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A precursor of language acquisition in young infants*

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Abstract

Four-day-old French and 2-month-old American infants distinguish utterances in their native languages from those of another language. In contrast, neither group gave evidence of distinguishing utterances from two foreign languages. A series of control experiments confirmed that the ability to distinguish utterances from two different languages appears to depend upon some familiarity with at least one of the two languages. Finally, two experiments with low-pass filtered versions of the samples replicated the main findings of discrimination of the native language utterances. These latter results suggest that the basis for classifying utterances from the native language may be provided by prosodic cues.

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The remarkable capacities of young infants for perceiving speech are well-documented (e.g., see Aslin, Pisoni, & Jusczyk, 1983; Kuhl, 1987 for recent reviews). For example, infants discriminate a wide variety of phonetic contrasts soon after birth (Bertoncini, Bijeljac-Babic, Blumstein, & Mehler, 1987; Eimas, Siqueland, Jusczyk, & Vigorito, 1971), and they are also able to cope with variations resulting from changes in intonation contours or talkers' voices (Kuhl, 1985). These speech perception capacities seem to have obvious relevance to the acquisition of language by providing the infants with a framework for organizing the linguistic input into categories. Such a perceptual framework serves to limit the space of possible hypotheses that the learner can entertain concerning the structure of the language being acquired (Chomsky, 1968; Morgan, 1986; Osherson, Stob, & Weinstein, 1984; Pinker, 1984; Wexler & Culicover, 1980).

A critical task for the infant acquiring language is to distinguish speech from the manifold array of noises that are present in the acoustic environment. Indeed, the infant will have to segregate sounds emitted from trucks, bells, machines, animals, and so forth from the class of sounds emitted by the human vocal tract. Even if such a classification were to be easily achieved by the infant, an additional problem must be solved. Namely, the infant must find some way to cope successfully with the variation that occurs in the speech signal as a result of changes in speaking rate, accents, talkers' voices, and so forth and yet do so in a way so as never to treat utterances from two different languages as belonging to the same language. The ability to segregrate utterances issuing from different languages is critical from the point of view of language acquisition. Learning a language requires mastery of the regularities that hold among its utterances. If utterances from several different languages are classified as belonging to the same language, then inappropriate generalizations may be drawn about the regularities that hold within the native language. At present, little is known about the ability of infants to detect the common identity of utterances issuing from the same language. Are the means to separate utterances in one language from another in place soon after birth or is a long period of familiarization with a particular language necessary?

To explore this issue, we have been conducting an extensive series of studies with 4-day-old French and 2-month-old American infants. The present paper provides a first report of our investigations. It relates our basic findings and presents some indication that they hold across different language backgrounds and test procedures.

Experiment 1

One indication that infants are able to group together utterances belonging to the same language would be if they could distinguish utterances in one language from those of another. However, it is not sufficient to show that infants discriminate a specific utterance in one language from one in another language because there is a myriad of differences (acoustic, phonetic, prosodic, etc.) that could support such a discrimination. Thus, even two different sentences from the same language could be discriminated on these bases. Consequently, what is required is that the infant be attentive to some identity that holds among utterances in a particular language despite any acoustic, phonetic or prosodic differences that exist among them. In other words, the infant must be able to classify together utterances from the same language on some basis that serves to differentiate them from utterances in other languages. For this reason, we decided to expose infants to a variety of utterances from one language and see whether they could detect a change to a variety of utterances in a second language.

A potential confounding factor in this type of study is that the infants might respond on some other basis than the change in languages. This could arise if different talkers were used to produce the utterances in the two languages, because previous studies have shown that infants are sensitive to changes in talkers (e.g., DeCasper & Fifer, 1980; Mehler, Bertoncini, Barriere, & Jassik-Gerschenfeld, 1978). One way of circumventing this potential confound is to have the same talker produce the utterances in the two languages. For this purpose we recruited a fluent bilingual speaker who spoke both languages without foreign accent (as judged by native speakers of the two languages) and at about the same rate. The talker who met these criteria was a French–Russian bilingual. We recorded speech samples from her in each of the two languages and presented these to 4-day-old French infants to see if they gave evidence of distinguishing French from Russian utterances.

Method

Subjects

The subjects were forty 4-day-old full-term infants from French monolingual families. The criteria for selection were that the infants weigh at least 2700 g, have a gestational age of 38 weeks or more, have an Apgar score of 10 five minutes after birth and have no known hearing deficit. The infants had an average weight of 3300 g (range: 2700 to 4070 g). In order to obtain 40 subjects, it was necessary to test 64. Infants were excluded for crying (4 Ss), failing to suck for three consecutive samples (16 Ss), and for failing to habituate within 30 trials (4 Ss).

Stimuli

A fluent French–Russian bilingual speaker tape recorded an oral account of some events in her life, once in French and once in Russian. The monologues in the two languages covered the same series of events. The speaker was not aware of what the speech samples were to be used for. From the tapes, 15 different samples with durations from 13 to 22 s were selected for each language. The samples from the two languages were matched as closely as possible for their overall durations and amplitudes. The overall mean durations for the French and Russian samples were 17.2 and 17.5 s respectively. Samples of speech were chosen to provide the infants with good indications of the prosodic characteristics of sentences in the two languages. For this reason, we were careful to select only samples that contained complete sentences. Thus, although the samples often contained several sentences, they always began and ended at a sentence boundary. For each language, a test sequence was prepared by randomly ordering the utterances and interspersing a 5-s silent interval between successive samples. This same sequence of samples was then recorded twice in a row to produce the test tape for the language.

Apparatus

All testing took place inside a specially equipped sound attenuated testing chamber at the Maternité Baudelocque (Hospital Cochin) in Paris. A sterilized blind nipple mounted on an adjustable mechanical arm and connected to a pressure transducer was used to record the infants' sucking responses. The pressure transducer was in turn connected to a series of electronic circuits and devices (specially designed by CEMI in Lyon) that were used to monitor and record sucking during the presentation of the speech sounds. Two Tandberg TD 20A tape recorders, a Scott 417A stereo amplifier and a Braun L 620 loudspeaker were used to provide the auditory output. An Apple computer was programmed to record and store the sucking rate to each sample and signaled the change from the first to the second phase of the test period.

Procedure

Ten infants were assigned randomly to each of four test conditions. Two of these were no language change control conditions: one consisted exclusively of Russian (Group RR) and the other of French (Group FF) samples. The other two groups were experimental groups. For one of these groups (FR), the infants heard French samples during the first phase of the test period, followed by Russian samples in the second phase. For the other group (RF), the Russian samples occurred first, followed by the French samples in the second phase. The stimulus samples were presented at an average sound level of 70 ± 2 dB SPL (approximately 15 dB above the background noise created by the ventilation system).

During testing infants were placed in a bassinet in a semi-reclining position facing a loudspeaker in the sound-attenuated chamber. After the pacifier was inserted in the infant's mouth, the threshold level of the suck counter linked to the pressure transducer was adjusted to yield sucking rates of between 25 and 35 sucks a minute. The adjustment to the threshold level was made in an effort to reduce the intersubject variability in sucking rates because of the large individual differences that exist in the amplitudes at which infants suck. A one-minute baseline period followed during which time sucking was recorded in the absence of any auditory stimulation. Up to this point, the procedure was identical to that of the HAS procedure (e.g., see Jusczyk, 1985b). During the two-phased test period that followed, each sample was presented in its entirety regardless of the infant's sucking behavior. Thus, unlike the typical HAS procedure, there was no contingency between sucking and the presentation of the speech samples.[1] Rather, the sucking method used here indexed the level of arousal exhibited by the infants during a period of stimulus presentation (e.g., see Bronshtein & Petrova, 1967). However, momentary fluctuations often occur in sucking rates. Given the short durations of our test trials (i.e., 13–22 s, equivalent to the durations of the samples), the variability introduced by these fluctations is apt to be aggravated over such short time spans. For this reason, sucking rates (sucks/min) were averaged over three consecutive samples. Habituation to the samples from the first language was measured on the basis of a decline in sucking rate. Because we wanted to give the infants ample exposure to samples in a particular language, the criterion for declination was not calculated until after the sixth samples occurred. From this point on, samples from the same language were presented until the sucking rate for a three-sample period declined by 33% from the maximum rate attained during a preceding non-overlapping three-sample period. Then the experimental groups heard samples from the other language, whereas the control groups continued to receive samples from the original language. This second phase lasted for nine samples.

