Development of precursors to speech in infants exposed to two languages*

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ABSTRACT

The study of bilingualism has often focused on two contradictory possibilities: that the learning of two languages may produce deficits of performance in each language by comparison with performance of monolingual individuals, or on the contrary, that the learning of two languages may produce linguistic or cognitive advantages with regard to the monolingual learning experience. The work reported here addressed the possibility that the very early bilingual experience of infancy may affect the unfolding of vocal precursors to speech. The results of longitudinal research with 73 infants aged 0;4 to 1;6 in monolingual and bilingual environments provided no support for either a bilingual deficit hypothesis nor for its opposite, a bilingual advantage hypothesis. Infants reared in bilingual and monolingual environments manifested similar ages of onset for canonical babbling (production of well-formed syllables), an event known to be fundamentally related to speech development. Further, quantitative measures of vocal performance (proportion of usage of well-formed syllables and vowel-like sounds) showed additional similarities between monolingual and bilingual infants. The similarities applied to infants of middle and low socio-economic status and to infants that were born at term or prematurely. The results suggest that vocal development in the first year of life is robust with respect to conditions of rearing. The biological foundations of speech appear to be such as to resist modifications in the natural schedule of vocal development.

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A key question in the evaluation of the speech capacity concerns the ways in which it may be possible to influence the development of precursors to speech in the first year or two of life. For theoretical reasons there is a fundamental need to verify aspects of the speech capacity that are or are not inborn and are thus relatively sensitive or insensitive to environmental effects, and for practical reasons, we seek knowledge of ways in which the environment influences development, knowledge that may assist us in the formulation of therapeutic interventions. Furthermore, the detailed study of early development of speech capabilities has the potential to reveal milestones of development that, when delayed, indicate a probable condition of disability that may warrant early treatment.

Study of infants exposed to two languages early in life is of particular interest in this context. The concern that learning two languages may require greater effort than learning one (Macnamara, 1967; Torrance, Wu, Gowan & Aliotti, 1970) raises the possibility that milestones of speech development may be delayed in the bilingual child. We shall refer to this concern as the 'bilingualism deficit hypothesis'. Parents and educators struggle with the decision to raise children monolingually or bilingually, in part because the hypothesis that it requires greater effort to learn language in bilingual environments is taken seriously, even though it is unverified. In fact, the literature on speech development is substantially silent on the question of whether or not early exposure to two languages might have a delaying effect on the appearance of precursors to speech. For all that is known empirically, the effect of bilingual exposure could be precisely the opposite of that predicted by the deficit hypothesis. Perhaps bilinguals profit from the rich exposure to differing linguistic inputs and achieve milestones earlier than their monolingual counterparts. This reasoning suggests a 'bilingualism advantage hypothesis', a position that has found some empirical support, with older children and adults. Bilingual speakers have been reported to outscore their monolingual peers on various measures of intellectual flexibility (Ianco-Worrall, 1972; Ben-Zeev, 1977). Further, studies of children whose schooling was conducted in a second language have suggested the existence of at least some bilingual advantages (Lambert, 1981). In infancy the possibility of bilingual advantage in development of precursors to speech has not been previously evaluated empirically.

Another special reason for interest in very early bilingual development is that study of infants in complex linguistic environments may offer new insights regarding the 'babbling drift' hypothesis, which asserts that infants’ babbled utterances tend progressively to resemble the phonetic character of the language to which they are exposed across the first year or so of life (Brown, 1958). The hypothesis is important because it suggests that concrete
phonetic changes occur in infant vocalizations under the influence of specific speech stimulation very early in life. Empirical results addressing the drift hypothesis have been numerous and complex. A number of studies have emphasized the early effects of language environment. Adult listeners have been reported to be capable of identifying infants of differing language backgrounds correctly (Weir, 1966; de Boysson-Bardies, Sagart & Durand, 1984). Vowel production and intonation contours of babbling have been reported to resemble those of the target language in studies based on both acoustic instrumental analysis and phonetic transcription by adult listeners (de Boysson-Bardies, Sagart, Hallé & Durand, 1986; de Boysson-Bardies, Hallé, Sagart & Durand, 1989). And most recently, phonetically transcribed consonants of infants in four language environments have been reported to differ in ways that seem at least partly predictable based on phonetic characteristics of the target languages (de Boysson-Bardies & Vihman, 1991).

