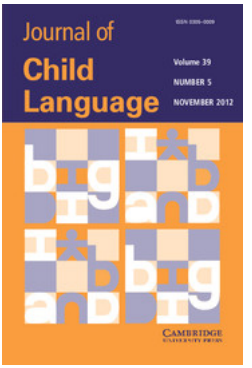

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Journal of Child Language / Volume 16 / Issue 03 / October 1989, pp 477 - 501
DOI: 10.1017/S0305000900010679, Published online: 17 February 2009

J. Child Lang. **16** (1989), 477–501. Printed in Great Britain

A cross-language study of prosodic modifications in mothers' and fathers' speech to preverbal infants*

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(*Received* 7 *July* 1988. *Revised* 7 *May* 1989)

ABSTRACT

This study compares the prosodic modifications in mothers' and fathers' speech to preverbal infants in French, Italian, German, Japanese, British English, and American English. At every stage of data collection and analysis, standardized procedures were used to enhance the comparability across data sets that is essential for valid cross-language comparison of the prosodic features of parental speech. In each of the six language groups, five mothers and five fathers were recorded in semi-structured home observations while speaking to their infant aged 0;10–1;2 and to an adult. Speech samples were instrumentally analysed to measure seven prosodic parameters: mean fundamental frequency

[*] This study is dedicated to Charles A. Ferguson. The research was supported by John D. and Catherine T. MacArthur Foundation Network on the Transition from Infancy to Early Childhood, and by a grant from the National Institutes of Health (MH 41511) awarded to the first author. For assistance in data collection and analysis, we are especially grateful to Catherine Durand, Elizabeth Kortlander, and Louis Moses. Address for correspondence: Anne Fernald, Department of Psychology, Stanford University, Stanford, CA 94305, USA.

(f_0), f_0-minimum, f_0-maximum, f_0-range, f_0-variability, utterance duration, and pause duration. Results showed cross-language consistency in the patterns of prosodic modification used in parental speech to infants. Across languages, both mothers and fathers used higher mean-f_0, f_0-minimum, and f_0-maximum, greater f_0-variability, shorter utterances, and longer pauses in infant-directed speech than in adult-directed speech. Mothers, but not fathers, used a wider f_0-range in speech to infants. American English parents showed the most extreme prosodic modifications, differing from the other language groups in the extent of intonational exaggeration in speech to infants. These results reveal common patterns in caretaker's use of intonation across languages, which may function developmentally to regulate infant arousal and attention, to communicate affect, and to facilitate speech perception and language comprehension. In addition to providing evidence for possibly universal prosodic features of speech to infants, these results suggest that language-specific variations are also important, and that the findings of the numerous studies of early language input based on American English are not necessarily generalisable to other cultures.

INTRODUCTION

In his influential comparative study of 'baby talk in six languages', Ferguson (1964) called attention to the special speech register used by adults in widely different languages when addressing infants and young children. Since the publication of that paper 25 years ago, numerous studies have validated and extended the list of features of child-directed speech observed by Ferguson, including the simplification of syntactic and semantic structure (e.g. Snow, 1972), special discourse features (e.g. Cross, 1977), and the use of exaggerated prosody (e.g. Garnica, 1977). However, while many of these characteristics of speech to children have now been extensively documented in American English samples, Ferguson's cross-linguistic perspective has not been widely adopted in research on language input. As a consequence of this anglocentric bias in the research literature, current models of the structure of early linguistic input and its relevance to language development may be unduly influenced by observations of child-directed speech which could turn out to be peculiar to English. Extensive cross-linguistic research is clearly needed in this area, in order to establish a legitimate data base which will both sustain and constrain generalizations about the role of the linguistic environment in early development. As a contribution to this long-range goal, the present study compares the prosodic modifications in mothers' and fathers' speech to preverbal infants in six languages: French, Italian, German, Japanese, and British and American English.