[1]The problem with using a contingent sucking procedure like HAS is that the very contingency that it imposes upon sucking and sound presentation makes it impossible to ensure that infants will receive only completed sentences. Thus, using HAS in the present circumstances would often result in utterances that began somewhere in midstream and ended at a place other than a sentence boundary. In other words the prosodic flow would be extremely unnatural.

Results and discussion

The average sucking rates for the four groups did not differ during the baseline period ($F(3,36) < 1.00$). Next, the data for the test period were examined. Some interesting asymmetries were noted in the way in which the infants responded, suggesting that the native language may have a special status for them. Thus, during the first phase (Figure 1), sucking rates were significantly higher for infants listening to French (groups FF and FR) than to Russian (groups RR and RF) as verified by an ANOVA on the last nine samples of this phase ($F(1,38) = 7.47, p = .009$). Also, during the second phase of the experiment, only the RF group (Figure 2) displayed a significant increase in sucking relative to its RR control ($F(1,18) = 8.16, p = .01$). By contrast, the FR group did not differ significantly from its FF control ($F(1,18) < 1.00$).

One interpretation of these asymmetries is that 4-day-old infants not only discriminate the two languages, but also that they prefer to listen to French. The suggestion of a preference comes from the fact that, in the first phase, infants displayed greater arousal to the French than to the Russian samples (i.e., they sucked at significantly higher rates for French). Moreover, in the

Figure 1. *Displays the change in sucking rate for the last three blocks of three consecutive samples during the first phase of Experiment 1 for the infants who heard French (F) and the infants who heard Russian (R). The bars above and below each point indicate the standard error of the mean.*

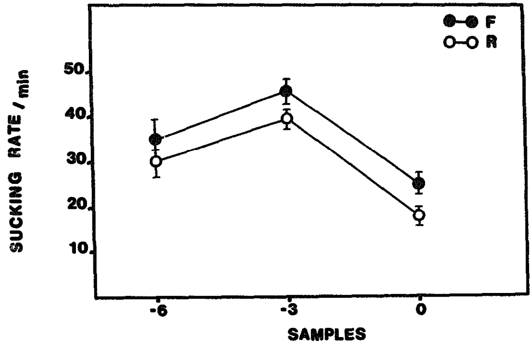
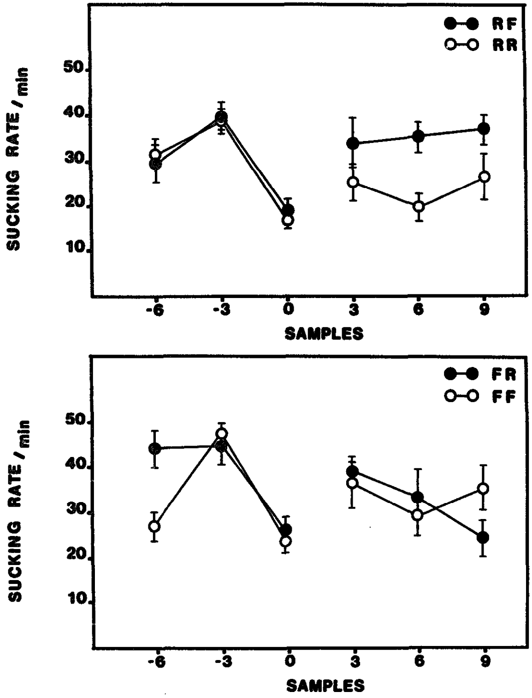


Figure 2. *The top panel displays the sucking rates of the infants who heard Russian during the first phase of Experiment 1. Group RF heard French during the second phase while group RR heard Russian. The comparable data for subjects who heard French during the first phase are shown in the bottom panel. Group FR heard Russian during the second phase while group FF continued to hear French. The bars above and below each point indicate the standard error of the mean.*



second phase, which began after they met the habituation criterion, the two experimental groups did not react to the language change in the same way. In the case of the RF group, the postshift stimulus is not only novel but from the preferred language, hence, sucking increases. However, for the FR group, the novelty effect for the change in language is offset by the fact that it is a change away from the preferred language.

Other explanations of the asymmetry are possible, but not very plausible to us. One possibility is that the noncontingent procedure was simply not sensitive enough to detect evidence of discrimination in infants going from French to Russian. However, this line of argument provides no account of the asymmetry itself, nor of the significant difference in sucking during the first phase of the experiment between those infants listening to French and those listening to Russian. A second possibility—that the discrimination results were simply a chance finding—cannot be ruled out definitively at this point (however, see Experiment 7).

Why do French infants have significantly higher response rates to French than to Russian samples? Is it because French is already familiar to them or is there some intrinsic property of the utterances themselves that would be attractive to infants of any culture, French or otherwise? For example, is there some characteristic property of French rhythm, prosody or phonological structure that is inherently attractive? An analysis of the samples indicated that the Russian utterances were spoken at a rate of 245 ($\pm$ 30) syllables per minute compared to 270 ($\pm$ 32) per minute in French.[2] Could a rhythmic difference of this sort have been responsible for the higher sucking rates to French samples? If so, then infants of any culture or language background should display the same sort of elevated responding in the presence of French samples. To explore this possibility, we conducted the following experiment.

Experiment 2

Every year in Paris there is a considerable number of infants born to foreign families—ones for whom the primary language spoken in the home is something other than French. Testing this group of subjects is one means of approaching the question of whether infants whose parents are not French speakers would also show greater arousal to French than to Russian samples.

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[2]This estimate assumes that even syllables which begin with long consonant clusters are to be counted as a single syllable. Halle (personal communication) notes that there are some grounds for counting syllables with long clusters as two syllables. If so, then the Russian rate should be increased from the estimate here, bringing it more closely in line with the French rate.

Method

Subjects

The subjects were twenty-four 4-day-old infants. The infants had an average weight of 3486 g (range: 3079 to 3892 g). Although these infants were born in Paris at the same maternity hospital, the primary language spoken at home was not French, but one of a diverse array of languages including Arabic, Portuguese, Spanish, Chinese, Indonesian, German, Polish, Italian and three African languages (Faong, Senegal, Togo). The infants were selected according to the same criteria as described in Experiment 1. In order to obtain the necessary number of subjects, 35 infants were tested. Infants were excluded for crying (2 Ss), failing to suck for three consecutive samples (8 Ss), and failing to habituate within 30 trials (1 S).

Stimuli

Same as described in Experiment 1.

Apparatus

Same as described in Experiment 1.

Procedure

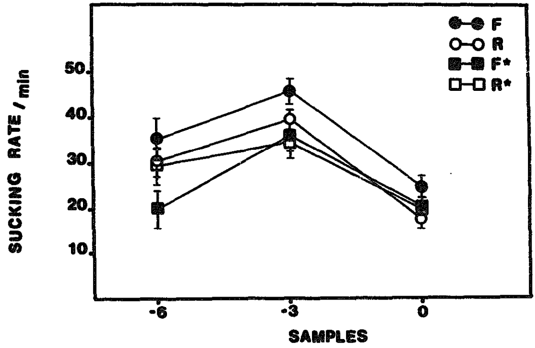
Six infants were randomly assigned to each of four test conditions: French–French (FF), French–Russian (FR), Russian–Russian (RR) and Russian–French (RF). In all other details, the procedure followed was the same as described for Experiment 1.

Results and discussion

Once again there was no evidence of significant differences among the groups for the baseline period ($F(3,20) = 1.38$, $p > .30$). However, in contrast to the previous experiment, the sucking rates registered during the test period provided no evidence that foreign infants discriminated the French and Russian samples. Thus, during the second phase, neither the FR group ($F(1,10) < 1.00$) nor the RF group ($F(1,10) < 1.00$) differed from its respective control group.

