EVIDENCE FOR LANGUAGE-SPECIFIC RHYTHMIC INFLUENCES IN THE REDUPLICATIVE BABBLING OF FRENCH- AND ENGLISH-LEARNING INFANTS*

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The reduplicative babbling of five French- and five English-learning infants was examined for evidence of language-specific rhythmic patterns. Three types of patterns were examined: final-syllable lengthening, timing of nonfinal syllables, and number of syllables per utterance. Both English and French exhibit final-syllable lengthening but, because of variable word stress, English tends to lengthen nonfinal stressed syllables, as well as final ones. Thus French final-syllable lengthening is more salient because it is the only regular source of lengthening. There is also some indication that the magnitude of final syllable lengthening is greater in French than in English. In addition, French nonfinal syllables, which are not subject to English variable word stress, are generally equal in length, whereas English tends to have more irregularly timed nonfinal syllables. Finally, French breath-groups often contain as many as four to six syllables, whereas intervals between stressed syllables in English rarely contain more than three syllables. The reduplicative babbling of the French and American infants showed characteristics of the ambient language. In particular, the babbling of the French infants showed a significantly higher percentage of final-syllable lengthening than that of the American infants. The magnitude of their final-syllable lengthening was also greater. The French infants also produced significantly more reduplicative babbles that were four or more syllables in length. Finally, the nonfinal syllables of the French infants tended to be more regularly timed than those of the American infants, although this pattern emerged only in the later stage of the infants' reduplicative babbles.

Key words: Language acquisition, babbling, French, speech timing

INTRODUCTION

Current research on child language acquisition has produced much evidence in favor of continuity in development between babbling and early speech (e.g., Ferguson, 1978;

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* The research reported here was supported by grant DC00403 to Catherine Best at Haskins Laboratories. We thank the families of our American and our French infants for their cooperation. A version of this paper was presented at the International Conference of Phonetic Sciences in Aix-en-Provence, France, August 1991. Catherine Best and Doug Whalen provided helpful comments on earlier drafts of the paper.

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Kent and Bauer, 1985; Menyuk, 1971; Menyuk and Menn, 1979; Oller, Wieman, Doyle, and Ross, 1976; Stark, 1980; Vihman, Macken, Miller, Simmons, and Miller, 1985). The child's babbling seems to "drift" (Brown, 1958) in the direction of the phonetic characteristics of the ambient language. However, the question of exactly how early the child's productions reflect the segmental characteristics of the native language has been much debated, with some researchers finding evidence for such effects during the first year of life while others do not. Thus, although Locke (1983) has argued that language-specific influences begin to emerge only when the children are well within the second year of life, Boysson-Bardies, Halle, Sagart, and Durand (1989) found that the formant frequency distributions of the vowels produced by ten-month-old infants from four linguistic environments reflected the distributions of vowel formant frequencies in the adult languages. More recently, Boysson-Bardies and Vihman (1991) have also found that the consonants produced by infants from different linguistic environments reflect the consonant distribution patterns in the adult languages.

Part of the discrepancy between the views of Locke and Boysson-Bardies and her colleagues may be due to differences in analysis technique. Locke focused on an interpretive review of studies that rely heavily on phonetic transcription, while Boysson-Bardies generally made use of acoustic analyses as well. Acoustic analyses are important in that they can provide evidence for changes in vocal development at stages when such changes are not yet detectable by ear. Thus, Macken and Barton (1980), in a longitudinal study using acoustic analysis, discovered that children learning the voicing distinction in English went through a stage during which they produced the contrast in a manner that was not perceptible to adults. Very little attention, however, either in terms of transcription studies or of acoustic or perceptual analyses, has been devoted to the early stages of prosodic development. Nevertheless, some have suggested (e.g., Crystal, 1979; Lewis, 1936) that infants may actually begin to reproduce the prosodic patterns of their language earlier than they produce the segments.