At the same time, negative results on the drift hypothesis have also been widely reported. Students of Weir who completed the drift study she began before her death found no evidence of language identification of babbling infants by adult listeners once proper methodological controls had been instituted (Atkinson, MacWhinney & Stoel, 1970). Similarly, Olney & Scholnick (1976) and Thevenin, Eilers, Oller & LaVoie (1985) found adults unable to identify the language background of babbling infants. Eady (1986) found no reliable differentiation between intonation contours of Cantonese and American infants in an instrumental acoustic study. And evaluations of consonant-like production of infants both acoustically and transcriptionally have produced no clear evidence of differences based on language background (Nakazima, 1962; Oller & Eilers, 1982; Eilers, Oller & Benito-García, 1984).

To reconcile these apparently diametrically opposed sets of outcomes, one supporting the drift hypothesis and one denying it, may require a careful look at methodological issues, a look that is beyond the scope of this paper (but see commentary in Locke, 1983). However, it is worthwhile at this point to highlight the fact that in spite of discrepancies of opinion about cross-linguistic infant phonetic development, researchers in the field of infant vocal development have not tended to disagree about the existence of other fundamental similarities in vocal development for infants being reared in very different language environments. Some of these similarities have been noted in the development of ‘infraphonological’ patterns (see Oller & Lynch, 1992) encompassing, for example, well-formed syllables (including consonant and vowel-like elements produced with rapid [< 120 ms] formant transitions between them). At the same time, in spite of the apparent agreement in the field, there has been little direct comparison of infraphonological development across infants of differing language backgrounds.

Another domain of relative agreement in the field of infant vocal studies concerns the idea that many phonetic properties of early well-formed syllables
seem to be shared across infants from widely differing backgrounds. For example, the preference of infants in widely differing environments for CV as opposed to VC syllables or for stop as opposed to fricative consonants is undisputed. What remains in dispute is whether there are also subtle phonetic differences between infants from differing language backgrounds, differences that may be seen against a background of substantial similarities.

The present work could hardly resolve the controversy, but it may shed some light on it. By evaluating the infraphonological development of infants reared in bilingual environments, it will be possible to provide empirical evidence on the nature of the background against which concrete phonetic development occurs, and by comparing the bilingual infants with monolingually reared peers, it will be possible to address the presumption that infants in differing environments progress similarly through infraphonological stages. This presumption suggests the possibility that babbling drift does not apply (or at least does not apply strongly) to infrastructural development of the speech capacity. At the same time, the study may help to provide an empirical view of the bilingual deficit hypothesis insofar as it may be thought to bear on potential delay in development of precursors to speech among infants exposed to multiple languages.

METHODS

Subjects

The study was conducted in the context of a long-term longitudinal effort to evaluate the communicative development of infants from a variety of backgrounds of language, socio-economic status and biological risk associated with prematurity. The monolingual infants were reared in homes where both parents as well as all siblings and other caretakers spoke the same language natively (in almost every case that language was English). The bilingual infants were reared in homes where there was substantial exposure to both English and Spanish due to the fact that among the consistently present caretakers one or more were native speakers of English and one or more were native speakers of Spanish. The longitudinal study of bilingualism had originally been intended to focus on ‘simultaneous’ bilingualism, the circumstance in which two languages are learned in side-by-side fashion from birth. Consequently, during the recruitment process bilingual families were sought wherein bilingual infants had consistent exposure to native-speaking caretakers from both languages.

The present study provides previously unreported data on 20 infants who were specifically recruited to the study in order to evaluate possible effects of bilingualism. However, nine additional ‘bilingual’ subjects to be considered here were originally recruited in the broader study that reported on roles of
both prematurity and SES (Steffens, Oller, Lynch & Urbano, 1992; Eilers, Oller, Levine, Basinger, Lynch & Urbano, 1993; Oller, Eilers, Steffens, Lynch & Urbano, 1994). At the time it was assumed these nine would be ‘monolingual’; the fact that they turned out to be ‘bilingual’ was a result of family interactions that had not been anticipated by the parents at the time of the infants’ births. The original assignment to the ‘monolingual’ category for these nine infants was based entirely on parent expectations (about what language they intended to speak with the child, whether the grandmother would be living with the family, and so on); the later assignment to the ‘bilingual’ category was based on subsequent (much more detailed) evaluation of the child and on parental report conducted through the fourth year of the lives of the children. Those children who proved in the later evaluations to have been living in ‘bilingual’ homes during the first year and a half of life were recategorized since the later assignments were deemed more reliable than the originals. In the cases of 44 other infants in the broader study, the original assignment to the category ‘monolingual’ proved consistent with the subsequent evaluations, and these infants constitute the ‘monolingual’ sample.