However, the most convincing evidence that foreign infants did not respond to the French samples as did the French infants comes from a consideration of the first phase data (Figure 3). The foreign infants listening to French sucked at rates comparable to French infants listening to Russian, rather than French infants listening to French. This observation is strongly confirmed by an ANOVA of a two (background: French vs. foreign) by two

Figure 3. *Displays sucking rates for the last three blocks of three consecutive samples during the first phase of Experiment 2 for infants from foreign speaking homes listening to Russian (R*) and to French (F*). For purposes of comparison, the data are also presented for the French infants in Experiment 1 who listened to the French (F) and the Russian (R) samples.*



(language: French vs. Russian) design performed on the combined data of Experiments 1 and 2. This analysis revealed a significant interaction ($F(1,60) = 5.86$, $p < .02$) directly attributable to the higher sucking rates manifested by French infants to French samples.

The data from the foreign infants indicate that it is not something intrinsic to the French and Russian samples that permit them to be discriminated. Rather, it appears infants must have some familiarity with a language in order to discriminate it from another. Moreover, the degree of familiarity required seems to be more than the occasional contact that foreign infants have with the French language. Nevertheless, the first two experiments only involved a comparison between French and Russian. It is difficult to know just how far one can generalize from this case to other languages. For this reason, we decided to investigate whether French infants might display some capacity to discriminate utterances from two different foreign languages. Not only would this extend our study to a new pair of languages, but it would provide a check on the results of the present experiment. Thus, one implication of the present results is that French newborns might not distinguish two foreign languages if some familiarity with at least one of the languages is necessary.

Experiment 3

In order to examine the ability of French infants to distinguish between utterances in two foreign languages, we recruited a new bilingual speaker who spoke Italian and American English fluently. As with our previous talker, this woman spoke the two languages without foreign accent and at about the same rate. She chose to orally recount several fairy tales in both languages while being tape recorded in a sound-insulated room. She had no prior knowledge of the nature of the experiment that we were planning. The test samples prepared from these recordings were then presented to a group of 4-day-old French infants to see whether they gave evidence of distinguishing the two languages.

Method

Subjects

The subjects were thirty-six 4-day-old infants from monolingual French homes. The infants had an average weight of 3332 g (range: 2948 to 3716 g). The infants were chosen according to the same birthweight and gestational criteria as in Experiment 1. In order to obtain the necessary number of subjects, 60 infants were tested. Infants were excluded for crying (8 Ss), failing to suck for three consecutive samples (15 Ss) and failing to habituate within 30 trials (1 S).

Stimuli

The stimuli were prepared in exactly the same way as for our French–Russian materials. Our bilingual speaker was tape recorded telling the same story in both English and Italian. From these tapes, 15 samples from each language were chosen. The mean overall durations of the samples were 15.0 and 15.1 s for the English and Italian respectively (the overall range was from 13 to 22 s). Once again, all samples began and ended at sentence boundaries. Test sequences for each language were prepared by randomly ordering the samples, interspersing a 5-s pause between samples, and recording the sequence twice in succession.

Apparatus

Same as in the previous experiments.

Procedure

Ten infants were assigned randomly to each of two experimental groups, English–Italian (EI) and Italian–English (IE). Eight subjects were randomly assigned to each control group, English–English (EE) and Italian–Italian (II). In all other respects, the procedure was the same as followed in the previous experiments.

Results and discussion

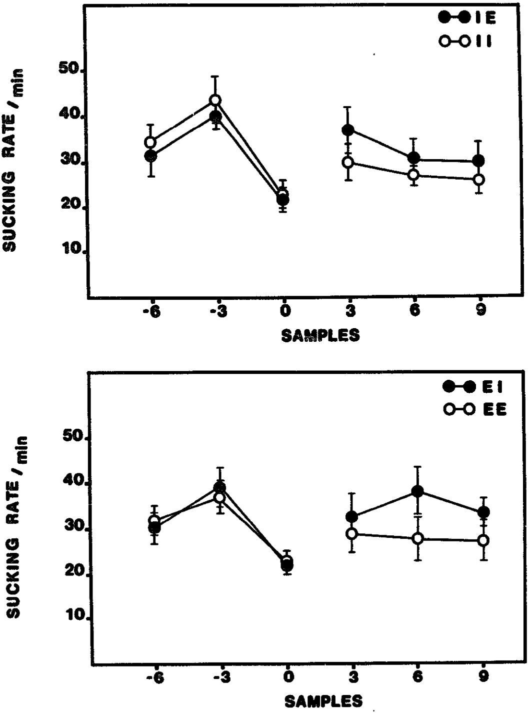
A check of baseline level responding revealed no significant differences among the four groups ($F(3,32) < 1.00$). The data were inspected for signs that one of the languages resulted in higher levels of sucking during the first phase of the experiment. No significant asymmetries in responding to the two languages were observed during the phase ($F(1,34) < 1.00$). Moreover, during the second phase (Figure 4), neither the IE nor the EI groups differed significantly from their respective control groups (IE vs. II, $F(1,16) = 1,11$; EI vs. EE, $F(1,16) = 1.45$). Hence, French 4-day-olds gave no evidence of discriminating English from Italian utterances.

Given the previous findings, one interpretation of the present results is that the ability to discriminate utterances from two languages depends upon some familiarity with at least one of the languages. However, some alternative explanations are also possible. For example, the fact that there was no evidence of discrimination in the present case need not be the result of a lack of familiarity with the two languages. Instead, perhaps the French infants failed because Italian and English utterances are somehow less discriminable than French and Russian ones. If this were the case, then we might expect that even infants who were familiar with one of the languages might have difficulty in discriminating English and Italian utterances.

Experiment 4

Was the failure of the French infants to distinguish English and Italian utterances a consequence of their lack of familiarity with the two languages or are these languages simply less discriminable? To explore these possibilities, as well as to examine the generalizability of our findings to other cultures and to different age groups, we decided to test American infants on both the French–Russian and the Italian–English contrasts. The first part of our investigation focused on the Italian–English contrasts. If it is the case that some familiarity with one of the languages is a prerequisite for discriminating it from another language, then American infants should have the necessary

Figure 4. *The top panel displays the sucking rates of the infants who heard Italian during the first phase of Experiment 3. Group IE heard English during the second phase while group II heard Italian. The comparable data for subjects who heard English during the first phase are shown in the bottom panel. Group EI heard Italian during the second phase while group EE continued to hear English.*



experience to discriminate the two languages. Alternatively, if the Italian–English contrast is simply more difficult than the French–Russian contrast, then they may be less able to distinguish the former as compared to the latter contrast.

Because facilities for testing 4-day-old American infants were not available to us at the time of testing, we decided to conduct our investigation with 2-month olds. This difference in age between American and French infants may appear to be a drawback. However, it provided us with an opportunity to detect possible developmental changes that might occur in older infants as a result of additional experience listening to a particular language. Developmental studies of speech perception in this age range have been relatively rare. The available data do suggest little in the way of perceptual changes during the first few months of life (but see Werker & Tees, 1984 for evidence of such changes between 8 and 12 months of age). Thus, Eimas et al. (1971) found no evidence of a difference in the way in which 1- and 4-month-olds responded to changes in voicing cues. Similarly, the report by Bertoncini et al. (1987) that newborns discriminate contrasts in place of articulation fits well with what has been observed for infants 3-months-old and older (e.g., Eimas, 1974; Morse, 1972). The one exception to this pattern comes from a paradigm that goes beyond the simple discrimination of two syllables and taps the capacity of infants to represent different syllables (Bertoncini, Bijeljac-Babic, Jusczyk, Kennedy, & Mehler, 1988). These researchers found some indication that 2-month-olds had finer grained representations of consonantal differences than did 4-day-olds. Given that the discrimination of two languages also requires infants to go beyond a simple discrimination of two syllables, the exploration of potential developmental differences seems worthwhile.