In a recent investigation (Whalen, Levitt, and Wang, 1991), we found both acoustic and perceptual evidence for language-specific effects in the F_0 contours of the reduplicative babbles of five French- and five English-learning infants. The reduplicative babbles were collected from infants who were recorded at home over a period of several months and who were on average 7;3 months of age at the time of the first recording used and 11;1 months of age at the time of the last recording used. In agreement with the higher incidence of rising intonations in adult French speech (Delattre, 1961), the reduplicative babbles of the French infants showed a significantly higher incidence of rising F_0 contours, both when tested perceptually and when analyzed acoustically, by comparison to those of the American infants.

In the present study we extended our investigations to three rhythmic properties of those reduplicative babbles: utterance-final lengthening, the timing of nonfinal syllables, and the number of syllables per utterance.

The first property, final-syllable lengthening at the ends of utterances, is a more salient feature of French, which is "trailer timed", according to Wenk and Wioland (1982), than of English. Although both French and English exhibit final-syllable lengthening at the ends of utterances, this type of final-syllable lengthening is more salient in French because French nonfinal syllables within phrases are not typically lengthened due to word stress, as are words in English. There has been some indication that French and American infants may develop final-syllable lengthening fairly early on. In examining the babbling of a group of French-learning infants. Konopczynski (1986) found that final syllables were longer on average than nonfinal syllables. from the age of eight months on, although this difference did not become significant until the children were 16 months old. Oller and Smith (1977), in examining the babbling of six English-learning infants ranging in age from eight to 12 months. found evidence for such lengthening in the babbling of some, but not all, of these American infants (*cf.* Mitchell, 1988). Furthermore, the degree of final syllable lengthening appears to differ for the adult languages. with French exhibiting a nonfinal to final syllable ratio of about 1 : 1.6 (see, e.g.. Levitt, 1991) whereas English has a 1 : 1.4 ratio (see, e.g., Smith, 1978). To see whether the incidence or magnitude of such lengthening might differ between the two language groups, we looked at French and English babbling longitudinally.

The second property, nonfinal syllable timing, is also different for the two languages. French has been classified as syllable-timed (e.g., Pike, 1945), with a rhythmic structure known as "isosyllabicity", which is characterized by syllables generally equal in length. However, this description ignores the important final-syllable lengthening in French (e.g., Wenk and Wioland, 1982). On the other hand, aside from the effects of emphatic stress, inherent segmental length differences, and initial syllable lengthening found in some speakers. *nonfinal* syllables in French are generally more equal in length than nonfinal syllables in English (Fletcher, 1991; Levitt, 1991). English does not exhibit very regularly timed nonfinal syllables, because variable word stress in English tends to lengthen nonfinal stressed syllables. If French nonfinal syllable timing has an effect on the infants' productions, then we would expect the French infants to exhibit more regularly-timed nonfinal syllables than English-learning infants.

The third property that we investigated, the number of syllables in a reduplicative babble, may be expected to differ in English and French because of differences in the stress patterns in the two languages. From the data provided by Fletcher (1991) in her analysis of the conversational speech of six native speakers of French, 56% of the speakers' polysyllabic "prosodic words", which included all unaccented syllables preceding an accented final syllable, were four or more syllables in length, on average. On the other hand, from the data provided by Crystal and House (1990) based on the read speech of six speakers of English, polysyllabic interstress intervals containing more than four syllables accounted for only six percent of the total, on average. Thus, we expected that our French infants might produce longer reduplicative utterances than our American infants.

METHOD

Subjects

The babbling of five English-learning infants (three male and two female) and five French-learning infants (four male and one female) was recorded weekly by their parents at home. The French-learning infants were recorded in Paris and the English-learning infants were recorded in the northeastern United States. Recordings began when the infants were between four and six months old and continued until they were between nine and 17 months old (see Table 1).

Procedure

Data collection. Both the American and the French infants were recorded on cassette tape recorders using high quality microphones. Home recording sessions lasted between 10 and 20 minutes. Parents were instructed to choose a time when their child was alert and unlikely to cry. They could elicit babbling by talking and gesturing, but they were told to be sure to stop speaking as soon as the infant began vocalizing. They were also told how to reduce external sources of noise (e.g., by removing noise-making toys from the immediate vicinity and by dressing the child in clothes that did not rustle). The microphone was to be held about 20 cm from the baby. The parents identified each individual taping by recording the date at the beginning of each session. A comment sheet was also filled out for each tape and included the date, time, and situation (e.g., "after breakfast") of each recording.