The cross-linguistic method has been used productively in research on

language acquisition to reveal both uniformities across languages and language-specific developmental patterns (Slobin, 1985*a*). Although language input has been much less systematically studied from this comparative perspective, cross-language data on speech to children can provide valuable information about features of the early linguistic environment which are culturally widespread as well as those which are specific to particular language communities. Just as comparative data on children's early productions have informed the debate on cognitive prerequisites for language development (Slobin, 1985*a*), the study of common input features across languages is potentially relevant to hypotheses about the role of child-directed speech modifications in facilitating acquisition. For example, evidence for prosodic universals in language input could provide indirect support for recent claims about innate perceptual and cognitive predispositions influencing language acquisition. Both Slobin (1973, 1985*b*) and Peters (1983) have proposed 'operating principles' that bias the child to attend selectively to perceptually salient stretches of speech. Similarly, Gleitman & Wanner (1982) argue that infants are predisposed to attend to stressed words, and that the stress-nonstress distinction provides the learner with an effective initial strategy for extracting relevant information from the speech stream. Both of these claims would seem to rest on the assumption that language input is to some degree organized so as to match the infant's perceptual biases, i.e. to provide important linguistic information in positions of perceptual prominence. To the extent that the exaggerated stress patterns of child-directed speech serve to enhance the acoustic salience of lexical and syntactic units (e.g. Fernald & Simon, 1984; Morgan, 1986), then comprehension could be further facilitated for the infant equipped with such initial processing biases. These arguments for language-independent perceptual and attentional predispositions could lead to the prediction of certain cross-linguistic uniformities in language input at the level of prosodic structure.

The use of a prosodically distinctive register in speech to children has been reported anecdotally in a wide variety of languages, including Arabic (Ferguson, 1964), Spanish (Blount & Padgug, 1976), Marathi (Kelkar, 1964), Latvian (Ruke-Dravina, 1976), and Sinhala (Meegaskumbura, 1980). However, the prosody of child-directed speech has received systematic acoustic analysis only in American English (e.g. Garnica, 1977; Stern, Spieker, Barnett & MacKain, 1983), British English (Shute & Wheldall, 1989), German (Fernald & Simon, 1984; Papousek, Papousek & Haekel, 1987), and Mandarin Chinese (Grieser & Kuhl, 1988; Papousek & Papousek, in press). These studies reveal that mothers use higher fundamental frequency (f_0), or pitch, wider f_0-excursions, shorter utterances, longer pauses, and more prosodic repetition in speech to infants than in speech to adults. Instrumental analyses of the prosody of male speech to children show that fathers also use

special intonation patterns with infants (Menn & Boyce, 1982; Papousek *et al.* 1987; Warren-Leubecker & Bohannon, 1984), as do male and female adults inexperienced with children (Jacobsen, Boersma, Fields & Olson, 1983), although these findings are limited to American English and German. Such observations from diverse cultures and subject populations have been cited as evidence for the universality of prosodic modifications in speech to infants and young children (Ferguson, 1977, 1978; Papousek, Papousek & Bornstein, 1985).

There are also a number of apparent exceptions to this trend which must be considered in evaluating the universality hypothesis. Three studies report that no special prosodic register is used in speech to infants: among the Kaluli of New Guinea (Schieffelin, 1979), among Quiche-Mayan-speaking mothers in Guatemala (Ratner & Pye, 1984), and in rural black families in North Carolina (Heath, 1983). However, two problems typical of these studies make it difficult to interpret their negative findings. The first concerns the limitations of the data and experimental design. The Schieffelin and Heath studies used no acoustic analysis measures to substantiate their claim that the prosodic characteristics of adult speech are not modified in speech to infants. While Ratner & Pye base their similar claim on an instrumental analysis of audio recordings, they acknowledge that this analysis was *post hoc* and that their tapes were not of optimal quality. Furthermore, their sample of infant-directed speech consisted of only 20 utterances each from three Quiche-Mayan and two American subjects.