Data from a few of the monolingual subjects were not available at the time of the previous reports, but have been included in the present work, so that in each case of monolingual/bilingual comparisons, all the children whose data could be appropriately utilized have been included. It should be noted that because some subjects from the previous reports are categorized as bilingual here, and because of the inclusion of a few additional monolingual children, the numbers of monolingual subjects in each category differ in the present report from the numbers in the prior publications.

The samples in the present study vary in size across language groups and ages. The comparison with the largest sample (that concerning onset of canonical babbling or CB) included 44 monolingual infants (30 full term, 14 preterm) and 29 bilinguals (22 full term, 7 preterm). For the longitudinal descriptions focusing on data at ages ranging from 0;4 to 1;6, the subset of the full term infants that participated in the periodic sampling through the second year of life is considered. This sample included 28 monolinguals and 17 bilinguals. Preterm infants were not considered due to the low number of bilingual preterms that participated in the regular sampling.

A systematic attempt was made to recruit monolingual and bilingual infants that were well-matched on dimensions other than language background and ethnicity. In particular, we aimed at acquiring a sample of bilingually raised infants that were of middle socio-economic status (SES) and not of lower SES than their monolingual comparators. This matching was workable in the Miami metropolitan area in part because the demographics of Dade County (unlike most regions of the nation) provide a relatively balanced SES picture across Hispanic and non-Hispanic white residents.
The SES of families participating in the study was assessed through interviews with the parents, and SES data were updated throughout the longitudinal study based on continuing contact with the families. The method of evaluation has been described in greater detail in Eilers et al. (1993). Briefly, it consisted of a combination of items from Hollingshead (1978) and Nam & Powers (1983). Three key dimensions were considered: parental education, parental employment pattern and family stability. In the resulting one to five scale, families were categorized to be of high (one), mid-high (two), mid-low (three), low (four) or very low (five) SES. All the families in the present study pertained to one of the first four categories. The 44 monolingual full terms had a slightly lower mean SES (2.70, s.d. = 1.49) than their 22 full term bilingual counterparts (mean = 2.55, s.d. = 1.06). Similarly, the 14 monolingual preterms were slightly lower in SES (mean = 3.14, s.d. = 0.86) than their seven bilingual counterparts (mean = 2.57, s.d. = 1.13).

The preterm infant sample from the broader longitudinal study and methods of determining prematurity have also been described previously (Eilers et al. 1993). In short, the infants were all healthy with birthweights between 1400 and 2100 g. The 14 monolingual preterms considered here were born prematurely by 7.03 weeks (s.d. = 2.54), while the seven bilinguals were born 6.93 (s.d. = 1.53) weeks prematurely.

Sampling to determine the onset of canonical babbling (CB)

Infants in the study were all recruited by the age of 2 months. Parents and infants were brought to the laboratory for an introduction to the longitudinal study soon thereafter. They were informed that they would need to visit the laboratory for tape-recorded sampling of infant vocalizations at least monthly during the first year of life and semimonthly during the infant’s second year of life. They were provided with a diary which was to be used to record key events in the child’s development during the periods in between visits to the laboratory. The parents were informed that it was especially important to notice and report the onset of certain key events, in particular CB, which was described to the parents as the beginning of controlled, repetitive production of well-formed syllables. Examples of CB were presented by tape-recording and were contrasted with other categories of infant sounds (e.g. squealing, growling and isolated vowel-like sounds). Parents quickly understood the idea of well-formed syllables. They were, however, reacquainted with the idea at each subsequent visit to the laboratory. In addition, there were periodic telephone conversations between laboratory staff and parents, conversations in which the vocal development of the infant was discussed in detail. Parents were asked to call the laboratory staff on the first day that they heard the infant produce canonical syllables repetitively. When they called, a series of appointments was scheduled. The goal was to see the infant in the
laboratory every day for five consecutive days as soon after the onset of CB as possible, and then twice weekly for the remainder of the month after the onset. In this way it was possible for laboratory staff to confirm the observation of the parent regarding the onset of CB through observations made both during the recording sessions and both before and after the recordings during the process of interview and preparation for recording.