Utterance sampling. Each tape was phonetically transcribed, and all infant speech-like vocalizations (except for squeals, growls, emotive sounds, and vegetative noises) were low-pass filtered at 4.9 kHz and digitized at 10 kHz via the Haskins Laboratories PCM system (Whalen, Wiley, Rubin, and Cooper, 1990). The vocalizations were divided into utterances, or breath groups, which were defined as a sequence of syllables that was separated from adjacent utterances by at least 700 msec of silence and which contained no internal silent periods longer than 450 msec in length. From the transcribed and digitized utterances, we selected all the reduplicative babbles, that is, those which contained the same consonant-like element as well as the same vowel-like element in successive syllables, according to our transcriptions.[1] By selecting only the reduplicative babbles of our infants, we reduced the variability that would have been introduced by multisyllabic utterances containing syllables with segments of inherently different lengths. This selection of reduplicative babbles thus allowed us to evaluate final-syllable lengthening within utterances.

Using these criteria, we obtained 208 reduplicative utterances, approximately half

[1] For an utterance to be considered reduplicative, it had to contain syllables that had been transcribed as beginning with the same consonant-like segment and containing the same vowel, broadly defined (i.e., low front, mid central, etc.). All of the utterances included for analysis were transcribed as reduplicative by both authors and there was complete agreement on the transcriptions for 62 percent of the stimuli. In the 38 percent of the cases where the transcriptions were not identical, 16 percent were due to a disagreement over the nature of the reduplicated consonant and 23 percent were due to a disagreement on the reduplicated vowel. For the consonant disagreements, about half (53 percent) were due to differences in place judgments and the rest differences in judgments of manner. Virtually all the vowel disagreements were due to judgments falling into adjacent classes, broadly defined as above. Indeed, when the reduplicated vowels were narrowly transcribed, the most typical disagreement between transcribers was whether the vowel was [æ] or [ɛ].

TABLE 1

Description of the source of the 208 stimuli

	Ages (in months) at which recordings were made	Ages (in months) at which reduplicative babbles were detected	Number of reduplicative babbles
French Infants			
MB	5–11	7–11	24
EC	6–12	6–12	42
MS	5–16	7–12	23
JZ	4–9	5–7	9
NB	4–14	8–13	8
American Infants			
MA	5–16	8–12	24
MM	5–17	7–12	35
CR	5–17	9–10	7
AB	5–17	8–11	18
VB	4–15	7–12	18

(102) from the English-learning children and half (106) from the French-learning infants.[2] For most of the infants, reduplicative babbles were detected only during a portion of the overall recording period. Thus, we obtained reduplicative babbles beginning essentially between six and nine months of age. (JZ's first reduplicative babble was detected at the end of his fifth month. All the other reduplicative babbles that he produced were recorded during his sixth and seventh months.) For most of the infants, we ended our collection of such babbles after 12 months or when the parents stopped recording. In the case of one French infant (NB) who had begun reduplicative babbling fairly late and who had produced relatively few tokens, we included reduplicative babbles from the thirteenth month (see Table 1).

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2 Fourteen utterances from three French infants analyzed previously in Whalen *et al.* (1991) (12 percent of the French utterances) were not used here either because a mistake was discovered in the original transcriptions or because the utterances were found, on rechecking, not be be separated from other vocalizations by at least 700 msec, as required by our criterion.

Acoustic analysis. The duration of each syllable was measured using a wave form editing and display program. A conservative criterion for measuring syllable length was adopted: The duration as measured included only the visibly voiced portion of each syllable. This criterion was adopted because the home recording environments were occasionally noisy and the noise could serve to obscure, in some cases but not in others, the breathy release of certain syllables. Although nonfinal syllables could be considered to extend to the onset of the following syllable, such an alternative measure was not available for final syllables, making comparisons between nonfinal and final syllable lengths problematic. Thus, in order to avoid such difficulties, breathy releases and inter-syllabic silences were not included in the syllable duration measurements.

