Perception, 1978, volume 7, pages 491-497

Infant recognition of mother's voice

Jacques Mehler, Josiane Bertoncini, Michèle Barrière
Centre d'Etude des Processus Cognitifs et du Langage, 54 Boulevard Raspail, Paris 6, France
Dora Jassik-Gerschenfeld
Laboratoire de Psychophisiologie Sensorielle, Université Pierre et Marie Curie, Paris, France
Received 29 July 1976, in revised form 31 October 1977

Abstract. Each of a group of one-month-old infants was reinforced, contingent upon nonnutritive sucking, with its mother's voice and the voice of a stranger. In this experiment, two conditions were applied. Under the first, the mother's speech was aimed at communicating with the infant, while, under the second, the mother's speech lacked prosodic and intonational aspects of normal speech. It was shown that infants will suck more for their mother's voices under the intonated condition only. It was concluded that a young infant prefers its own mother's voice provided the mother speaks normally.

1 Introduction

The capacity of very young infants to handle acoustic stimuli is an area which is beginning to be fairly well known. Eimas et al (1971), Moffitt (1971), and Morse (1972) have shown that these abilities extend into the phonological domain. Very young infants seem to perceive phonologically similar stimuli as belonging to categories which are quite like those employed by the adult language user. In addition, the boundaries between categories are determined in part by initial dispositions (Lasky et al 1975) and in part by the environment (Streeter 1976). Since the early work of Mattingly et al (1971), other authors have furthermore attempted to prove that initial dispositions may be specific to the language mode. Whatever the evidence for these claims may be, it must be pointed out that it has already been challenged. Recently, Cutting and Rosner (1974) and Jusczyk et al (1977) have found instances of categorical perception for nonspeech sounds. For instance, a sound wave with a rise time below 35 ms sounds like a plucked chord but is perceived as a bowed chord for longer rise times. Eimas (1975) showed that infants discriminate between stimuli sounding like /r/ and /l/ in linguistically motivated ways, i.e. they make the distinction if the relevant cues for categorization are present in the normal linguistic context and are not isolated. This experiment, furthermore, may have some importance in the understanding of the mechanisms for phonological growth. Morse (1972) demonstrated that infants between one and two months of age distinguish the acoustical cues for place of articulation and for rising or falling intonation in linguistically relevant ways.

Thus, though initial dispositions for classifying phonologically similar stimuli are well established in the very young infant, other equally relevant dispositions contributing towards language growth may also be present in infants even if they are less well known. For instance, some mothers claim that their infants are capable of recognizing their voices even when they are not in sight. Other mothers maintain that their infants are sensitive to changes in the intonational patterns of their speech. Some of our own pilot work in the area tends to confirm such intuitions. Furthermore, Miles and Meluish's (1974) work in the area having shown that very young children tend to respond to their mother's voices with greater sucking rates

than for other female voices, it would seem that there may be some way in which a young infant locks into its mother's speech through the recognition of her voice. Previously, other authors have made similar claims (Friedlander 1970; Kaplan and Kaplan 1971). However, as Eimas (1975) has pointed out, the evidence for recognition of the mother's voice or for reaction from the infant to suprasegmental aspects of speech must be considered at best as doubtful.

Our intention upon embarking on this study was to ascertain in greater detail whether the very young infant is capable of discriminating its mother's voice and if this was so, to question the nature of this capacity. In addition to the particular phonological system used by the speaker a number of other parameters can be used in this type of identification, including characteristic timbre and intonation. If infants recognize their mothers' voices in terms of these parameters then it is possible to ask whether such recognition can take place in the absence of proper intonational cues.

If the very young infant responds with greater interest to its mother's voice than to other voices, there may possibly be a mechanism which allows the infant to lock into linguistically relevant aspects of its acoustical environment. Furthermore, on the basis of the same mechanism and given that output of the vocal tract is for the most part linguistic, it might plausibly be argued that there is a difference between listening to phonological stimuli and listening to other types of acoustic stimuli.

The purpose of this study was therefore to reveal the role of intonation in recognition of the mother's voice. Each subject heard either intonated or nonintonated speech recorded either by its own mother or another infant's mother. It is our contention that the infant's sucking rate tends to increase when it hears its mother use intonated speech and to decrease when it hears a strange voice or, to be more precise, when a change in speaker takes place. When the infants hear nonintonated speech, we assume that responses will in any case be perturbed and that differences in sucking rate will be very slight.