Although the HAS procedure works well with 2-month-olds (e.g., Jusczyk, 1985b), pilot work in our laboratory suggested that the sucking arousal method that we used with the 4-day-olds was not well-suited to testing infants at this age.[3] This led us to adopt a measure of "looking while listening" as an index of the infant's ability to distinguish the utterances in the two languages. The change in methods provided us with an additional opportunity to examine the generalizability of our results. To the extent that the same patterns of results obtain despite the different methods, we have powerful converging evidence that infants can discriminate one language from another.

[3]The problem is that because of the noncontingency between sucking behavior and the production of the sounds, there are great individual differences with respect to the 2-month-old infant's persistence in sucking during the course of the experiment. The individual differences with respect to willingness to suck tend to be reduced for a contingent procedure like HAS, but as we noted above (Footnote 1) this procedure does not allow for an uninterrupted presentation of the samples. For this reason, we chose the looking while listening method.

Method

Subjects

The subjects were 40 infants from monolingual English-speaking families. The infants averaged 10.7 weeks in age (range: 7.9 to 12.2 weeks). In order to obtain the necessary number of subjects, 110 were tested. Infants were excluded for crying (49 Ss), failing to habituate within 24 trials (13 Ss), sleeping (5 Ss) and failing to look at the display for two successive trials during the first phase (3 Ss).

Stimuli

The same Italian–English recordings were used as in Experiment 3. Only two slight modifications were made in preparing the stimulus tapes. First, for each language, we recorded a randomly ordered sequence of 12 stimulus samples (as opposed to all 15) twice in a row to prepare the stimulus sequence for the first phase of the experiment. The remaining three samples were held out for use as test stimuli. Only these three stimuli were recorded for use during the second phase of the experiment. This allowed us to present infants in the control groups with novel utterances from the same language that they had been listening to during the first phase of the experiment. The second change was a slight prolongation of the intertrial interval (ITI) to 7 s (as opposed to the 5 s used previously). The longer ITI seemed preferable given the change to a looking while listening procedure.

Apparatus

All testing took place inside a small sound-insulated room. Situated inside this room were an infant chair, a JBL(4301B) loudspeaker and an opaque projection screen. The opaque screen was situated just above the loudspeaker and included a small slit through which an experimenter in an adjacent room could view the infant. The equipment in the adjacent room included a stereo-amplifier, two tape recorders, a Kodak slide projector and a response box which was linked to a LSI 11/73 computer. The response box was used to record looking times which were stored on the computer. The computer was programmed with an algorithm to calculate the habituation criterion, and determined when testing advanced to the second phase.

Procedure

Infants were seated in the chair facing the projection screen. Parents were seated behind and out of view of the infant. The parents wore headphones and listened to recorded music during the test period. Two experimenters were situated in the adjacent room. One of them, the observer, looked through a small slit and pressed buttons on a response box to indicate the start and finish of each trial and when the infant was fixating on the picture projected on the screen. The observer was wearing headphones and listening to recorded music. In addition, she had no knowledge of the test condition to which the infant had been assigned. Thus, she was a blind (or, more accurately, deaf) observer. The second experimenter was responsible for assigning the infant to the appropriate test condition, operating the slide projector and tape recorders and for changing the stimulus set once the habituation criterion had been achieved. For some infants, a second observer was also used in order to provide a reliability check on judgments of fixation. The interobserver reliability scores were on the order of 90% agreement.

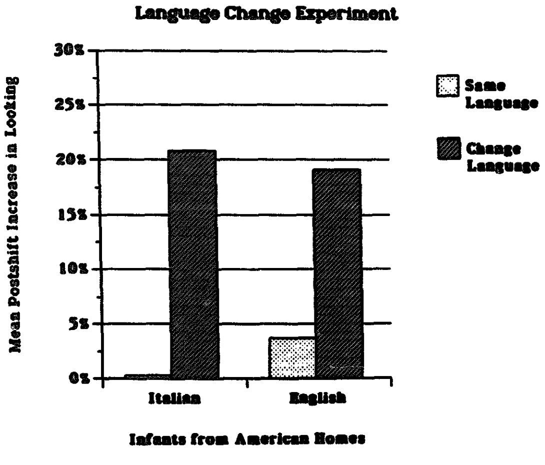
For all test trials, the sequence of events was the same. A slide of a woman was projected on the screen and remained on throughout the trial. The same slide was used for every trial; it never varied. At the end of a trial, the slide was extinguished and remained off for 7 s, at which time the next trial began. The onset and offset of the slide coincided with the auditory presentation of one of the speech samples. The observer was alerted to the start and termination of a trial by the switching on and off of the slide projector. She pressed different buttons to indicate when the infant was and was not looking at the slide during the trial. The computer calculated the percentage of the time for a given sample that the infant fixated on the slide.

During the first phase of the experiment, infants heard different samples from only one of the two languages (20 heard English and 20 heard Italian). The samples were presented at intensity levels comparable to those used for the French infants (i.e., 70 ± 2 dB SPL). The first phase lasted until the fixation time for a block of three consecutive trials declined by 50% from the longest time recorded for an earlier block of three consecutive trials. Then the second experimenter stopped the first tape recorder and started the second one. The second phase of testing began and lasted for three trials. During this second phase, half of the subjects (10 from each language group) heard three samples from the other language, whereas the remaining subjects served as controls and heard three new samples from the same language as before. Thus, as in Experiment 3, there were four test conditions: English–Italian (EI), English–English (EE), Italian–English (IE) and Italian–Italian (II).

Results and discussion

The data were examined to determine whether the groups differed in their fixation times during their initial exposure to the two languages, i.e., during phase one. A one-way ANOVA indicated no significant differences across

Figure 5. *Displays the mean percentage increase in looking for the postshift period for the experimental (change language) and control (same language) groups in Experiment 4. Note that the groups are designated according to which language (Italian or English) was presented during the first phase of the experiment.*



conditions in the time to habituate ($F(3,36) = 1.17$). Thus, there was no indication that the two languages differed in their initial impact upon looking times. Moreover, the control and experimental groups did not differ during the first phase of the experiment.

Discrimination of the utterances from the two languages was indexed using difference scores obtained by subtracting the average fixation time for the last three first-phase trials from that of the first three second-phase trials. The scores for each experimental group were compared to that of the appropriate control group (i.e., EI vs. EE and IE vs. II). In both instances (see Figure 5), the experimental group manifested significantly longer fixation times than the controls ($t(18) = 2.61$, $p < .01$ for IE vs. II and $t(18) = 2.11$, $p < .025$ for EI vs. EE).

Thus, 2-month-old American infants are able to discriminate English from Italian utterances. Because the same stimulus materials were used here as in Experiment 3, the failure of the French infants to distinguish the utterances from the two languages must be attributed to something other than the discriminability of the utterances themselves. A number of possibilities suggest themselves. First, as noted earlier, it may be the case that some familiarity with one of the two languages is necessary to be able to distinguish them. In this sense, the present results accord well with those of Experiment 1. In both cases, infants tested on a contrast between their native language and another language gave evidence of distinguishing utterances from the two languages. However, other explanations are also possible. For example, the infants in the present study were considerably older than the 4-day-olds in Experiment 3. Hence, it could be argued that the Italian–English discrimination is still a more difficult one than the French–Russian one, and that the greater maturity of the older infants brings with it some enhanced ability to detect such a difficult contrast. In other words, that as in the Bertoncini et al. (1988) study, we have uncovered additional evidence for developmental changes in speech processing during the first 2 months of life. A further possibility is that the looking while listening task is a more sensitive measure of discrimination than the sucking task used with younger infants. To explore these alternatives, we decided to conduct the following experiment.

Experiment 5

The notion that it was the greater sensitivity of the task or greater maturity of the 2-month-olds and *not* their familiarity with one of the languages that enabled them to discriminate English and Italian implies that these infants should also be able to distinguish the French and Russian utterances. In contrast, if familiarity with one of the two languages is necessary, then one would expect that American infants unfamiliar with either French or Russian should not be able to discriminate utterances from these two languages. For this reason, we decided to test a group of 2-month-olds on their ability to distinguish the French and Russian samples used in Experiments 1 and 2.