A random sample of 36 utterances was remeasured to test for measurement reliability. There were 186 separate measurements involved. The average duration difference between the first and second sets of measurements was 7.6 msec. The correlations between the original and remeasurements for the duration of final-syllable lengthening (see below) were very high; 0.98 for English and 0.99 for French.

RESULTS

The results will be described in terms of evidence for final syllable lengthening, isosyllabicity, and utterance length.

Final syllable lengthening. We assessed final syllable lengthening by comparing the length of the final syllable of each reduplicative utterance to that of the penultimate syllable. We counted only those final syllables 20 msec or more longer than the penultimate syllable in the same utterance as lengthened. Thus, for each infant, we calculated the percentage of utterances showing final-syllable lengthening (see Table 2). This method of testing for final-syllable lengthening seemed most appropriate to us for use with reduplicative utterances. Table 2 also provides mean penultimate and final syllable lengths for each child in those utterances counted as lengthened as well as overall.[3]

The French infants showed final syllable lengthening in 54.3% of the utterances on average, whereas the American infants showed final syllable lengthening in 28.9% of their utterances. This difference was significant [$t(8) = 3.04, p < 0.009$, one-tailed].

As can also be seen from Table 2, there were differences in the magnitude of the final-syllable lengthening for the French and the American infants. Thus, percentage increase in final syllables in lengthened utterances averaged 61.4% for the French infants and 32.1% for the American infants. This difference in percentage increase was significant [$t(8) = 3.88, p < 0.003$, one-tailed]. There was a similar difference in the percentage

3 Three utterances produced by the French infants (two by MS and one by JZ) contained final syllables that were more than 2.5 times longer than the penultimate. Since the overall number of tokens, especially in the case of JZ, was not great, the measurements for those syllables were included in the means as only 2.5 times the penultimate.

TABLE 2

Final-syllable lengthening

	Percentage of lengthened utterances (N in parentheses)		Mean syllable length (msec) (Mean percentage change in parentheses) Lengthened utterances Penult.	Final		Overall Penult.	Final	
French Infants								
MB	33.3	(24)	189.7	284.1	(49.8)	217.1	214.9	(−1.1)
EC	38.1	(42)	216.2	327.9	(51.7)	271.9	277.1	(1.9)
MS	69.6	(23)	261.3	416.0	(59.2)	261.8	365.7	(39.7)
JZ	55.6	(9)	270.5	495.3	(83.1)	328.8	415.7	(26.4)
NB	75.0	(8)	299.9	489.1	(63.1)	306.1	420.8	(37.5)
Mean:	54.3		247.5	402.5	(61.4)	277.2	338.8	(20.9)
American Infants								
MA	29.2	(24)	251.3	318.4	(26.7)	276.7	265.6	(−4.0)
MM	25.7	(35)	316.6	435.7	(37.6)	384.2	328.6	(−14.5)
CR	28.6	(7)	252.2	303.9	(20.5)	281.8	221.2	(−21.5)
AB	33.3	(18)	303.5	446.4	(47.1)	282.9	277.8	(−1.8)
VB	27.8	(18)	200.2	257.9	(28.8)	240.9	229.8	(−4.6)
Mean:	28.9		264.8	352.5	(32.1)	293.3	264.6	(−9.3)

of change between final and penultimate syllables in the overall set of utterances, with an average of 20.9% increase for the French and 9.3% decrease for the Americans. This difference was significant as well [$t\,(8) = 3.19, p < 0.006$, one-tailed]. (See Table 2.)

Isosyllabicity. We measured isosyllabicity, i.e., the relatively regular timing of nonfinal syllables within each utterance, by calculating the standard deviation of the durations of nonfinal syllables for each utterance of three syllables or more and determining the mean standard deviation for each infant. Although the French infants did show lower standard deviations on average (54.5 msec), indicating more regularly timed utterances than the English (65.4 msec), the difference was not significant [$t\,(8) = -0.69$, ns]. (See Table 3.)

