Phonological Memory Skill in Monolingual and Bilingual 23-Month-Olds

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The task of word learning must include forming a lexical entry. That is, on encountering a new word, the child must store in memory the new sound sequence. A substantial body of research has demonstrated that individual differences in the ability to store novel sound sequences (i.e., phonological memory) are related to vocabulary development. For example, in children between 3 and 5 years, phonological memory has been found to predict children's word learning in a laboratory setting (Gathercole, Hitch, Service, & Martin, 1997) and, in longitudinal studies, to predict actual vocabulary growth (Gathercole & Baddeley, 1989; Gathercole Willis, Emslie, & Baddeley, 1992). Evidence suggests that phonological memory plays a role in early word learning as well; among 20-month-old children, phonological memory is related to concurrent vocabulary size (Hoff, 2001).

It is well established that memory depends on having a system of representation that captures the to-be-remembered stimuli. For example, word sequences that conform to grammatical rules are easier for adults to repeat than anomalous sequences (Miller & Isard, 1963), and possible middle-game configurations of chess pieces are easier to remember than random arrangements of chess pieces—but only for people who know the rules of chess (Chi, 1978). Similarly, a substantial body of evidence argues that phonological memory depends on phonological representations. At age 5 years, children who are better at identifying phonemes and producing rhymes show better phonological memory skills (Bowey, 2001). Adults show better memory for sound sequences that conform to the language they know than for sound sequences in a foreign language (Service & Craik, 1993; Service & Kohonen, 1995; Soares & Hoff, 2000).

Children acquiring two languages may have less well-established systems of phonological representation for each language than monolingual children of the same age. The evidence on this point is scanty, as there has been little work on phonological development in bilingual children, but the findings are suggestive. There is evidence from infants that the time course of establishing phonetic representations and perhaps even the nature of those representations is different in the bilingual compared to the monolingual child (Burns, Werker, & Scott, 2001). Other evidence from 2-year-olds suggests that bilingual children may process both their languages through a single phonological system—the system of whichever language the child hears more (Navarro, 1998; Navarro, Pearson, Cobo-Lewis, & Oller, 1998).

Together the evidence that (a) phonological memory is related to vocabulary learning, (b) phonological memory is related to knowledge of the phonological system to which new sound sequences conform, and (c) bilingualism affects phonological development suggest that bilingual children may have less well-developed phonological memory skills than monolingual children of the same age. This possibility is of particular interest because, if true, it would modify the current view of what shapes lexical development in bilingual children. There is good evidence that bilingual children and young adults have smaller vocabularies in each of their languages than do monolingual children of the same age (Pearson, 1993; Pearson, Fernandez, Lewedeg, & Oller, 1997; Hoff & Elledge; 2003). The current view is that this difference reflects differences in the amount of input in each language that children receive (Pearson et al., 1997). The evidence with respect to phonological memory and word learning suggests an additional reason: bilingual children may have more difficulty learning new words because they have more difficulty remembering new sound sequences. To pursue this possibility, the present study was designed to test the hypothesis that phonological memory for English-like stimuli is less accurate in children acquiring English in bilingual environments than in English-learning monolingual children.

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1. Method

1.1 Participants

As part of an ongoing study of early lexical development in monolingual and bilingual children, data were available on the phonological memory skills, articulation skills, and vocabulary knowledge of 9 children acquiring English in monolingual environments and 9 children acquiring English in bilingual environments. The study was conducted in South Florida; Spanish was the language other than English for 5 out of the 9 bilingual children. The monolingual group included 6 boys and 3 girls, mean age = 23.1 months SD = 1.21; the bilingual group included 6 boys and 3 girls, mean age = 22.85 SD = .52.

1.2 Measures

The measure of phonological memory was a nonword repetition test. The measure of articulation skill was a test of the children's ability to repeat real words. Vocabulary knowledge was assessed using the MacArthur Communicative Development Inventory (CDI).