A second interpretative problem concerns the customary use of prosodic registers for other sociolinguistic purposes in two of the cultures observed. Ratner & Pye (1984) mention the high-pitched deference register used by Quiche-Mayan adults to show respect for the addressee, which could account for the unusually high mean-f_0 in their adult–adult speech sample. It is important to note that the absolute f_0-level reported for Quiche-Mayan speech to infants is in fact HIGHER than the mean-f_0 reported for English motherese in the same study, and comparable to the mean-f_0 reported by other investigators for motherese in English (e.g. Garnica, 1977), German (Fernald & Simon, 1984; Papousek *et al.* 1987), and Chinese (Grieser & Kuhl, 1988; Papousek & Papousek, in press). Ratner & Pye's failure to find a RELATIVE difference between infant- and adult-directed Quiche-Mayan speech could reflect a ceiling effect due to the use of raised pitch to express deference in that culture. Among the Kaluli, Schieffelin (1979) reports that while mothers do not address their infants directly, they frequently speak 'for' the infant in a high-pitched voice. This Kaluli practice may in some respects be functionally equivalent to speaking motherese, providing the infant with prosodically salient auditory input. In any case, since it appears that both Quiche-Mayan and Kaluli mothers are, in fact, speaking in high-pitched voices with their infants, it seems premature to conclude that there are no prosodic modifications in child-directed speech in these cultures.

The only conclusion to be drawn from these diverse findings is that the question of the universality of prosodic modifications in child-directed speech is unresolved. Furthermore, the resolution of this controversy cannot be achieved through comparisons across single-language studies which rely heavily on anecdotal report, small and heterogeneous samples, and non-standardized observational procedures, and which fail to take into account other relevant sociolinguistic influences on the uses of prosody in different cultures. A central goal of the study reported here was to provide a substantial data base obtained using standardized procedures for data collection and acoustic analysis, in order to compare the global prosodic characteristics of infant-directed and adult-directed speech across several languages.

Although the majority of languages in this study are European and thus closely related historically, they represent considerable diversity in prosodic structure. Both German and English are 'stress' languages, in which f_0-prominence is used extensively to convey emphasis, while French makes relatively greater use of duration to indicate stress (Delattre, 1963). Furthermore, f_0-movements in French occur in relation to word boundaries, while pitch movements in English are limited mainly to stressed syllables (Vaissière, 1983). In Italian, where considerable variability in word order is allowed, emphasis is marked more frequently by fronting the focused word than by the use of prosodic stress (MacWhinney & Bates, 1978). Even in the two dialects of English in this study, there are characteristic differences in prosodic pattern. In American English, for example, a rising f_0-contour is used for a yes–no question, while in British English a falling f_0-contour is more typical for questions (Cruttenden, 1986). Since both emphasis and yes–no questions are purported to be prominent features of child-directed speech (e.g. Newport, 1976; Fernald & Mazzie, 1983), these language-specific differences in the use of intonation to convey emphasis and to ask questions could result in distinctive patterns of prosodic modification in speech to children, even among these closely related European languages.

The choice of Japanese as a non-Western language to be included in this comparative study was motivated by several considerations. First, Japanese contrasts markedly with the Indo-European languages in linguistic and prosodic structure. For example, both emphasis and the interrogative form are typically marked by the addition of word- or sentence-final particles, rather than by intonational cues, in polite Japanese speech (Kuno, 1973). Furthermore, Japanese is a 'pitch accent' language, in which f_0-patterns can influence lexical meaning for some words. Both the use of particles instead of prosodic marking, and the use of tonal contrasts to specify lexical meaning are features of Japanese that could conceivably limit the degree of prosodic exaggeration found in child-directed speech.

Another way in which Japanese provides an interesting and relevant contrast to European languages is in the cultural conventions influencing

language use. In Japanese society, the 'display rules' governing the expression of facial and vocal affect dictate that both positive and negative emotions be masked in many social situations. Ekman (1972) found that both American and Japanese subjects showed evidence of distress when they were covertly observed while watching a stress-inducing film; however, when interviewed later, Japanese subjects were much more likely than American subjects to smile when describing the content of the film. In a cross-cultural study of the production and perception of facial affect, Shimoda, Argyle & Riccibitti (1978) found that the emotions in Japanese facial expressions were much more difficult to identify than in English or Italian facial expressions, even for Japanese subjects. In research on vocal affect perception, Magno-Caldognetto & Kori (1983) found that both Italian and Japanese listeners had considerable difficulty in identifying the intended affect in Japanese vocalizations, although Italian vocalizations were identified correctly by both groups of listeners. These findings all suggest that Japanese emotional expressions, both in the face and in the voice, are frequently attenutated in social interactions among adults. If these culturally specified rules governing affective expression among adults are also typical of interactions with children, then this factor too could reduce the extent of prosodic exaggeration found in child-directed speech in Japanese in comparison with European languages.