2 Method

2.1 *Subjects*

Forty infants ranging from four to six weeks in age were tested in the course of this study. Infants were randomly assigned to one of four independent groups (see section 2.4). Each group was made up of ten infants with a mean age ranging from thirty-three to thirty-six days. In all, fifty-two infants were tested. Data for twelve infants were not included either because the infants fell asleep during the experiment or because they did not suck on the nipple for a long enough period of time. All the infants were obtained as a result of the cooperation of a group of pediatricians and the neonatal service of the Port Royal Maternity Clinic. None of the families who participated in the study were remunerated for their help although taxi fares to and from our laboratory were reimbursed.

2.2 *Stimuli*

The mothers of the infants tested made one recording of their voices lasting at least 1 min 40 s. The recording was made either with proper intonation or in a monotone. For the proper intonation, we asked the mothers to talk to their infants in their usual fashion. After having been instructed to speak as she normally did to her child, the mother was placed in a recording room before a microphone. Her infant was not with her but it was suggested that if she found herself short of material she should think about her normal daily activities with the infant (feeding, bathing, playing, etc). If she still had trouble in making her recording, one of the experimenters held the infant up in front of the window separating the recording

room from the experimental room. The only restraint placed on the mother was that she not address the infant by name or in any other fashion that might be familiar to it.

Recording instructions to mothers whose infants were tested with monotone speech were different. The mothers were asked to read word by word from the page of a book, proceeding from the bottom right-hand corner of the page leftwards and up one line at a time.

2.3 *Equipment*

A nonnutritive sucking technique was used: all infants were made to suck on a nipple that was connected to a pressure-transducing device. Output from the pressure transducer was cumulated in an integrator for which a threshold was established. Each time the integrator attained the designated threshold a timer was triggered for a duration fixed by the experimenter. We used this timer to trigger an Ampex AG-440-B tape recorder. Sound was transmitted through a Lansing JBL 77 loudspeaker. The sucks and their integration, the onset of the voice, and the duration of the reinforcements were all recorded on both a Schlumberger FM four-channel tape recorder and a Siemens Mincograph event recorder. On each trial a clock allowed us to measure the time between one reinforcement and the next and to calculate the sucking rate between two reinforcements. This is considered as a reliable indicator of the subject's degree of interest because the faster the infant sucked the more rapidly it would get to hear another fragment of speech.

Infants sat comfortably throughout the experiment in an orientable infant chair.

2.4 *Procedure*

Experimental procedure was as standardized as possible without jeopardizing the possibility of establishing a good rapport with the infant and its parent. Two experimenters participated in all tests. One of them took the infant on arrival and played with it in order to establish a relationship with it. In the meantime, the other experimenter questioned the parent in order to gather information concerning the infant's prenatal, natal, and postnatal situation. After this first step had been completed, one of the experimenters accompanied the mother to the recording room while the other one remained with the infant.

Mothers were asked to record their speech and were only shown their children if they had difficulty in making the intonated recording. It was hoped that the sight of the infant would trigger communicative responses if they did not come spontaneously. Once the recording was completed, experimentation began. All adults were kept out of the infant's line of vision during experimentation.

The experimental design took into consideration the two factors of interest to us: intonation and familiarity of voice. The two factors were carefully counterbalanced or crossed. Thus each one of the forty infants tested was assigned to one of the four experimental groups. The subjects in groups M and M′ were reinforced with their mothers' voices first and with the voice of a stranger afterwards. Each subject in the O and O′ groups received the stranger's voice first and then that of its own mother. Subjects in groups M and O heard recordings of well-intonated speech while subjects in groups M′ and O′ heard a tape recording of voices recorded in a monotone. Subjects in all groups could secure reinforcement by sucking on a nonnutritive nipple. Whenever the pre-established level of cumulative pressure was attained, 20 s of reinforcement were delivered over a loudspeaker. After five such reinforcements had been secured, and with no discontinuity, the nature of the reinforcement was changed from the sixth reinforcement on. Thus, in our design, intonation and familiarity with the speakers are factors that were completely crossed, i.e. we used a factorial design. Each infant participated in one and only one group.