Method

Subjects

The subjects were 40 infants from monolingual English-speaking homes. All parents of prospective subjects were questioned to determine whether the infants had any occasion to listen to either Russian or French speakers. Only those infants without such prior exposure were tested. The infants averaged 10.1 weeks in age (range 7.8 to 12.1 weeks). In order to obtain the necessary number of subjects, 115 infants were tested. Infants were excluded for crying (55 Ss), failing to habituate within 24 trials (12 Ss), sleeping (4 Ss), and failing to look for two consecutive trials during phase one (4 Ss).

Stimuli

The same Russian and French materials employed in Experiments 1 and 2 were used here. The only difference was that the test tapes were prepared in the fashion described in Experiment 4. That is, for each language, a randomly ordered sequence of 12 samples was recorded twice in a row for use in the first phase of the experiment. The remaining three utterances from the language were recorded separately for use in the second phase. Thus, once again new utterances from either the familiar or novel language were always presented during the second phase.

Apparatus

The same apparatus was used as in Experiment 4.

Procedure

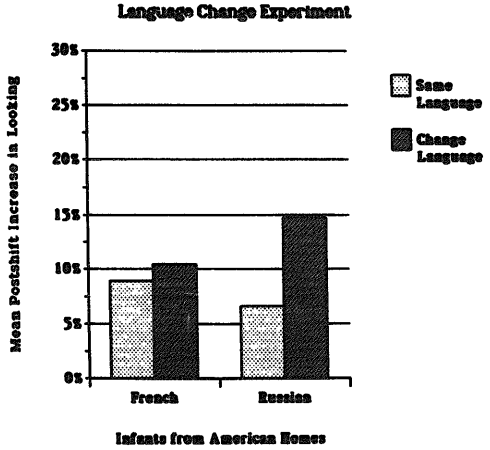
Ten infants were assigned randomly to each of four test conditions: French–Russian (FR), French–French (FF), Russian–French (RF) and Russian–Russian (RR). In all other respects, the procedure followed was identical to that in Experiment 4.

Results and discussion

Once again during the first phase of the experiment there was no evidence of significant differences in fixation times that resulted from listening to French versus listening to Russian ($t(38) = 0.35$). Nor were there any indications of differences between experimental and control groups in fixation times for the first phase.

Discrimination performance was analyzed using the difference scores obtained by subtracting the average fixation time for the last three trials of the first phase from that of the first three trials of the second phase (see Figure 6). In contrast to the previous experiment, neither experimental group differed significantly from its control in fixation time during the second phase of the experiment ($t(18) = 0.21$ for FR vs. FF and $t(18) = 1.28$ for RF vs. RR). Moreover, as with the English and Italian samples in the previous experiment, there was no evidence of significant asymmetries in responding to the French and Russian samples during the second phase. Hence, there

Figure 6. *Displays the mean percentage increase in looking for the postshift period for the experimental (change-language) and control (same language) groups in Experiment 5. Note that the groups are designated according to which language (Russian or French) was presented during the first phase of the experiment.*



was no indication that American infants discriminated the French and Russian utterances.

The present results appear to undercut the suggestion that the American infants' ability to distinguish the Italian and English samples was the result of either task or age factors. Were it simply a question of the kind of task used or the greater maturity of the 2-month-olds that permitted them to distinguish the English and Italian samples, then it is hard to understand why they did not discriminate the French and Russian samples given the ability of 4-day-old French infants to do so. Instead, the fact that the same overall pattern of results obtains for 2-month-old American infants tested with a different procedure provides converging evidence for the tentative conclusion that we drew regarding the results of the first three experiments. Namely, some familiarity with one of the languages is apparently necessary in order to distinguish it from another language.

Having shown that the young infant's ability to discriminate the native language from a foreign language generalizes to another culture and another language pair, it is necessary to discover the means by which this is accomplished. Thus, we can begin to ask about the information that the infant uses to make this distinction. The following three experiments address the issue of what sort of information is sufficient to allow the infant to distinguish the native language from another language.

Experiment 6

There are many ways in which languages differ with respect to their sound structure. For example, they may include different phonetic segments. They also may differ in their prosodic characteristics such as their rhythms or stress patterns. Because such differences are manifested directly in the acoustic stream of speech, one may question whether the source for the discriminative ability that we have noted is based upon some gross acoustic characteristics rather than on some coherent linguistic organization of the utterances. For example, in the present case, perhaps our talkers employed different pitch registers for each of the languages. More generally, we might ask if the infant could simply be responding to the appearance of certain spectral characteristics (e.g., such as the proportion of aperiodic to periodic noise) when discriminating the native language from another one. If so, then any permutation of the original input strings may suffice to allow the infant to distinguish ones derived from the native language from those of another language. Alternatively, it may be necessary that the acoustic cues preserve the essential patterning of spectral changes characteristic of utterances in the language in order for discrimination to occur.

One means of examining this issue is to present infants with the same overall variations in spectral energy that occurred in our speech samples, but to do so in a way inconsistent with the spectral changes associated with lawful utterances in the language. Playing the original stimuli backwards is one way of doing this. Manipulating the stimuli in this manner preserves their absolute spectral characteristics while distorting the direction of changes in a way inconsistent with the linguistic organization of the languages. To the extent that infants still discriminate the utterances derived from the native language from those of another language, it would indicate that some attention to gross variations in spectral energy are sufficient for this purpose. It seemed most reasonable to examine this issue with 4-day-olds because, by 2 months, one might expect that the exposure that infants have had to sentences in the native language may well have led them to develop expectations about the direction of spectral changes that occur in the language. Hence, any tendency to rely on overall spectral features seems most apt to show itself in the younger age group.

Method

Subjects

The subjects were thirty-two 4-day-old infants from monolingual French homes. The infants had an average weight of 3370 g (range: 2830 to 4060 g). The same birthweight and gestational criteria as in Experiment 1 were used in selecting subjects. In order to obtain the necessary number of subjects, 64 infants were tested. Infants were excluded for crying (9 Ss), failing to suck for three consecutive samples (21 Ss), failing to habituate within 30 trials (1 S) and equipment failure (1 S).

Stimuli

The same stimulus samples employed in Experiment 1 were used in the present study. The stimulus tapes were re-recorded backwards for use in the present experiment. In all other respects, the stimuli were identical to the original ones.

Apparatus

Same as described for Experiment 1.

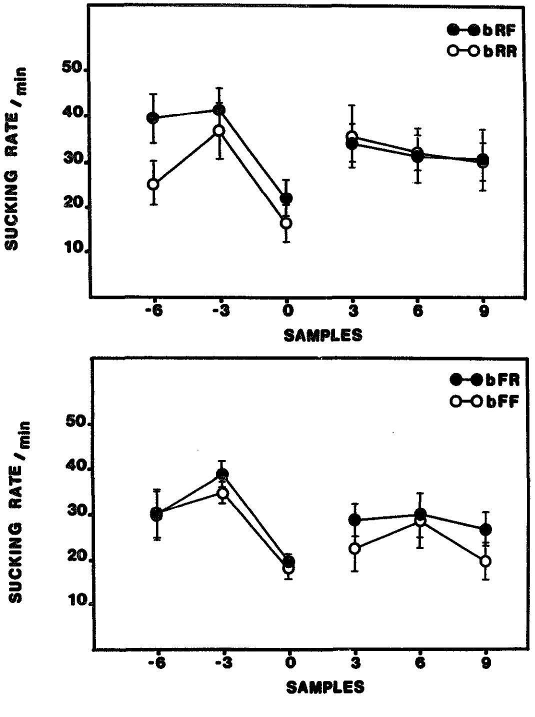
Procedure

Eight infants were assigned randomly to each of two experimental groups—backwards French–Russian (bFR) and backwards Russian–French (bRF) – and to each of two control groups—backwards French–French (bFF) and backwards Russian–Russian (bRR). In all other aspects, the procedure was identical to the one used in Experiment 1.