TABLE 3

Mean standard deviation in msec for nonfinal syllables
(number of utterances containing three or more syllables in parentheses)

	Overall	Early period	Late period
French Infants			
MB	42.1	61.4 (7)	27.1 (9)
EC	60.7	68.7 (12)	47.1 (7)
MS	53.3	79.8 (7)	16.2 (5)
JZ	94.0	126.8 (5)	53.0 (4)
NB	22.3	8.7 (1)	26.8 (3)
Mean:	54.5	69.1	34.0
American Infants			
MA	64.9	49.1 (6)	80.8 (6)
MM	85.6	76.9 (13)	94.2 (13)
CR	42.2	33.7 (1)	45.0 (3)
AB	42.2	45.4 (3)	38.9 (3)
VB	92.3	74.7 (2)	101.0 (4)
Mean:	65.4	56.0	72.0

In order to see whether there was a significant shift in this tendency over the period during which reduplicative babbling was detected for each child, we divided each infant's utterances into two age periods. Because the age at which infants begin to produce reduplicative babbles varies, we divided each infant's utterances in to two groups, such that the first group of "early" reduplicative utterances was produced during the first half of the total time period containing reduplicative babbles for that infant. and the second group of "late" reduplicative utterances was produced in the second half of the time period. The mean standard deviation was again calculated for each infant during the early and the late time periods (see Table 3). This procedure left us with a number of cells with very few utterances. so that it did not seem appropriate to run an ANOVA on these data. However. the standard deviations of the utterances produced by four of the French infants decreased in the later stage whereas those of four of the American infants increased. so that eight of the ten infants showed a shift in the predicted direction

TABLE 4

Number of reduplicative utterances that are two, three, four, or five or more syllables in length

	Two	Three	Four	Five+		Percentage of long utterances (4 or more syllables)
French Infants						
MB	8	4	4	8		50.0
EC	23	6	5	8		31.0
MS	11	7	4	1		21.7
JZ	0	3	0	6		66.7
NB	4	0	3	1		50.0
Total:	46	20	16	24	Mean:	43.8
American Infants						
MA	12	5	5	2		29.2
MM	9	14	6	6		34.3
CR	3	3	0	1		14.3
AB	12	4	2	0		11.1
VB	12	5	0	1		5.6
Total:	48	31	13	10	Mean:	18.9

for their group. This shift is marginally significant by a binomial sign test ($p < 0.055$). Thus, the French infants appear to have developed more regularly timed utterances, whereas the American infants appear to have developed more irregularly timed productions.

Utterance length. The percentage of "long" (four or more syllables) reduplicative babbles was calculated for each of the French and American infants (see Table 4). The French infants produced more long utterances (43.8%) than the American infants (18.9%). This difference was significant by [$t(8) = 2.59$, $p < 0.02$, one-tailed]. Table 4 also includes the distribution of utterance lengths of two, three, four, and five or more syllables for each infant.[4]

Discussion

We found acoustic evidence for language-specific rhythmic effects in the reduplicative babbling of French and English infants. Our French infants produced a higher percentage of final-syllable lengthening, final lengthening of greater magnitude, and a greater proportion of utterances four or more syllables in length than our English-learning infants. These effects on the vocalizations of the French infants are in keeping with patterns found in the adult language. In addition, French infants produced more regularly timed nonfinal syllables, although only in the later stage of their reduplicative babbles. Again, such an effect is in keeping with adult spoken French, in which unaccented, nonfinal syllables are relatively equal in length (Fletcher, 1991; Levitt, 1991).

In general, our findings concerning final-syllable lengthening are relatively consistent with other reports of evidence for early final lengthening in French (Konopczynski, 1986) and somewhat less systematic lengthening in English (Oller and Smith, 1977; but *cf.* Mitchell, 1988). We also found evidence for a greater magnitude of lengthening in the productions of the French infants as compared to the American infants. Halle, Boysson-Bardies, and Vihman (in press) have found a similar difference in final-syllable lengthening in the disyllabic utterances of French and Japanese children about 18 months of age, with the French children's productions showing final-syllable lengthening, whereas those of the Japanese children, in whose language final-syllable lengthening is less prominent, do not.