The concordance between parent report of onset and laboratory staff's subsequent evaluation was very high. Only two cases (both monolingual) were found where the laboratory evaluation did not confirm the parental judgement that the infant had entered the canonical stage. In both of those cases it appeared that the infants had gone through a 'blip', a brief period of well-formed syllable production that ends abruptly within a day or so. Such blips of CB have been observed in prior diary-based studies of early development (B. Smith, personal communication; Oller, 1980). The parents of these two infants indicated at the time of the first visit after the designated onset date that the infant had indeed started babbling on the day of the report, but had stopped, and was no longer producing canonical syllables. The laboratory evaluation in both cases confirmed that the infant was not producing canonical syllables. The scheduled appointments were postponed, and parents were instructed to call again when canonical syllables were observed. In both cases, the next call from the parents was followed up by a series of visits that confirmed the canonical status of the infants.

**Sampling to determine relative frequencies of various vocal categories**

The longitudinal laboratory evaluations have been described in prior work (Oller et al. 1994). Briefly, free vocalization samples were recorded in a sound treated chamber on high-fidelity audio equipment. Each session was 20–30 minutes in duration. The mother (or another caretaker) along with a laboratory assistant was present during each recording. In general, the goal was to obtain a vocalization sample of at least 70 nonvegetative utterances (i.e. ’babbling’ was counted but crying, laughing, moaning, etc. were not) from each infant in each session. Laboratory assistants kept a rough count of vocalizations during sessions. The sessions for the monolingual subjects and the nine bilinguals who were originally categorized as 'monolingual' were conducted monolingually.

The sessions with the 20 bilingual infants who were specifically recruited as 'bilingual' had a special characteristic associated with our intention to elicit vocalizations in both English and Spanish environments. As a consequence, each of these bilingual sessions was broken into two parts, a first one in which the laboratory assistant and parent spoke in one language and a second portion in which they spoke in the other one. Thus, 10–15 minutes were conducted in Spanish and 10–15 in English, with a goal of 35 utterances
from the infant in each language setting. The order of languages was counterbalanced across sessions.

Statistical analyses showed no reliable differences on any of the measures of the study between the 20 bilingual infants who participated in the special two-language sessions and the nine who participated in monolingual sessions. Consequently the 29 ‘bilingual’ infants were treated in analyses as consisting of a single group.

Coding

The recordings were reviewed by transcribers trained according to the procedure described in Oller et al. (1994). Each vocalization was categorized as consisting of a certain number of syllables, and each syllable was categorized as having a nucleus that was either a quasivowel (produced with vocal tract at rest) or a full vowel (produced with vocal tract postured out of the at rest state by jaw lowering, tongue bunching, lip rounding, etc.); if the syllable included one or more consonant-like elements, the syllable was further categorized as marginal (including a notably slow transition from consonant to vowel) or canonical (including the typically rapid transition between consonant and vowel). These categories are described in Oller (1980) and are shown to offer a developmental scale of vocalization both on theoretical and empirical grounds.

Theoretically, the production of canonical syllables represents a high level of speech-like vocalization, because such syllables combine (1) the well-formed features of full vocalic nuclei, (2) at least one consonantal element, and (3) a well-formed transition between the consonant and vowel-like elements. Marginal babbling represents a combination of items (1) and (2) but not (3), and it is consequently viewed as a less advanced vocal type. Production of full vowels represents feature number (1) but neither (2) nor (3). Production of quasivowels incorporates none of the three features, and is viewed as having speech-like quality only because it entails normal phonation, a property of all the types of babbling considered here. Consequently, the four categories can be neatly ordered theoretically in terms of their degree of adherence to principles of syllabic well-formedness.

Empirically, the categories are similarly orderable. Quasivowels, representing the least advanced category theoretically, are the first vocalizations with speech-like quality to be produced in very early infancy. Full vowels, pertaining to the next theoretical category, come later, still in the first half-year of life, and show that infants have gained control of producing normal phonation with a vocal tract that is postured in a variety of ways and thus capable of transmitting contrasts of vocalic quality. Marginal babbling, the third theoretical category, begins to occur when infants put full vowels together with articulations that can be interpreted as consonant-like. This event, usually in the middle of the first year, shortly precedes the onset of CB,
the most advanced of the major infraphonological categories, which appears under infant control usually during the middle or late middle portions of the first year of life.