Results and discussion

A check of baseline level responding revealed no significant differences among the four groups. The data were inspected for signs that one of the two languages resulted in higher levels of sucking during the initial phase of the experiment. Unlike Experiment 1 wherein French samples produced significantly higher sucking rates, no significant differences ($F(1,30) < 1.00$) were observed in sucking rates during the first phase for the backwards French

Figure 7. *The top panel displays the results of the infants who heard the backwards Russian samples during the first phase of Experiment 6. Group bRF heard French during the second phase while group bRR continued to hear Russian. The comparable data for those infants who heard the backwards French samples during the first phase are shown in the bottom panel. Group bFR heard Russian during the second phase while Group bFF continued to hear French.*



versus the backwards Russian samples. Similarly, during the second phase of the experiment (see Figure 7), neither the bFR nor the bRF groups differed significantly from their respective control groups (bFR vs. bFF, $F(1,14) < 1.00$; bRF vs. bRR, $F(1,14) < 1.00$). Hence, the French 4-day-old infants gave no evidence of discriminating the backwards French and Russian samples.

The present results suggest that French 4-day-olds are basing their discrimination of French and Russian samples on something other than the simple presence of certain spectral features in the different language samples (e.g., more aperiodic noise in the Russian samples due to the greater number of fricatives present). Similarly, it is unlikely that some other global factor such as the ratio or distribution of pauses to speech provide the basis for discrimination of the different language samples. Nor could possible changes in pitch register associated with each language serve as a basis for discriminating the two languages since the same range of pitches was available in the backwards samples. Thus, it appears necessary that the patterning of the spectral changes be consistent with ones found in the native language in order for discrimination to occur.

Experiment 7

Given the suggestion that the cues for discriminating the native language from another may be closely tied to the particular patterns of spectral changes associated with utterances in the language, we can attempt to specify more precisely the type of information that the infant uses. There are a number of possibilities. With respect to their sound structures, languages differ in which sounds they include (i.e., their phonetic structure), the way these sounds can be ordered in utterances (i.e., phonotactic structure), and in their prosodic characteristics (e.g., rhythm, intonation and stress patterning). Potentially, any of these characteristics might serve to distinguish one language from another. However, there are some reasons for favoring the role of prosodic cues. First, the results of the preceding experiment suggest that it is not simply the presence of particular types of sounds in the input that is important (i.e., the existence of particular phonetic segments), but of some patterning consistent with the language structure (such as the phonotactic or prosodic features). Second, given that infants as young as 4 days old are able to discriminate the native language from another, it is not unlikely that prenatal exposure plays a role in the process. Certainly, recent studies appear to indicate that some speech information passes through the uterus to the fetus (e.g., DeCasper & Spence, 1986; Querleu & Renard, 1981; Vince, Armitage, Baldwin, Toner, & Moore, 1981). However, any speech information that does get to the fetus is greatly attenuated with respect to its intensity and frequency range (best estimates are that only information below about 800 Hz gets through). This means that much of the information necessary for distinguishing among phonetic segments is not available prenatally. However, some information regarding prosodic characteristics such as rhythm, stress and intonation may be preserved in the impoverished signal. Thus, the potential exists for prenatal exposure to the characteristic prosodic patterning of the native language. Consequently, we decided to investigate whether there is sufficient information in the prosodic characteristics of utterances to allow infants to discriminate the native language from a foreign one. To test this possibility, we created low-pass filtered versions of our original French and Russian samples and presented them to a new group of 4-day-old infants.

Method

Subjects

The subjects were thirty-two 4-day-old infants from monolingual French homes. The infants had an average weight of 3386 g (range: 3036 to 3766 g). The infants were selected according to the same birthweight and gestational criteria as in Experiment 1. In order to obtain the necessary number of subjects, 64 infants were tested. Infants were excluded for crying (6 Ss), failing to suck for three consecutive samples (20 Ss), sleeping (4 Ss), and equipment failure (2 Ss).

Stimuli

The same French and Russian samples used for Experiment 1 were low-pass filtered at 400 Hz for use in the present experiment. Stimulus tapes were prepared from the low-pass filtered versions of the samples. Because the filtering process reduces the overall amplitude of the signal, adjustments were made in the volume controls so that the stimuli could be played at the same loudness levels as in previous experiments (i.e., 72 ± 2 dB SPL). In all other respects, the stimuli were the same as those in Experiment 1.

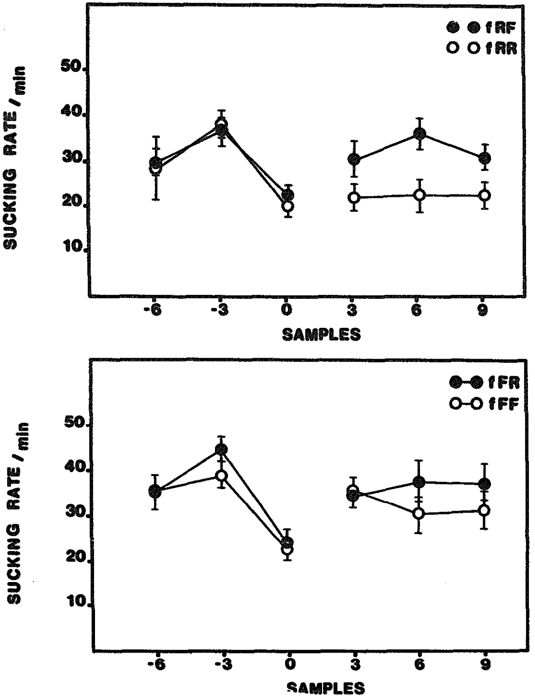
Apparatus

Same as that used in Experiment 1.

Procedure

Eight infants were assigned randomly to each of two experimental groups—filtered French–Russian (fFR) and filtered Russian–French (fRF)—and to each of two control groups – filtered French–French (fFF) and filtered

Figure 8. *The top panel displays the results of the infants who heard the low-pass filtered versions of the Russian samples during the first phase of Experiment 7. Group fRF heard French during the second phase while Group fRR continued to hear Russian. The comparable data for those infants who heard the filtered French samples during the first phase are shown in the bottom panel. Group fFR heard French during the second phase while Group fFF continued to hear French.*



Russian–Russian (fRR). In all other respects, the procedure was identical to that used in Experiment 1.

Results and discussion

There was no evidence of significant differences among the four groups in their baseline rates of sucking ($F(3,28) < 1.00$). The data for the first phase were then inspected for evidence that significantly higher sucking rates were associated with filtered versions of the native language, French, as opposed to the foreign language, Russian. In contrast to the findings of Experiment 1, the difference between French and Russian, although in the same direction, was not statistically significant ($F(1,30) = 2.10$, $p = 0.146$). However, the data from the second phase of the experiment (see Figure 8) did fully replicate those of Experiment 1. Namely, there was a significant increase in sucking for the fRF group relative to the RR control ($F(1,14) = 6.50$, $p < .02$), but no significant difference between the fRR group and the fFF control ($F(1,14) = 1.10$ $p > .30$). Thus, infants gave some evidence of discriminating the low-pass filtered versions of the utterances from the two languages.

Several comments about the data are in order. First, the data confirm the pattern of discrimination noted for the 4-day-olds in Experiment 1. Thus, the infants showed significant increases in sucking for changes from the foreign language to the native language, but not for changes in the opposite direction. Thus, this tendency survived even the drastic reduction of available speech information brought about by low-pass filtering the signal at 400 Hz. In contrast, the significantly elevated rates of sucking for the native language strings that we observed in the first phase of Experiment 1 was not reproduced. It is difficult to say whether the filtering is responsible for this or whether it is simply a consequence of random variation. Thus, it is possible that the filtering renders the speech uninteresting for the newborns, or perhaps it contains only some of the cues which they attend to in unfiltered speech samples. In order to gain a fuller understanding of the role of prosodic cues, we decided to test an additional group of American 2-month-olds on filtered versions of the Italian and English utterances.