In this test of final-syllable lengthening, we chose an utterance-based approach and restricted our analysis to reduplicative babbles so that we could eliminate duration effects due to inherent differences in segmental lengths and to the differences in tempo in the child's productions from one recording session to the next. This allowed us to look at each utterance for evidence of lengthening. However, this approach also tended to limit the number of utterances available for analysis. Thus, even though we found significant differences in the magnitude of the lengthening produced in both the lengthened utterances and overall between the French and the American infants, it must be remembered that these percentages were calculated over utterances (and a relatively small number of utterances for some infants) that varied in segmental structure and presumably in tempo. It is important to remember that infant vocalizations tend to be quite variable.

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4 The significant difference in final-syllable lengthening is not due to the French infants' greater use of longer reduplicative babbles. A separate t-test of the percentage of disyllabic utterances in which the final syllable was at least 20 msec longer than the penultimate for the nine infants who produced disyllabic utterances yielded a significant result [$t(7) = 2.07$, $p < 0.04$, one-tailed], with the French infants producing final-syllable lengthening in 53% of their disyllabic utterances as compared to the Americans who produced final-syllable lengthening in 24% of their utterances.

Nonetheless, our results provide an important comparative perspective by showing that the infant's tendency to produce final-syllable lengthening and the magnitude of that lengthening can be influenced by the patterns of final-syllable lengthening in the adult language.

Since most previous studies of syllable timing in infant vocalizations have focused on final-syllable lengthening, relatively little was known about emerging rhythmic patterns for nonfinal syllables. Thus, our finding that the timing of the nonfinal syllables in the French reduplicative babbles tends to become more regular over time, whereas in the American reduplicative babbles the timing becomes more variable, adds new information concerning nonfinal rhythmic patterns and provides important additional support for the effect of the rhythmic structure of the ambient language on infant babbling. Similarly, our finding of utterance length differences between the French and American infants can be seen as further evidence for the effect of the rhythmic structure of the ambient language.

We do not believe that these results provide evidence for direct infant imitation of parents' speech. The results of experimental studies that have looked for immediate, direct vocal imitations by infants have been mixed, with studies often failing to find such imitation (e.g., Siegel, Cooper, Morgan, and Brenneise-Sarshad, 1990). We also do not believe that it is likely that the infant heard reduplicative utterances from his/her parent just prior to vocalizing, since we detected no such utterances in our recordings. The infant's tendency to produce certain kinds of rhythmic patterns cannot really be deemed imitation in this instance because the adult utterances provide models that are too abstract and often too distant in time and space to serve as sources for imitation. What we are seeing, we believe, is the result of articulatory habits that are built up as a result of the infant's long-term exposure to the language. These patterns may then be reinforced by parental feedback.

Evidence that infants show an early sensitivity to rhythmic patterns supports the possibility that they could begin to reproduce some of those properties after long exposure. Thus, Demany, McKenzie, and Vurpillot (1977), using a visual fixation habituation procedure, demonstrated that two-month-old infants could discriminate two series of tone bursts presented in different rhythmic organizations. Infants' sensitivity to some specific rhythmic properties of language has also been demonstrated. Spring and Dale (1977) showed that infants could discriminate two bisyllabic utterances when they differed in syllable stress. Infants could perform this task both when the syllable stress was cued by all three typical prosodic markers, F_0, duration, and amplitude, as well as when the stress was cued by duration alone. In addition, Fowler, Smith and Tassinary (1985) found evidence to support the notion that stress beats provide the basis for infants' perception of speech timing, just as they do for adults.

Furthermore, by the age of two, children have already largely mastered a number of the syllabic timing properties of their language. Thus, Allen (1983) has shown that French children exhibit final-syllable lengthening in polysyllabic words by two years of age. Although the patterns of final-lengthening produced by the children were more variable than those produced by French adults, the children's median ratios of nonfinal to final syllables were very comparable to those of French adults, roughly 1 : 1.6. Similarly, Smith (1978) has shown that English-speaking children between two and three years of age have mastered final-syllable lengthening as well, with a nonfinal to final ratio of close to 1 : 1.4 for both the adults and the children.