A third potentially relevant point of contrast between Japanese and Western societies is a difference in child-rearing practices and philosophies. Comparisons of mother–infant interaction in Japanese and American samples reveal major cultural differences in parenting behaviours and patterns of attachment (Miyake, Campos, Kagan & Bradshaw, 1986). Caudill & Weinstein (1969) report that the expressed goal of Japanese mothers is to maintain the infant in a calm state, while American mothers are more likely to encourage activity and higher arousal in the infant. This difference in values could account for Fogel, Toda & Kawai's (1988) finding that Japanese mothers tend to vocalise less frequently to their infants than do American mothers. Since Japanese child rearing traditions, as well as the structure and use of the Japanese language, differ in these diverse ways from the European sample in this study, we might expect Japanese speech to children to differ as well (see Morikawa, Shand & Kosawa, 1988). However, we predict similarities in intonation patterns across languages, reflecting common strategies of prosodic modification in child-directed speech.

In the study reported here, substantial samples of mothers' and fathers' speech to preverbal infants closely matched in age were analysed using instrumental procedures. Throughout this study, considerable attention was devoted to the development and application of standardized procedures on several levels, including subject selection, observation, audiorecording, transcription, acoustic analysis of speech samples, and data reduction and

analysis. While standardization on each of these levels would obviously be desirable in any single-language study, it becomes an issue of critical importance in a comparative study, where it is essential to be able to demonstrate that different patterns of results among languages are not simply attributable to procedural differences. Given the scope and multilingual nature of such a study, however, the potential influence of confounding factors is greatly increased. For example, since it was not possible in this study to use multilingual observers equally fluent in French, Japanese, Italian, German and both dialects of English, observers were inevitably confounded with language. If the observer in language A were more experienced or congenial than the observer in language B, the adult-directed speech elicited in language A might be relatively more animated than that in language B. In language A, it might then appear that adult- and infant-directed speech were more similar in their prosodic characteristics than in language B, a subtle experimenter effect that would be indistinguishable from a true language effect. Since the confound between observer and language could not be avoided in this study, we attempted to reduce its potential effects by using experienced researchers as observers, trained to follow a standard procedure in all recording sessions. In addition, the first author was present at all recording sessions, to ensure that data collection procedures were identical across language groups.

Standardization across language samples was a concern in data analysis as well as in data collection. Selecting a random sequence of infant-directed speech from each recording session for intensive acoustic analysis could result in samples consisting primarily of rough-and-tumble play, on the one hand, or of soothing, on the other. These speech samples would undoubtedly have very different prosodic characteristics, related to differences in the communicative function and emotional intensity of the parents' vocalizations to their infants in these two situations. In order to ensure that difference in prosodic patterns among subjects were not attributable to differences in the communicative function of the vocalisations sampled, excerpts from a variety of activities and conversational context were included in the speech sample for each subject. Here too standardized sampling procedures were used to enhance the comparability across data sets that is prerequisite for valid cross-language comparison of prosodic features in parental speech.

METHOD

Subjects. The 60 subjects in this study were all parents of infants between 0;10 and 1;2. Each subject was a native speaker of one of the following languages: Italian, German, French, British English, American English, or Japanese. Five mothers and five fathers represented each of the six language groups. All subjects were residents of a major metropolitan area in their

native country, with the exception of the Japanese families, who were visiting the San Francisco area for a short period as affiliates of Japanese companies. The occupations of the parents in this study ranged from working class to professional, although 80% of the mothers were homemakers. With the exception of the Japanese, where all the fathers were businessmen and all the mothers were homemakers, the range and distribution of occupational status were represented approximately equally across language groups.