Experiment 8

Methods

Subjects

The subjects were 48 infants from monolingual English-speaking families. The infants averaged 11.4 weeks in age (range: 9.3 to 12.1 weeks). In order to obtain the necessary number of subjects, 136 were tested. Infants were excluded for crying (63 Ss), failing to habituate within 24 trials (14 Ss), sleeping (4 Ss), and failing to look at the display for two successive trials during the first phase (7 Ss).

Stimuli

The same English and Italian samples employed in Experiment 4 were used to prepare the stimuli for the present experiment. Test tapes were prepared using a Krohn-Hite filter to low-pass filter the utterances at 400 Hz. The output levels on the playback equipment were adjusted to compensate for the loss of intensity caused by the filtering process. The stimuli were played to the subjects at loudness levels comparable to Experiment 4 (i.e., 70 ± 2 dB SPL). In all other aspects, the stimuli were comparable to those in Experiment 4.

Apparatus

Same as described in Experiment 4.

Procedure

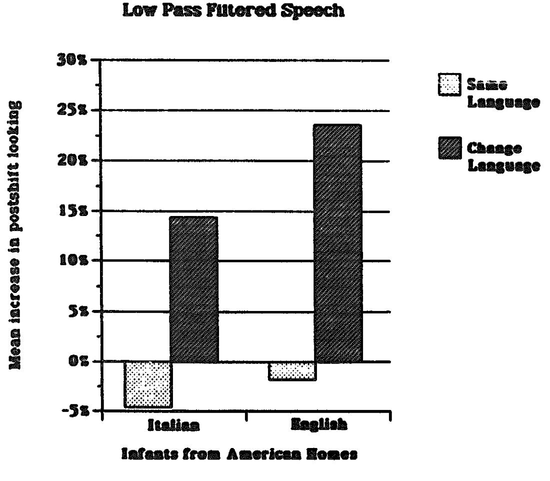
Twelve infants were assigned randomly to each of four test conditions: filtered English–Italian (fEI), filtered English–English (fEE), filtered Italian–English (fIE) and filtered Italian–Italian (fII). In all other respects, the procedure was identical to that followed in Experiment 4.

Results and discussion

The data during the first phase of the experiment were analyzed to determine whether there were any indications that the infants fixated longer while listening to the filtered samples from one language as opposed to the other. As was true for the unfiltered samples used in Experiment 4, there was no evidence of significant differences in fixation times while listening to the filtered English versus the filtered Italian samples ($t(22) = 1.25, p > .50$). Nor were there any indications of significant differences between experimental and control groups in fixation times for the first phase.

Discrimination performance was analyzed using the difference scores obtained by subtracting the average fixation time for the last three first-phase trials from that of the first three second-phase trials (see Figure 9). As in Experiment 4, both the fIE and the fEI groups displayed significantly longer fixation rates than their respective control groups during the second phase of the experiment (fIE vs. fII, $t(22) = 2.52, p < .01$; fEI vs. fEE, $t(22) = 4.15$, $p < .001$). Thus, the present results with the low-pass filtered samples com-

Figure 9. *Displays the mean percentage increase in looking for the postshift period for the experimental (change language) and control (same language) groups in Experiment 8. Note that the groups are designated according to which low-pass filtered language (English or Italian) was presented during the first phase of the Experiment.*



pletely replicate those obtained with the unfiltered versions in Experiment 4. Hence, the low-pass filtered versions of the utterances contain enough information to allow American infants to distinguish the English and Italian samples.

Taken together, the results of these last two experiments suggest that prosodic cues may be important in allowing the infant to identify utterances as belonging to the native language. Thus, even when most information about other types of cues is stripped away, the remaining prosodic cues are sufficient for distinguishing utterances from the native language. This is not to say that the infant might not be able to successfully discriminate the utterances on some other basis as well if the prosodic distinctions were neutralized in some way. Only further testing will be able to tell us whether the prosodic cues are absolutely necessary. In the meantime, the present findings demonstrate that prosodic factors must be given serious consideration in accounting for the way in which infants are able to identify utterances as belonging to their native language.

General discussion

Overall, these experiments show that infants, as young as 4-days-old, are able to discriminate utterances in their native language from those in an unfamiliar one. In contrast, when both languages were unfamiliar to them, the infants displayed no capacity to distinguish the utterances in one language from those in another. Moreover, the failure to distinguish the two unfamiliar languages is not simply due to their being less discriminable than the other contrast. This point is made forcefully by the fact that each type of language contrast was successfully discriminated by infants for whom one of the languages was familiar. Finally, the results of Experiments 7 and 8 with low-pass filtered speech samples suggest that there is enough information in the prosody to allow infants to distinguish the native languages strings from those of a foreign language.

One of the striking aspects of the present study is the fact that the overall pattern of findings holds across two different cultures, with infants of two different ages and under different test procedures. We recognize that questions can be raised about the wisdom of varying all these factors in the same study. However, what we find most striking about the data reported here is the fact that, despite the differences in age and in procedure, the same basic pattern emerges. Namely, a contrast involving a familiar language is detected, whereas one involving two unfamiliar languages is not. In this sense, the two different procedures can be said to provide converging evidence that the phenomenon reported is indeed a real one. Thus, the infant has an aptitude to classify together utterances from the language to which he or she is exposed (i.e., the native language). The only indication of any sort of developmental trend is that the older infants do not show a preference for the familiar language. This may arise for a number of reasons, including the methods used and the possibility that, at two months, the response to novelty may simply outweigh any preference for the native language.

As we noted earlier, the present study is only the first step towards understanding how the infant is able to classify utterances as belonging to the same language. Many aspects remain to be investigated before we can have a clear understanding of this process. For example, what is the source of the information that allows the infant to discriminate native language strings from foreign ones? The present study demonstrates that there is sufficient information in speech that is low-pass filtered at 400 Hz to discriminate the utterances. As noted earlier, attenuating the signal in this fashion, leaves the prosody intact while stripping away most of the distinctive phonetic information. Therefore, the results demonstrate that infants have the capacity to discriminate the utterances on the basis of their prosodic organization. The suggestion that attention to prosody may be important to discriminating the utterances fits well with other observations made regarding infant speech perception. For example, Fernald and Kuhl (1987) have shown that prosodic factors are an important determinant in the preference that older infants display for motherese over adult-directed speech. Similarly, it has been shown that certain discrimination results (e.g., recognition of the mother's voice from that of a stranger) cannot be obtained under conditions where the natural flow of prosodic is disrupted (Mehler et al., 1978).

However, we are *not* presently in a position to say that infants rely solely, or even principally, on prosodic information to distinguish intact native language utterances from foreign ones. It may very well be the case that a manipulation that neutralized prosodic differences, while leaving the phonetic structure intact, would also allow infants to distinguish utterances belonging to their native language. In other words, it may be the case that infants are also able to use phonetic differences as a basis for discriminating native language utterances from foreign ones. Certainly, the whole history of research on speech perception capacities demonstrates that young infants are remarkably sensitive to fine distinctions between phonetic segments, even those that exist in languages other than their native one (e.g., Aslin, Pisoni, Hennessey, & Perey, 1981; Lasky, Syrdal-Lasky, & Klein, 1975; Streeter, 1976; Werker & Tees, 1984). Thus, the present study shows only that the infants are capable of using prosodic differences for discriminating the languages. It does not rule out other possible sources for this capacity. Additional work is necessary to determine which, if any, other factors are reasonable bases for the discrimination ability noted here.

Moreover, even if the question regarding the importance of prosodic factors were to be resolved, a number of important questions would still remain concerning the precise nature of the information that the infant uses. For example, if attention to prosodic structure is the chief basis for the discriminative ability, then which aspect of prosody is critical? Is it the intonation contour, the stress pattern or something else? A closely related issue concerns the extent to which the ability observed here is tied to the native language. The present study only looked at four different languages, all of which are Indo-European. Would use of a wider set of languages produce the same type of results? It seems difficult to believe that the capacity to discriminate utterances from two different languages is so specifically linked to the native language. Hence, one might speculate that there are other languages that share in the same properties that infants use for discriminating the native language utterances from foreign language utterance.