1.2 Procedure

The children were videotaped in interaction with an examiner in a university laboratory playroom. The mothers were present but did not participate. In the context of toy play, the examiner asked the child to repeat labels for 9 animals that are typically known by children this age (" Look, here's a *turtle*, can you say *turtle*?") and to repeat 9 nonwords that were presented as names for toy characters (" His name is *clird*, can you say *clird*?"). The lists of words and nonwords each included three 1-syllable, three 2-syllable, and three 3-syllable items; all nonwords conformed to the phonology of English. They are presented in Table 1.

Table 1. Real words and nonwords presented for repetition

Real word stimuli	Nonword stimuli
Duck	Clird
Cow	Tull
Frog	Grall
Tiger	Ballop
Camel	Prindle
Turtle	Rubid
Elephant	Dopalate
Butterfly	Bannifer
Alligator	Brasterer

1.3 Scoring

The children's imitations of words and nonwords were scored in terms of the percent of syllables that were accurately repeated (all phonemes correctly reproduced). All scoring was done by one graduate student who had previously achieved better than 90 percent interrater reliability with a second scorer. (In other analyses of similarly-collected data, this measure correlated at $r > .9$ with scoring in terms of the percent of phonemes accurately reproduced.)

2. Results

Comparisons of the scores on each measure for the children in monolingual and bilingual environments are presented in Table 2. The direction of difference for all measures was toward the children in monolingual environments outperforming the children in bilingual environments. However, the sample size was small and the variances large. Only the difference in real word repetition was statistically significant. Across all children, vocabulary size was significantly related to accuracy of real word repetition ($r(16) = .54$, $p = .01$) and marginally related to accuracy of nonword repetition ($r(16) = .36$, $p < .08$).

Table 2. Means, standard deviations, and *t*-test comparisons of children acquiring English in monolingual and bilingual environments

Measure	Monolingual group	Bilingual group	*t*-test
Real word repetition accuracy [1]	88.00 (6.87)	60.11 (45.31)	$t(8.37) = 1.83$, $p = .05$
Nonword repetition accuracy [1]	74.00 (29.56)	58.67 (45.01)	ns
CDI vocabulary percentile	56.11 (31.99)	36.56 (36.53)	ns

[1] Scored as percent of syllables correctly repeated

3. Discussion

These data are preliminary. The CDI data from these samples are consistent, however, with previous findings in the literature suggesting that young children who live in an environment that requires them to learn two languages initially build their vocabularies at a slower pace than children acquiring only one language. These, and other data in the literature, suggest in addition that where there are vocabulary differences there will also be differences in phonological skills. In the case of real word repetition accuracy, lexical knowledge may aid memory for the sound sequences to be produced (Dollaghan, Biber, & Campbell 1993). In the case of nonword repetition accuracy, the connection is less direct but consistent with the view that vocabulary knowledge and phonological knowledge are related (e.g., Walley, 1993).

These findings suggest that differences between monolingual and bilingual children in the size of their vocabularies in one language may not be entirely direct effects of the amount of exposure to that language. Rather, there may also be indirect effects, mediated by the effects of bilingualism on phonological development. The bilingual child not only has less exposure to each language from which to learn words but, at least initially, may be less able to form representations of newly-encountered sound sequences.

Given the preliminary nature of these data, the conclusion from this study is a hypothesis: that bilingualism affects language-specific phonological knowledge and that the effects of bilingualism on vocabulary development are, in part, mediated by those effects on phonological development. Future research testing this hypothesis should include longitudinal studies of the predictive relations between phonological skills, phonological memory, and vocabulary growth. Future research should also examine effects of bilingualism on both languages the child is acquiring. The prediction would be that the effects of bilingualism on the phonological skills required for word learning should be greater, the greater the differences between the phonologies of the two languages the child is acquiring. Finally, future research should chart the development of phonological skills, phonological memory, and vocabulary across the word learning period to investigate whether phonological development in

bilingual children differs only in its initial stages or whether phonological representations remain altered by the knowledge of another language.

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