Recording procedures. Recordings were made in the homes of participating families in Paris, Rome, Munich, London, and the San Francisco area. One or two visits were made to each family, except in the case of the Japanese subjects, where three visits were made in order to reduce reactivity effects. All recording sessions were supervised by the first author, who conducted the sessions alone in the British, American, and German families, and who was accompanied by a bilingual translator when visiting the Italian, French, and Japanese families. Observation sessions were scheduled for a convenient time when the family was normally together. After an initial warm-up period, when the observers discussed the goals of the study with the family and got acquainted with the infant, each parent was recorded individually for 15 min in each of two Addressee conditions: Adult–Infant (A–I) and Adult–Adult (A–A). In the A–I condition, parents were asked to play with the infant as they normally do. Parents were also requested to play a favourite game with the infant and to ask the infant to fetch a favourite toy, if these situations did not spontaneously occur during the observation period. Each parent also showed the infant a short picture book provided by the observer. This format ensured that a variety of typical parent–infant activities was recorded in each family, and that the activities sampled were similar across the six language groups. In the A–A condition, each parent was recorded in an informal conversation with the other parent and the observers about work, family life, and the child's development.

Audiorecordings were made on a Uher 4200 portable reel-to-reel recorder, using a Lektrasonics wireless FM receiver and transmitter, and an Audio-technika lapel microphone. The microphone, clipped to the parent's collar, was connected by a cord to the FM transmitter. The transmitter, a small wallet-sized case, was worn in a special cloth belt around the adult's waist. These procedures ensured high-quality audio recordings, necessary for acoustic analysis, while allowing parents and child freedom of movement around the home during the recording session.

Data reduction and analysis. The audiorecordings in each language were transcribed by a native speaker, and translated, when necessary, into English. In order to eliminate noise, speech samples were first band-pass filtered (80–1200 Hz) using a Krohn–Hite electronic filter. The speech samples were then

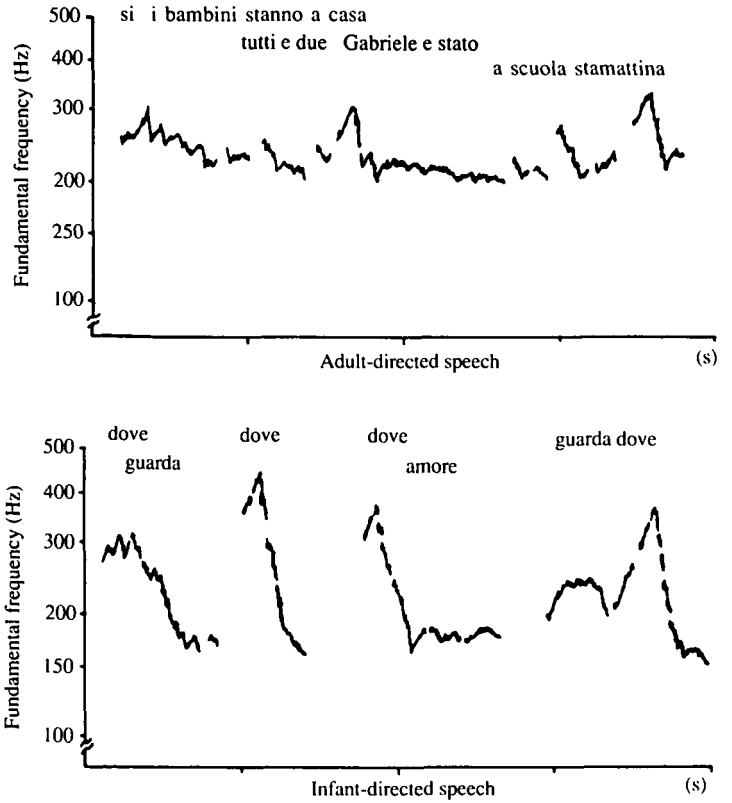

Fig. 1: Fundamental frequency contours in the speech of an Italian mother to an adult and to an infant aged 1;1.

processed on a Visi-Pitch speech analyser interfaced with an IBM PC/XT computer, a configuration which enables measurement in continuous speech of fundamental frequency, amplitude, and duration. Examples of f_0-contours in mothers' and fathers' speech, derived from the Visi-Pitch display, are shown in Fig. 1 and 2. Following the segmentation procedures used by Fernald & Simon (1984), an 'utterance' was defined acoustically rather than linguistically, as a section of speech bounded by pauses greater than 300 msec (cf. Jaffe & Feldstein, 1970).