Let us consider one such possibility. An often noted distinction in the prosodic organization of languages is the one between stress-timed and syllable-timed languages. Stress-timed languages are ones wherein the time between accented syllables is said to be approximately constant. In contrast, in syllable-timed languages, each syllable is presumed to have about the same duration. Consequently, if the infant were classifying utterances on such a basis one would expect that discrimination between a syllable-timed and a stress-timed language should be relatively easy compared to one, say, between two syllable-timed languages. In fact, the present pattern of results suggests that the important parameter is something other than one distinguishing stress-timed and syllable-timed languages. Russian and English are both considered to be stress-timed (e.g., see Cruttenden, 1986), whereas French and Italian are both syllable-timed languages.[4] This means that the same type of distinction was posed in each of our language pairings. Hence, if the stress-timed versus syllable-timed distinction were a sufficient basis for classifying the utterances, then both the French and American infants should have been able to distinguish both pairings. In fact, each group only distinguished the one involving the native language.

Although the present results appear to preclude a grouping of utterances based on a factor such as stress- versus syllable-timing, they do not rule out other such means of grouping languages into families based on their structural features. The notion that there are certain important parameters that distinguish groups of languages, and that language acquisition proceeds by setting certain parameters according to the input being received is not a new one (e.g., Chomsky, 1981). It is a proposal that merits serious consideration in the study of language acquisition and the paradigms employed in the present study may provide a means of gathering empirical data on it.

Similarly, a number of questions can be raised concerning the type of familiarization that is necessary with a language in order for it to be discriminable from another. The present study suggests that a long period of postnatal

[4]We note that there is considerable disagreement in linguistic circles over the validity of the stress-timed/syllable-timed distinction. Moreover, assumption that Russian is a stress-timed language is not universally accepted. Thus, it is sometimes claimed that Russian is more properly classified as a syllable-timed language. If this is the case, then the present study had one pairing involving two syllable-timed languages (i.e., French and Russian) and another involving a stress-timed (English) versus a syllable-timed language (Italian). However, recall that the French infants did not distinguish the English from the Italian utterances. Therefore, the main point—that the syllable-timed versus stress-timed distinction cannot explain our results—still stands.

experience is not necessary, as witnessed by the performance of 4-day-old French infants. However, it does not answer the question of whether any postnatal experience is required or whether the limited type of information available to infants prenatally (e.g., Querleu & Renard, 1981; Vince et al., 1981; Spence & DeCasper, 1987) is sufficient for this purpose. One way to examine this issue would be to test infants during the first day of life as a means of reducing the amount of postnatal exposure that they have to language. Research of this type is currently under way in our laboratory. In any case, whether the critical exposure to the native language occurs prenatally during the last few months of gestation or postnatally during the first few days of life, it is clearly something other than a learned behavior in traditional terms. Prenatally or within the first few days of life, there is little that could be construed as selective reinforcement or feedback for classifying utterances as belonging to the native language. Indeed, to say that our subjects have "learned" to classify utterances in this way does not bring us any closer to understanding the underlying mechanisms. Clearly, a great deal of biological prewiring must be in place to account for the precocity with which the infant groups together utterances from the native language. Indeed, the speed and facility with which infants detect characteristic features of the native language suggest an innately guided learning process (Gould & Marler, 1987). Thus, many other species appear to be genetically programmed to attend to specific cues in specific behavioral contexts. The well-known abilities of many bird species to fixate on certain physical characteristics in identifying members of their own species is a good example of this process. An even more pertinent parallel may be found in the song-learning behavior of swamp sparrows. Marler and Peters (1977) have shown that, although song input is necessary for song sparrows to learn the species-typical song, these birds are highly selective with respect to the kind of input that they will accept. In the realm of human behaviors, the highly specialized nature of linguistic processes and their predominant role in communication would seem to target them as likely candidates for innately guided learning processes. Indeed, the early competences which infants display in perceiving speech sound differences (e.g., Aslin et al., 1983; Kuhl, 1987) suggest a strong genetic component.

Attention to the early age at which infants discriminate native language utterances should not cause us to overlook possible developmental changes. As noted earlier, there is little evidence of developmental changes in basic speech perception processes over the first few months of life. In fact, the picture most often presented is one in which the young infant is portrayed as able to discriminate phonetic differences that could potentially occur in any language, and develops by focusing on only those contrasts that are relevant to the native language (e.g., Jusczyk, 1985a; Mehler, 1985). Evidence in support of this position comes from recent work demonstrating that at 6 months of age infants from English-speaking homes are able to distinguish foreign language contrasts, but by 12 months of age they do not (Werker & Tees, 1984). One suggestion as to what is happening is that as infants begin to acquire a vocabulary for recognizing words, they attend only to those differences relevant to distinguishing among words in the native language (Jusczyk, 1985a). In effect, the non-native language contrasts come to be ignored because they play no role in word distinctions in the native language.

How do the present results fit with what we know about the development of speech perception? The only suggestion of a developmental change in the present study was that there was an asymmetry in the discrimination results of the newborns (i.e., changes to the native language produced higher sucking rates, whereas changes to the foreign language did not) that did not occur for the 2-month-olds. Other than this, the main findings for the two age groups were the same despite the changes in procedure. We interpreted the difference in the two groups as attributable to the newborn's preference for the native language. However, to verify this, it would be wise to collect more data with a group of Russian infants at this age. Presumably, they, too, should show a preference, but this time for Russian over French. Similarly, if by 2 months of age, novelty effects offset the preference for the native language, then one would expect that not only would French and Russian infants display no preference for the native language strings, but neither would Italian infants.

Other than this, there were no apparent developmental differences in the ability to distinguish utterances from two languages.[5] Thus, neither age group discriminated contrasts between two foreign languages. However, this is not to say that there are no changes in this ability with increasing age and linguistic experience. In particular, if the ability to discriminate languages is not tied so specifically to the native language, but rather to a family of languages, then one would expect that the infant might become attuned to the differences among the various languages within the family. Evidence from the cross-linguistic studies (i.e., Werker & Tees, 1984) as well as some recent work looking at speech segmentation in long utterances (e.g., Hirsh-Pasek, Kemler Nelson, Jusczyk, Cassidy, Druss, & Kennedy, 1987; Jusczyk, Hirsh-Pasek, Kemler Nelson, Kennedy, Woodward, & Piwoz, submitted) suggests that a basic reorganization of speech perception processes may occur in the latter half of the first year of life.

[5]There is some suggestion that this ability may be stable at least through the first 5 months of life. Thus, Bahrick and Pickens (in press) found that 5-month-olds from the Miami area were able to discriminate Spanish from English passages.

In conclusion, although many details remain to be investigated, the present series of experiments demonstrates that infants as young as 4 days old are capable of distinguishing utterances from their native language from those of another language. This ability appears to be another indication of the way in which the infant comes biologically prepared to acquire language.

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Résumé

Deux groupes de bébés de communautés linguistiques différentes ont été testés sur leurs capacités à discriminer des séquences de discours spontané prononcées par un locuteur bilingue en deux langues différentes. Des nouveau-nés de quatre jours, français, sont capables de discriminer des séquences en français de séquences similaires en russe. Des nourrissons américains de deux mois ont manifesté un comportement similaire en présence de séquences en anglais et en italien. Cependant aucun groupe d'enfants ne montre de réponse de discrimination pour des séquences extraites de deux langues étrangères (français, russe pour les enfants américains; anglais, italien pour les nouveau-nés français). Ceci est également le cas pour des nouveau-nés étrangers nés en France, en présence d'énoncés en français et en russe. Ainsi pour discriminer des énoncés de deux langues différentes, une certaine familiarité avec l'une d'entre elles semble nécessaire. Enfin les nouveau-nés et les nourrissons ont également montré des réactions de discrimination pour des versions filtrées des énoncés. Ces derniers résultats suggèrent que les enfants pourraient classer les énoncés comme appartenant à leur langue maternelle sur la base d'indices prosodiques.