Regardless of group, after the five initial reinforcements characteristic of that group, the sixth reinforcement was always different. No two infants were given the same strange voice in addition to that of their own mother.

3 Results

If we compare the sucking rate preceding the fifth reinforcement with that following the sixth, an important difference emerges in the responses of group M and group O. In fact, when the reinforcement changes, the medians in sucking rates are differently affected for the two groups. In figure 1, the medians corresponding to both groups, before and after the change in reinforcement, are presented. As can be seen, the infants in group O show a marked increase in their sucking rates when they hear their own mothers, after five reinforcements with the voice of a strange mother. Of course, such an increase in sucking rate might be due to the novelty of the reinforcer rather than to the nature of the novelty. However, such a view is not consistent with the responses that are observed when considering the group M infants. In fact, these infants respond to the change in reinforcer in a fashion that is almost the opposite of the one observed with the infants in group O. Although the change from a reinforcer that consists of speech by their mothers to speech by a stranger constitutes a novelty, infants in group M markedly decrease their sucking rate. Such a decrease may possibly result from a preference for their mothers' voices or from the fact that sucking is generally more intense when the infant hears its own mother rather than the voice of a stranger. In either case, the likelihood that the infant is reacting exclusively to the novelty irrespective of the nature of that novelty does not seem to be great in the light of these results.

Considering the infants who participated in groups M′ and O′, namely infants whose reinforcements always consisted of voices in monotone, we can try to assess the importance of intonation in the infants' responses. The results of infants in these groups are also presented in figure 1. When the mother's voice is normally intonated it is an efficient stimulus and leads to an increase in the infants' sucking rates. Furthermore, this voice maintains the sucking rate at a high level. The effect of the strange mothers' voices is not objectively as effective in increasing the infants' sucking rates nor in sustaining their intensity.

If under reinforcement with normally intonated speech the reactions to voice change show marked variations according to group, in the monotone condition there is almost no difference between the groups. Overall, the sucking rates are slightly lower when sucking was reinforced by monotones than when it was reinforced by

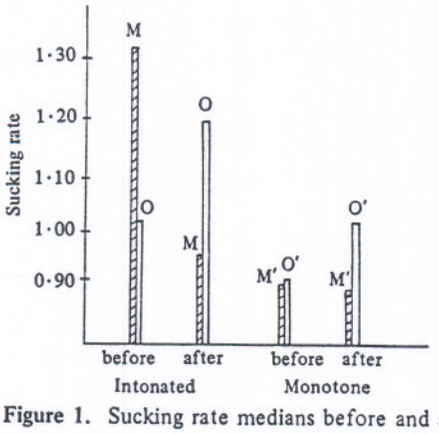

Figure 1. Sucking rate medians before and after change in reinforcement.

properly intonated speech. It would thus seem that monotone reinforcements do not have the same behavioral consequences as properly intonated speech. If we look at figure 1, no noticeable difference between groups O′ and M′ appears readily observable, though for group O′ there is a slight increase in sucking rate when the reinforcement changes. This result might suggest a slight recognition of the mother's voice even in a monotone.

A Student t test was carried out upon each of the groups to establish whether the differences in sucking rates before and after the voice change were statistically significant. Groups O and M yielded $t = 1{\cdot}84$ ($p < 0{\cdot}10$) and $t = 2{\cdot}06$ ($p < 0{\cdot}10$) respectively. Because of the high intersubject variability that is inherent in research with infants, these figures can be considered as resulting from significant differences.

Insofar as groups M′ and O′ are concerned, no such differences seem to emerge. Variations in sucking rate are so slight that they fail to induce any significant differences. In fact, the ts for groups O′ and M′ were $t = 1{\cdot}63$ and $t = 0{\cdot}80$ respectively. From these results it may be argued that when voices are presented in monotone an infant does not respond differentially to the voice of its own mother in contrast to the voice of another mother.