For each subject, 50 infant-directed and 50 adult-directed utterances were randomly selected for further acoustic analysis, with two selection criteria: (1) the utterances were free of extraneous noise, and were of adequate quality for acoustic analysis; (2) the utterances were sampled approximately equally from the several different conversational contexts represented in each

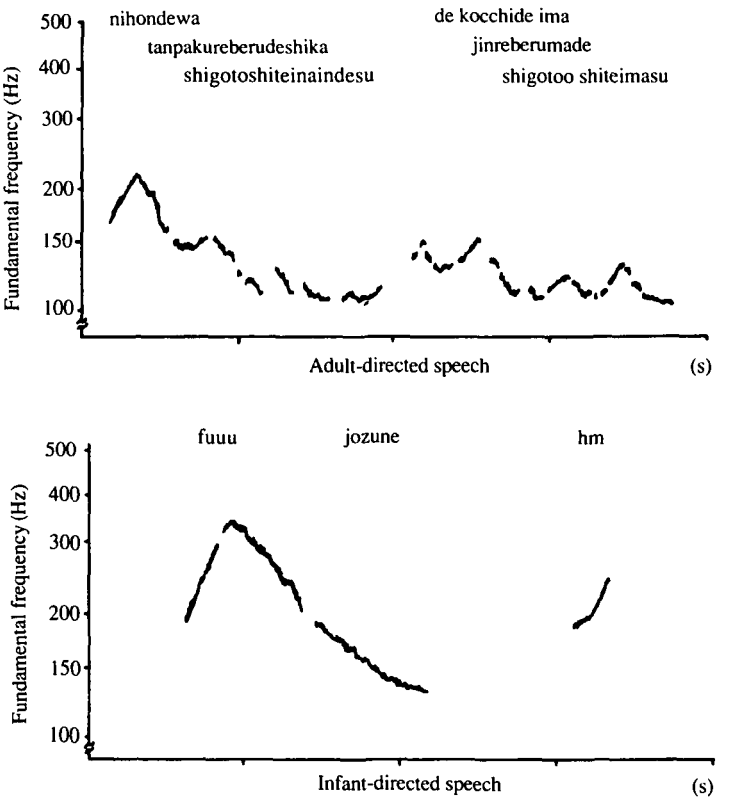

Fig. 2: Fundamental frequency contours in the speech of a Japanese father to an adult and to an infant aged 1;0.

recording condition. The following acoustic measurements were made for each utterance:

(1) MEAN FUNDAMENTAL FREQUENCY: calculated in hertz (Hz) by the computer;
(2) F_0-MAXIMUM: the highest f_0-peak in the utterance;
(3) F_0-MINIMUM: the lowest f_0-value in the utterance;
(4) F_0 RANGE: calculated by subtracting f_0-minimum from f_0-maximum;
(5) UTTERANCE DURATION: measured (in msec) using amplitude envelope plots to identify utterance boundaries;
(6) PAUSE DURATION: measured (in msec) using amplitude envelopes to identify pause boundaries; only pauses (> 300 msec) which followed the analysed utterance, and which were not followed by a change of speaker, were included in the analysis.

While fundamental frequency is the physical correlate of the perceptual variable pitch, f_0 does not, in general, vary linearly with pitch. For example, a 100 Hz change in f_0 from 200 to 300 Hz will be perceived as subjectively much greater in magnitude than an equivalent physical change from 800 Hz to 900 Hz. In order to facilitate meaningful comparison of changes in pitch across male and female speakers differing in f_0-range, the raw scores for changes in f_0 were converted into semitones. The semitone scale, derived from the musical scale, treats all logarithmically equivalent f_0 differences as equivalent pitch differences. While this equal-ratio division of the f_0-range is not the only way to represent the relation between frequency and perceptual response (see Stevens, Volkmann & Newman, 1937), it is conventionally accepted as an appropriate means of normalization across speakers (e.g. Grieser & Kuhl, 1988).

For each speaker in each language, the acoustic measurements for the A–A and A–I speech samples (see Appendix, Tables 1–7) were used to compute seven prosodic parameters. Each of these derived parameters represents a ratio or a difference score reflecting the direction and magnitude of CHANGE in f_0 or duration, when A–I speech is compared to A–A speech for a particular speaker.