Given these findings concerning infants' perception and young children's production of certain rhythmic properties, it is perhaps not surprising that we find early language-specific effects on the timing of infant babbling. However, certain rhythmical aspects of language appear to be easier to acquire than others. Thus, children acquire some of the more global rhythmic patterns of their language, such as the typical final to nonfinal syllable ratio, before they acquire the more fine-grained aspects of consonant timing (e.g., Allen and Hawkins, 1980; Smith, 1978). Similarly, although our results suggest an early beginning for children's development of control of final-syllable lengthening and of utterance length, it appears that these properties are more easily produced than the regular timing of nonfinal syllables in French. Children's vocal productions are notably more variable than those of adults and gradually move towards more adult-like stability (see, e.g., Kent, 1976). Producing regularly-timed syllables would thus be more difficult for children than for adults.

The infant's acquisition of the rhythmic properties of his/her language is only part of the process of acquiring a native prosody. Unfortunately, little is known about the developmental sequence that children follow in acquiring the other major, language-specific prosodic patterns, F_0 contours and amplitude patterns. There is again some reason to believe that children are quite sensitive to these other sources of prosodic information from early infancy and that this sensitivity may lead to productive use of prosodic cues in their vocalizations at an early age. Thus, with respect to F_0 contours, for example, Fernald (Fernald, 1985; Fernald and Kuhl, 1987) has shown that infants prefer the speech register known as "motherese" and that this preference is determined by the F_0 patterns of motherese rather than its amplitude or duration patterns. In terms of infants' productive use of intonation, we found (Whalen *et al.*, 1991) language-specific differences between French and American infants' F_0 patterns, as indicated earlier. Languages also differ in their typical amplitude patterns and how those patterns are linked to prosodic differences in F_0 and timing, but few studies of children's developing mastery of the syllable amplitude patterns of their native language have been conducted (*cf.* Allen, 1983; Tonkova-Yampol'skaya, 1973).

However, there is also some evidence to suggest that this sensitivity to and productive use of prosodic information may diminish around 9–10 months of age, when the child may begin to concentrate on developing the articulatory control to produce his/her first words. Best, Levitt, and McRoberts (1991) investigated the ability of infants who were either 6–8 or 10–12 months old to discriminate a prosodic contrast (questions *vs.* statements) in English (their native language) and in Spanish. The 6–8 month olds discriminated the prosodic contrast in both languages, whereas the 10–12 month olds failed to discriminate the questions from the statements in *both* Spanish and English. There was also some indication in the present data that the later reduplicative babbles of some of the French and American infants were somewhat less likely to show final-syllable lengthening than those produced at the beginning, despite the infant's longer exposure to the final-syllable lengthening patterns of his/her language at that point. Similarly, Boysson-Bardies, Sagart, and Durand (1984) found that listeners could discriminate French from Arabic babbling, but only from eight-month-old and not from ten-month-old infants. Finally, a recent study of five Italian infants between the ages of four and eight months by D'Odorico and Franco (1991) found that the infants use different vocalization types in different communicative contexts. These vocalization types are identified by the acoustic analysis of their prosodic features such as minimum and maximum F_0 and duration. However, the infants stop using these idiosyncratic, context-determined vocalizations at around nine months of age.

Once children have achieved sufficient articulatory control to begin to produce their first words, how then does their command of the prosodic characteristics of their language develop? Although not much research has been devoted to this question, some studies with young children learning tone languages suggest that children can reproduce tonal patterns more accurately than rhythmic patterns (Kirk, 1973) as well as more accurately than speech segments (Kirk, 1973; Li and Thompson, 1977). As indicated above, Allen (1983) and Smith (1978) have also provided some evidence of the way in which French and American children acquire some of the timing patterns of their languages. Our research suggests that infants may have an early start in learning some of the more global properties of the F_0 contours (Whalen *et al.*, 1991) and the syllable rhythm patterns of their native language, but much remains to be learned about the full developmental course that children follow in acquiring their native prosodies.

(Received August 13, 1991; accepted December 10, 1991)

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