The categories have been found to be easily identifiable by normal adult listeners with very little instruction. Listeners who are to serve as judges of tape-recorded utterances appear to need very little definitional training or experience with recorded examples. They do of course need to learn terms to describe the different kinds of infant sounds. It appears that listeners learn quickly apparently because they have intuitive knowledge of what makes a sound speech-like, and what deviations from speechiness are particularly important developmentally. It seems plausible that normal listeners would have such intuitive knowledge, because if they did not, they would surely have difficulty recognizing speech in contrast with other kinds of sounds. Normal listeners must know how to differentiate speech from the background of noise in which it is so commonly embedded in the experience of real conversational comprehension.

The primary quantitative measures of infant production of infraphonological categories in a sample of vocalizations are based on ratios of the number of syllables in each category to the number of syllables in all categories. After training and reliability checks to verify that all members of the transcription team were able to categorize vocalizations within 10% of the mean ratio value for the group of transcribers on each of the four dimensions (quasivowels, full vowels, marginal syllables, canonical syllables), the seven transcribers were instructed to code a set of tapes. Each infant’s data were assigned to a single transcriber. The order of coding was randomized by age, however, and each transcriber was assigned a proportional number of infants from each subgroup (bilingual vs. monolingual, preterm vs. full term, low SES vs. high SES). This balancing and randomization was intended to preclude confounding of group effects with possible intertranscriber differences, and also to preclude confounding of age effects with intratranscriber drifting in criteria of judgement over the period of coding.

The trainees were instructed to code the first 70 utterances on tapes from monolingual infants. For bilingual infants, they coded the first 35 utterances (associated with the first half of the session) and then fastforwarded the tape to the beginning of the second half of the session to code an additional 35 utterances. The notion ‘utterance’ included both babbling and early meaningful vocalizations of the children. During the samples from 6;8 and later, the transcribers reported that there were clearly examples of meaningful vocalizations, some canonical, some not canonical, and some involving quasivowels. However, the coded data were not systematically subcategorized regarding meaningfulness.

Data on meaningful speech development in the children studied here have
been reported separately, and have generally indicated that the infants progressed at a relatively normal pace in acquisition of vocabulary. First words for the monolingual children occurred at 1;0 with a range of 0;9 to 1;4 (Oller, Levine, Eilers & Pearson, in press). Research with the bilingual children suggests similar ages of onset for speaking and for vocabulary sizes through at least age 1;6 for total vocabulary (including words in both English and Spanish; Pearson, Fernández & Oller, 1993).

Hypotheses

If the implications of the bilingualism deficit hypothesis are true, then one might find early effects of the presumed added burdens of learning and listening that may be imposed on the bilingual infant. CB, the crowning event of the first year of speech-like vocal development, might be delayed in the bilingual children due to this overburdening. Further, in keeping with the thrust of the hypothesis, one would expect to see low proportions of usage of canonical syllables in the bilingual children by comparison with their monolingual peers. Finally a lower proportional usage of full vowels and higher usage of quasivowels might be expected in the group suffering from overburdening. In each case the added burden would be expected to produce a delay in development.

Of course in the abstract it seems possible that precisely the opposite could occur, in keeping with the bilingual advantage hypothesis. Perhaps bilingualism presents the infant with a rich opportunity of diverse phonetic input. The infant might profit from that diversity and seize the opportunity to accelerate learning and development. In that case, the milestones might appear earlier in the bilingual infants than in monolingual peers, and the proportional usage of high categories of speech-like vocalizations might favour the bilinguals as well.

There is a subsidiary hypothesis that can be considered as well. The study offers data on onset of CB in infants in various categories of SES and in infants born prematurely. There is mounting evidence that when infants are in a condition of risk for developmental disabilities, the probability that they will show developmental delay is increased disproportionately if there are additional risks present. This is sometimes referred to as the ‘multiple risk’ problem. If, in the present study, the premature infants or the low SES infants are assumed to be at risk, and if bilingualism is assumed to constitute an additional risk, as the deficit hypothesis suggests, then bilingual premature and low SES infants may show notably greater delays due to their condition of multiple risk. Of course it is possible that none of the factors actually contributes to risk of delay for speech-like vocalizations.
The onset of CB in monolingual and bilingual infants proved to be remarkably similar. The 30 full term monolingual infants began the stage at a mean of 27.3 weeks (s.d. = 4.77), while the 20 full term bilinguals began, not later, but earlier, at 26.7 weeks (s.d. = 5.32), a difference of about 4 days. The difference is far too small to be statistically reliable by an independent samples t-test ($p = 0.67$). The mean difference is only 11\%-13\% of a standard deviation for the groups. In order to provide a further quantitative indication of the extent of the similarity between the groups in onset of CB, 95\% confidence intervals were computed. The confidence interval evaluation provides a quantitative similarity analysis by placing upper bounds on plausible differences between the bilingual and monolingual groups in CB onset given the means and variances of the two groups observed in the study. Put another way, the similarity analysis specifies an interval within which any difference that might obtain between the groups (if the study were rerun) could be expected to fall. That analysis suggests that if there is a real difference between the populations that these groups represent (a difference that this study missed), that difference is very unlikely to be greater than 3.44 weeks (favouring the bilinguals) or 2.21 weeks (favouring the monolinguals).

