in determining the contexts in which children are most likely to produce complex syllable/word structures. It is therefore not surprising that Spanish-speaking children appear delayed in coda production word-finally, since most words in Spanish are di- or trisyllabic, and stress typically falls on the penultimate syllable. Interestingly, however, Spanish final coda consonants are earlier acquired in Spanish-German bilinguals than in Spanish monolinguals (Lleó, 2006). This suggests that the high frequency of more complex syllable structures in bilinguals' German enhances their earlier acquisition of more complex syllable structure in Spanish. This is a particularly interesting case where the phonological characteristics of one part of the lexicon have an accelerating effect on the other. It would therefore be interesting to know if the longer words found in Spanish also enhance earlier acquisition of multisyllabic words in bilinguals' German.

As discussed above, the phonotactic characteristics of the ambient lexicon influence the rate at which complex syllable structures are acquired. Similarly, the prosodic characteristics of the ambient lexicon (stress pattern, average number of syllables per word) influence the shape of children's early (prosodic) words. Unlike Spanish, where most words in child-directed speech contain two or three syllables, 80% of the lexical items used in conversation with English-speaking children are composed of only one

https://doi.org/10.1017/S0305000910000449 Published online by Cambridge University Press

syllable (Roark & Demuth, 2000), and disyllables typically have stress on the first syllable (e.g. *apple*). As one might expect, these language-specific differences in the distributions of word shapes in the ambient lexicon has a large impact on the shape of children's early words, with English target words of three syllables often being truncated to two, forming a disyllabic trochaic (stressed–unstressed) foot (*banana* > ['nænə]) (Pater, 1997). A similar pattern is found in early Dutch, where Fikkert (1994) further reports cases of a child shifting stress in a word such as *giraffe* from the final stressed syllable to the initial unstressed syllable to ensure production of a disyllabic trochaic foot. Both are cases where the prosodic structure of the ambient lexicon plays a large role in determining the shape of children's early word productions. Such truncations persist until around age 2;6, when phonological representations expand to include the presence of a word-initial unfooted syllable (see Demuth (2009) for further discussion).

French, on the other hand, has (phrase) final (iambic) stress. Furthermore, half of the vocabulary in child-directed speech is monosyllabic and half disyllabic (Demuth & Johnson, 2003). One might therefore expect that children learning French would truncate three-syllable words, but would produce two-syllable words intact. However, some French-speaking children truncated disyllabic target words to CV, omitting an entire syllable if it contains a segment they cannot produce (e.g. *culotte* [kylɔt] > [tɔ] 'pants') (Demuth & Johnson, 2003). This suggests that the high frequency of monosyllabic CV words in the French lexicon (e.g. *eau* [o] 'water') provides the learner with a well-formed possible word structure that is available in cases where the target cannot be met. Thus, again, at least some learners attempt word forms they cannot correctly produce, even to the extent of omitting entire syllables.

Interestingly, these effects are not limited to monomorphemic words, but carry over to multimorphemic forms as well. Researchers have long realized that children's production of grammatical morphemes is inconsistent. Gerken (1996) was one of the first to note that children's variable production of grammatical morphemes is prosodically conditioned. Thus, two-year-olds are more likely to produce an article if it can be prosodified as part of a disyllabic trochaic (strong–weak) foot with a preceding monosyllabic word (*He* [*saw the*] *piggy*) than if it follows a disyllabic word that is already a disyllabic foot (*He* [*catches*] *the piggy*). Demuth & McCullough (2009) confirmed that Gerken's experimental findings generalized also to spontaneous speech, and similar findings were found for French (Demuth & Tremblay, 2008) and Sesotho (Demuth & Ellis, 2009), despite the fact that the three languages have different prosodic/rhythmic structures. This suggests that the restriction is on children's representation of prosodic structure. Once this becomes more developed around the age of

https://doi.org/10.1017/S0305000910000449 Published online by Cambridge University Press

2;3–2;6, children are more likely to produce grammatical morphemes that fall outside of the disyllabic foot. Note that this is similar to the course of development for monomorphemic words (e.g. *banana*), suggesting that this is a robust phonological phenomenon. Further support for this position comes from Spanish (Demuth, Patrolia, Song, & Masapollo, in press), where the constraint on producing only disyllabic feet is moderated due to the high frequency of three-syllable words in the ambient language. This again suggests that the prosodic structures in the ambient language play a major role in determining the shape of children's early words, be they morphologically simple or complex.

Children's variable production of both grammatical morphemes and coda consonants is also influenced by the position in which the lexical item occurs in the utterance. For example, Song, Sundara & Demuth (2009) found that two-year-olds were more likely to produce third person singular *-s* in utterance-final compared to utterance-medial position, in both spontaneous speech and in elicited imitations. As in the case of the variable production of coda consonants, they suggest that this is due to the longer duration of final compared to medial syllables (cf. Hsieh, Leonard & Swanson, 1999). Further research has shown that this effect also holds for two-year-olds' production of both plural *-s* (Theodore, Demuth & Shattuck-Hufnagel, in press) and monomorphic stop codas (Theodore, Demuth & Shattuck-Hufnagel, in submission). It thus appears that children's early lexical and morphological production abilities are partly influenced by the phonological contexts in which they appear.

Much of what we know about children's early word shapes comes from phonetic transcription. However, children's early word productions can also contain acoustic cues to feature contrasts that adults cannot detect. For example, Macken & Barton (1980) showed that English-speaking two-year-olds make voicing contrasts for onset consonants that are not perceived by adults because the children's VOT (voice-onset-time) boundary does not have adult-like values. Furthermore, Song & Demuth (2008) found that one- to two-year-olds exhibit compensatory lengthening for the coda consonants they do not produce, and Theodore *et al.* (in submission) found that two-year-olds employ acoustic cues to consonant closure for stop codas that adults perceive as omitted.

In sum, findings from all the above studies suggest that children's early phonological and lexical representations may be more fully intact than is often assumed. Thus, although the production of adult-like word forms is a gradual process that may take several years, children nonetheless exhibit an awareness of segmental, syllable and word structure that goes beyond what they accurately produce. Ultimately, these processes will be better understood in the context of a developmental theory of language planning

https://doi.org/10.1017/S0305000910000449 Published online by Cambridge University Press

and production, where phonological knowledge and implementation are considered as part of lexical and grammatical competence.

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