However, before we draw any conclusions it may be interesting to analyze subjects' behavior in the four groups. In order to evaluate the individual response incidence we have used a nonparametric (Mann–Whitney U) test because such a test provides us with an overall comparison of the groups, depending on the subjects' reactions to the voice change. In fact, for groups O and M $U = 17$, which puts the difference between the groups at $p < 0{\cdot}02$. Hence, we tend to accept the fact that the behavior of the subjects in group M is different from that of the subjects in group O when the change in voice intervenes. This confirms our expectation concerning recognition of the mother's voice in intonated speech. On the other hand, for the monotone speech our $U = 28$ ($p > 10$) and leads us to retain the hypothesis whereby groups M′ and O′ are drawn from the same population and do not differ significantly in their sucking rate variations following the voice change. This appears to confirm the hypothesis that intonation plays a crucial role in the recognition of a voice by an infant. In table 1 we present the number of infants that increased, decreased, or did not alter their sucking rates. We used two different scoring criteria. In the overall scoring criterion we counted all changes between that preceding the fifth reinforcement and the one following the sixth reinforcement, regardless of magnitude. Under the minimal-change criterion we scored only those infants whose variation in sucking was at least 15%. That is, if an infant's rate of sucking changed by less than 15% after the change of voice, we classified that infant as neutral. We used these two criteria more for methodological reasons than anything else since the overall significance of the results does not change very much. In fact, if we take the minimal-change criterion and ignore those infants who are neutral[1] we see in table 1 that for group M five infants decreased their sucking rates while one increased its rate. For group O five infants increase their sucking rates while none decrease theirs. This result is significant by $p < 0{\cdot}02$ on Fisher's exact probability test. If the overall criterion is used, the results are similar in that for group M two infants increased their sucking rates while eight decreased theirs. Exactly the reverse is obtained for group O. This distribution allows us to reject the hypothesis at $p < 0{\cdot}05$.

[1] Only the infants that react at the point where the voice changes are of interest to us. Those who do not react may be infants who were distracted, or infants who for some reason or another do not have discriminative response to the change. For the purposes of our hypothesis it is sufficient that the number of infants who demonstrate a discriminative response is greater than what could be reasonably attributed to pure chance.

The use of the minimal-change criterion leads us to consider almost the whole of groups M′ and O′ as neutral. In the overall-scoring criterion we obtained no crucial difference between the increases and the decreases in both groups. Obviously, neither of these scoring criteria leads to a difference between groups O′ and M′ for the monotone speech.

Table 1. Effects of change in reinforcement on sucking rates; + indicates increase, - indicates decrease, and 0 indicates no change.

	Group O			Group M			Group O′			Group M′		
Sucking rate	+	-	0	+	-	0	+	-	0	+	-	0
Scoring criterion												
overall	7	3	-	2	8	-	7	3	-	3	6	1
minimal-change	5	0	5	1	5	4	2	0	8	-	1	9

4 Discussion

The results presented above support the view that thirty-day-old infants under some conditions distinguish their mothers' voices from other female voices. However, it appears that in order for this to be so the mother's voice must be properly intonated. If the mother reads word by word from a page in a book in such a way that there is no intonation in her speech, the child apparently does not manifest a discriminative response at the onset of its mother's voice or to the substitution of the nonintonated voice by that of a stranger. But when the mother speaks in her usual fashion her speech is not only intonated but also addressed directly at the infant. Our experimental design does not allow us to distinguish the respective roles of these two main parameters.

In an earlier and incomplete report of some of these data Mehler et al (1976) have shown the mean sucking rate of the infants for each one of the successive reinforcements. It appears quite clear from these data that the rates are not particularly smoothe. For instance, in group O a sizeable increase in sucking rate for the fifth reinforcement may underlie the important change that is observed for the sixth reinforcement. Be this as it may, the method employed in this experiment is one in which rate is used more as an indicator of the infants' level of activation than (as is usually done) as an indicator of operant response.