In previous work from our laboratory, no support was found for the expectation that prematurity and low SES would constitute risks for vocal development. At the magnitude of prematurity and low SES evaluated in these earlier studies, no delay in CB onset was found in either case. Lower SES infants showed slightly, though not statistically reliably, earlier onset than their higher SES counterparts, and prematures showed reliably earlier ($p = 0.053$) onset than full terms after age correction for gestation (Eilers et al. 1993). Overall, the present data, combining information from the monolingual infants of the prior study and bilinguals from the current one, show a similar pattern, with no evidence of prematurity or low SES as delaying factors.

The data on bilingual infants evaluated separately in the present study also showed a lack of evidence for SES or prematurity as risk factors. The seven bilingual premature infants at corrected ages showed earlier onsets (mean = 23.2 weeks, s.d. = 6.64) than the 22 full term bilinguals, a difference of 3.5 weeks. This difference is comparable in magnitude to that found in Eilers et al. (1993) for preterm vs. full term monolinguals, but does not reach statistical significance ($p = 0.24$) given the small sample size. The 17 low SES bilingual infants (those categorized as level 3 or 4) also showed no delay in onset (mean = 24.9 weeks, s.d. = 4.44) with respect to the 13 mid SES bilinguals (those categorized as level 1 or 2, mean = 27.05 weeks, s.d. = 7.05). The difference favouring the low SES group was not statistically reliable ($p = 0.34$).
Table 1. Longitudinal data: samples available

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Fig. 1. Canonical babbling ratio for infants in the three categories. Canonical babbling ratio (number of canonical syllables divided by total number of syllables) for infants in three categories: monolingual infants of middle socio-economic status, monolingual infants of low socio-economic status, and bilingual infants of mixed socio-economic status. Where the display permits, standard error bars are included as indicators of dispersion.

The analysis of transcribed longitudinal data on full term bilingual and monolingual infants showed a similar lack of support for either the bilingualism deficit hypothesis or its inverse. In these analyses, the monolingual infants were broken down into mid SES and low SES subgroups, a distinction that was maintained for two reasons. First, prior data (Oller et al. 1994) had shown a reliable SES effect for volubility (utterances per minute) – mid SES infants vocalized more often (though they did not use more advanced types of vocalizations) than their low SES counterparts. Second, the bilingual group for whom longitudinal data were available was composed of families of mixed low and mid SES, but a breakdown into subgroups for analysis would result in inordinately small sample sizes at some ages. The resulting groups included 18 bilinguals (mean SES = 2.5, s.d. = 1.20), 15 monolingual mid SES infants (mean SES = 1.73, s.d. = 0.70), and 13
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monolingual low SES infants (mean SES = 3.69, s.d. = 0.48). Table 1 summarizes the number of available longitudinal samples at each age.

For each sample, ratio measures were computed as the number of syllables in each category divided by the number of syllables in all categories. To understand the values, it is important to note that CB syllables always include vowels, though vowels sometimes occur in isolation (that is, not in CB syllables). By definition, quasivowels cannot occur in CB syllables; they can occur alone or in the company of consonant-like articulation, but the result is not deemed canonical within the infraphonological model. Since CB syllables require vowels, both CB and vowel ratios increase as an infant’s vocalizations mature. As expected, then, split-plot ANOVAs revealed reliable main effects for age on CB ratio \( [F(7,234) = 41.63, p < 10^{-37}] \) and vowel ratio \( [F(7,234) = 18.93, p < 10^{-18}] \). All three groups of infants showed strong gains in both measures from 0;4 to 0;10 with slower gains thereafter, indicating that the measures do provide a gauge of vocal development when mean values are considered for groups of at least this size (see Figs 1, 2). However, intragroup variance was high, as indicated by error bars in the figures. Moreover, individual infants showed substantial session to session variability (even after onset of CB), as has been reported previously for samples of this size (Steffens et al. 1992; Oller et al. 1994). Such variability was typical of all three groups. For instance, one bilingual infant produced a sample with a CB ratio of 0.33 at 0;10 and dropped to 0.01 at 1;2; a monolingual mid SES infant produced a sample with CB ratio of 0.53 at 0;6 and 0.11 at 0;8; and a monolingual low SES infant produced a sample with CB ratio of 0.41 at

![Fig. 2. Full vowel ratio for infants in the three categories.](image)

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Thus, although the age effects for CB ratio and vowel ratio were strong, their reliability was limited by large variance values within groups and within subjects across ages.

Given the variances and considering the data in Figs 1 and 2, it should be no surprise that neither CB ratio nor vowel ratio showed reliable main effects for group. With high intragroup variance it would be necessary to obtain a large intergroup difference to reach statistical reliability. The differences here were minimal: bilinguals’ CB ratios (mean = 0.276) were very near those of mid SES monolinguals (mean = 0.296), and low SES monolinguals (mean = 0.267). The bilinguals thus trailed the monolingual mid SES group in CB ratio by 0.02, less than 12% of the average standard deviation within groups found at each age. Translating this difference into developmental time by referencing to the average increase in CB ratio month by month in the study, it can be said that bilinguals trailed the monolingual mid SES group by 20 days of development, and that they led the monolingual low SES group by 9 days.

The situation for vowel ratio was similar: bilinguals’ vowel ratios (mean = 0.794) were very near those of mid SES monolinguals (mean = 0.750), and low SES monolinguals (mean = 0.758), differences of about one quarter of the average standard deviation within groups found at each age. By using as a reference developmental growth in vowel ratio across all groups for the 14 month period, it can be said that the bilingual infants’ vowel performance was better than that of mid SES monolinguals by 2.5 months, and was better than that of low SES monolinguals by 2.0 months.

The analysis of data on volubility, as indicated by utterances per minute, was restricted to the first 35 utterances in each sample. This limitation was imposed in order to maintain comparability of transcriptional sampling across groups. To understand this limitation, remember that for tapes of monolingual infants the first 70 consecutive utterances were transcribed. For bilingual infants the first 35 utterances were transcribed. The other 35 utterances for the bilingual infants’ tapes were transcribed starting at the first utterance in the second half of each session (the point where the experimenter and parent switched languages) – not necessarily at the 36th utterance. Because there was no way to gauge directly the effect of the resulting possible hiatus in transcriptional sampling that occurred for the bilingual group only, it was decided to confine the analysis in both monolingual and bilingual infants to the first 35 utterances, the segment of the sample for which the transcription procedure was conceptually parallel across the two groups.

The 35-utterance analysis showed no tendency for bilingual infants to produce fewer vocalizations than their monolingual counterparts. Fig. 3 indicates that monolingual mid SES infants tended to have somewhat lower relative volubility early in the sampling period, but somewhat greater
volubility later in the period. Mean volubility across the 14 months differed little among the groups (bilingual mean = 6.36 utterances per minute; monolingual mid SES mean = 7.19; monolingual low SES mean = 6.29). The groups did not differ reliably in volubility in this evaluation [$F(2,32) = 0.81, p > 0.45$], though prior results (Oller et al. 1994) based on 70 utterances (presumably providing greater stability of data) from the monolingual groups did show reliably greater volubility in the mid SES group than the low SES group. It may be noteworthy that even though the results were not reliable statistically, the mixed SES bilingual group mean value fell between the mid SES and low SES groups of monolinguals on this measure of volubility.

**Discussion**

A key goal of this research was to assess the relative growth in precursors to speech for bilingual and monolingual infants. The bilingualism deficit hypothesis suggests that bilingual infants might show slower development in key milestones owing to presumed special processing burdens imposed upon the bilingual infant who, of course, must deal with two kinds of input — two segmental phonologies, two prosodic systems, two vocabularies, two kinds of syntax and so on. The bilingualism advantage hypothesis expresses the opposite expectation. Bilinguals might be thought to be in a position to profit from the richness of their linguistic environment, and this richness might facilitate especially rapid progress in the development of precursors to
speech. The results of the research supported neither of these hypotheses. There was no tendency for bilingual infants to trail their monolingual counterparts in key indicators of prelinguistic phonological performance. At the same time there was no reliable tendency for the bilinguals to show accelerated development.