From the results it thus appears quite clear that there are changes in the infants' activation levels from reinforcement to reinforcement but that the only fluctuations that may be significant are those that intervene when there is a change of stimulation. The nature of the change in response, however, does not allow us to conclude that the infants are motivated by fatigue. In fact, even though the infants in group M decrease their sucking rates, the infants in group O tend to increase theirs in response to a switch in voice. Such a result must be viewed as indicating a preference for the mother's voice or at any rate a higher level of activation in response to the mother's voice than to the strange voice. Furthermore, the results of groups O′ and M′ show that infants respond in the above-mentioned fashion if and only if their mothers' voices are properly intonated. However, it is difficult to say whether or not the characteristic cue for the infant comes exclusively from the intonation factor or not. In fact, we have noticed in the course of the many recordings that have been made in our laboratory that recordings of properly intonated speech provide a higher tone of voice. Whether this change in fundamental frequency is one of the parameters to which the child responds or not must be carefully evaluated. This being said, it is clear that the lower part of the spectrum

carries the fundamental frequency constituting that aspect of the voice that could best be received by the organism in utero. A pilot experiment which we conducted, and in which we tested fifteen infants with the first 500 Hz filtered out of the mother's voice, demonstrated no discriminative response to the change. However, negative results, particularly when small populations are concerned, must be treated with great caution. If future research still fails to reveal discrimination with the lower portion of the acoustical spectrum filtered out, then it might be concluded that infants use a great many parameters at once in discriminating their mothers' voices and are hence confused when any one of these is obstructed.

Finally, we should like to add that intonation, as some authors have already claimed, is perhaps a crucially important parameter in the construction of the first structures of the speech environment. Such a view has been upheld by Weir (1962) and Kaplan and Kaplan (1971). Our work certainly indicates that infants may be sensitive to such a parameter but only further research will demonstrate how it operates.

Acknowledgements. We would like to thank Dr Varangot and his team of the Maternité de Port Royal and most particularly Dr C Amiel and Mademoiselle Pacquet for their very valuable cooperation. We are also grateful to Dr Aldo Naourri who gave us the benefit of his long experience as a pediatrician and provided us with much valuable advice in dealing with young infants. We thank the Centre d'Electronique et de Mini Informatique in Lyons for having constructed the system for registering and analyzing the suction of the newborn infant. We are particularly grateful, moreover, to Professor Marc Jeannerod, who was instrumental in designing this equipment and who has constantly provided valuable suggestions and help. This research was made possible by the support of the Institut de Recherche et Coordination Acoustique et Musicale, the Harry Frank Guggenheim Foundation, and CNRS ATP 1432 and 1968.

References

Cutting J E, Rosner B S, 1974 "Categories and boundaries in speech and music" *Perception and Psychophysics* 16 564–570

Eimas P D, 1975 "Auditory and phonetic coding of the cues for speech: discrimination of the ($r-1$) distinction by young infants" *Perception and Psychophysics* 18 341–347

Eimas P D, Siqueland E R, Jusczyk P, Vigorito J, 1971 "Speech perception in infants" *Science* 171 303–306

Friedlander B Z, 1970 "Receptive language development in infancy: issues and problems" *Merrill-Palmer Quarterly* 16 7–52

Jusczyk P, Rosner B S, Cutting J E, Foard C, Smith L, 1977 "Categorical perception of nonspeech sounds in the two-month old infant" *Perception and Psychophysics* 21 50–54

Kaplan E, Kaplan G, 1971 "The prelinguistic child" in *Human Development and Cognitive Processes* Ed. J Eliot (New York: Holt, Rinehart and Winston) pp 358–381

Lasky R E, Syrdal-Lasky A, Klein R E, 1975 "Vot discrimination by four and six and a half month old infants from Spanish environments" *Journal of Experimental Child Psychology* 20 215–225

Mattingly I G, Liberman A M, Syrdal A K, Halwes T, 1971 "Discrimination in speech and non speech modes" *Cognitive Psychology* 1 131–157

Mehler J, Barrière M, Jassik-Gerschenfeld D, 1976 "La reconnaissance de la voix maternelle par le nourrisson" *La Recherche* 70 786–788

Miles M, Meluish E, 1974 "Recognition of mother's voice in early infancy" *Nature (London)* 252 123–124

Moffitt A R, 1971 "Consonant cue perception by twenty to twenty-four-week old infants" *Child Development* 42 717–731

Morse P A, 1972 "The discrimination of speech and nonspeech stimuli in early infancy" *Journal of Experimental Child Psychology* 14 477–492

Streeter L A, 1976 "Language perception of 2 month old infants shows effects of both innate mechanisms and experience" *Nature (London)* 259 39–41

Weir R H, 1962 *Language in the Crib* (The Hague: Mouton)