Expressed this way, the outcome represents a negative result. The similarity of the bilingual and monolingual outcomes can, however, be viewed positively. Mean differences in onset of CB between the groups were only a few days, favouring the bilinguals. To put those values in perspective, normally developing children have been observed to begin CB at as early as 4 months of age, and as late as 10 months of age, a difference of 26 weeks. The smallest reliable group differences that have been observed in CB onset are those between full term and preterm infants in the study of Eilers et al. (1993), who found preterm infants at corrected ages beginning the canonical stage a little over 3 weeks before their full term counterparts. Lynch, Oller, Steffens, Levine, Basinger & Umbel (1995) have found that Down syndrome infants begin canonical babbling about 8 weeks after their normally developing counterparts, and a variety of studies on effects of hearing impairment (Stoel-Gammon & Otomo, 1986; Vinter, 1987; Konopczynski & Vinter, 1990; Eilers & Oller, 1994) have reported that deaf infants begin canonical babbling many months later than normally hearing infants. In this context, the obtained difference of 4 days between bilinguals and monolinguals seems notably small, and suggests that if there is any real difference between monolingual and bilingual infants in CB onset, it would be hard to see how it could have much practical significance.

Evaluation of the longitudinal data on CB and vowel ratios obtained from transcripts of laboratory samples from monolingual and bilingual infants also yield a lack of support for either the bilingualism deficit hypothesis or the advantage hypothesis. The bilingual infants showed somewhat higher vowel ratios after 10 months of age than monolinguals, but the differences were not statistically reliable.

Substantial effort was expended in the present work to obtain monolingual and bilingual groups matched for SES, in part because there has been extensive criticism of prior research (e.g. research reviewed and critiqued by Peal & Lambert, 1962) on bilingualism that has not taken this precaution. It is well known that in many domains of language learning, low SES represents a notable risk (Osborn, 1968; Hart & Risley, 1981, 1992; Harris, Barrett, Jones & Brookes, 1988). However, in the present evaluation of precursors to speech development, there was no discernible tendency for low SES to retard infraphonological development. Whether the infants were monolingual or bilingual, low SES infants actually showed slightly earlier onset of CB, and there was no discernible tendency for CB ratio or vowel ratio to be depressed.
The present work also revealed no tendency for volubility to be depressed in bilingual infants, although the evaluation may have been hampered by small samples that could be compared across bilingual and monolingual groups (35 utterances per session).

Premature bilingual infants at corrected ages showed an acceleration in onset of CB that was of about the same magnitude as that reported for monolingual infants by Eilers et al. (1993), though here it was not statistically reliable. The combination of prematurity, low SES and bilingualism seemed to yield no tendency for the developmental process to be slowed down, and it would be fair to summarize by saying that monolingual and bilingual infants showed fundamental similarity in the development of all the infraphonological features that have thus far been evaluated.

The striking degree of similarity between monolingual and bilingual groups also suggests a summarial comment on the babbling drift hypothesis. The comment, of course, assumes that bilingual learners might, theoretically, show effects of their experience in the two languages and consequently might differ in vocal production from monolingual counterparts. The empirical bilingual/monolingual comparison suggests that infrastructural development of syllabic control is affected little if at all by mother tongue environments within the first year of life, and that if there are important effects of environment, they may apply only to details of articulation rather than to infraphonological development. The issue of specific language effects on details of articulation in infants remains to be resolved empirically. A number of studies have reported modifications in details of articulation for both vowels and consonants in infants of differing language backgrounds (see e.g. de Boysson-Bardies et al. 1984, 1986, 1989; de Boysson-Bardies & Vihman, 1991), but a number of other studies have failed to isolate effects of language environment (Atkinson et al. 1970; Olney & Scholnick, 1976; Eady, 1980; Eilers et al. 1984).

It is perhaps justifiable to speculate that the biological heritage of the young human organism predisposes it to a specific pattern and timetable of infraphonological development. That pattern and timetable appear to resist modifications that might delay the emergence of key milestones. Variations in SES do not seem to delay them. Prematurity appears to accelerate them through a mechanism that may involve the especially early auditory exposure to speech and speech-like sounds experienced by premature infants who emerge into the extrauterine environment before their full term counterparts do. The fact that early simultaneous exposure to two languages yields no discernible effect on the course of infrastructural vocal development is seen in this context as just one more indication of a biological canalization.

Perhaps the onset of CB is a focal event of infancy, an event that has proved through the course of evolution to be developmentally important enough to
keep intact and to maintain on course in the face of varying circumstances of living.

REFERENCES