(1) CHANGE IN MEAN-F_0: The number of semitones between the mean-f_0/utterance in A–I speech and the mean-f_0/utterance in A–A speech;
(2) CHANGE IN F_0-MAXIMUM: The number of semitones between the mean f_0-maximum/utterance in A–I speech and the mean f_0-maximum/utterance in A–A speech;
(3) CHANGE IN F_0-MINIMUM: the number of semitones between the mean f_0-minimum/utterance in A–I speech and the mean f_0-minimum/utterance in A–A speech;
(4) CHANGE IN F_0-RANGE: the difference in semitones between the mean f_0-range/utterance in A–I speech and the mean f_0-range/utterance in A–A speech, where the f_0-range calculation is based on: $12 \log_2(f_0\text{-maximum}/f_0\text{-minimum})$.
(5) CHANGE IN F_0-VARIABILITY: the difference in semitones between the standard deviations of the mean-f_0/utterance for A–I and the mean-f_0/utterance for A–A speech, where the conversion of the standard deviation into semitones is based on: $12 \log_2[1 + (\text{Std. Dev.}/\text{Mean-}f_0)]$.
(6) CHANGE IN UTTERANCE DURATION: the difference (in msec) between the mean utterance durations for A–I and A–A speech;
(7) CHANGE IN PAUSE DURATION: the difference (in msec) between the mean pause durations for A–I and A–A speech.

These parameters were derived such that a positive value reflects an increase in a given prosodic measure in infant-directed speech relative to adult-directed speech, zero indicates no difference between the two, and a

negative value reflects a decrease. For six of the seven prosodic parameters, positive values were expected, corresponding to increases in mean-f_0, f_0-maximum, f_0-minimum, f_0-range, f_0-variability, and pause duration in A–I speech relative to A–A speech. For utterance duration, negative values were predicted, reflecting relatively shorter vocalizations in speech to infants than in speech to adults.

RESULTS

The results of the analysis of mean-f_0, f_0-maximum, f_0-minimum, and f_0-range in speech to infants and adults across language and gender are summarized in Fig. 3. For each of these four f_0-measures, mean values are also presented in the Appendix (Tables 1–4), as are mean values for f_0-variability (Table 5), utterance duration (Table 6), and pause duration (Table 7).

The analyses of the cross-language data were designed to address three major questions: first, do mothers and fathers in all six language groups studied modify the prosodic characteristics of their speech when addressing an infant? Secondly, are there differences among languages in the nature and extent of these prosodic modifications in infant-directed speech? And thirdly, are there differences between mothers and fathers in their use of prosodic modifications in speech to infants? While these questions are related, the first focuses on COMMON patterns of prosodic modification across language and gender, while the second and third focus on VARIATION within the common patterns related to gender and language or culture. For both sets of analyses, the same strategy was followed: multivariate analyses were first performed on the seven dependent measures, and if the multivariate null hypothesis was rejected, univariate tests were then used to investigate group differences on each variable taken alone. MANOVA was the appropriate test in this case, given the intercorrelation among the multiple dependent measures (Bray & Maxwell, 1985).

To address the question of common prosodic modifications in infant-directed speech across languages and speakers, the seven prosodic parameters derived from the acoustic measurements were first examined simultaneously, to test the null hypothesis that the set of means was equal to zero. Significant differences between infant-directed and adult-directed speech were revealed by MANOVAs performed on the total sample, $F(6, 54) = 72{\cdot}77$, $p < 0{\cdot}0001$, on mothers, $F(6, 24) = 35{\cdot}24$, $p < 0{\cdot}0001$, and on fathers, $F(6, 24) = 31{\cdot}88$, $p < 0{\cdot}0001$, as well as on each of the six language groups: French, $F(6, 4) = 17{\cdot}30$, $p < 0{\cdot}01$; Japanese, $F(6, 4) = 18{\cdot}42$, $p < 0{\cdot}01$; Italian, $F(6, 4) = 7{\cdot}16$, $p < 0{\cdot}04$; German, $F(6, 4) = 6.85$, $p < 0{\cdot}04$; British English, $F(6, 4) = 11{\cdot}35$, $p < 0{\cdot}02$; American English, $F(6, 4) = 25{\cdot}41$, $p < 0{\cdot}01$.

Univariate t-tests conducted for each of these samples on the parameters indexing change in mean-f_0, f_0-maximum, f_0-minimum, f_0-variability,

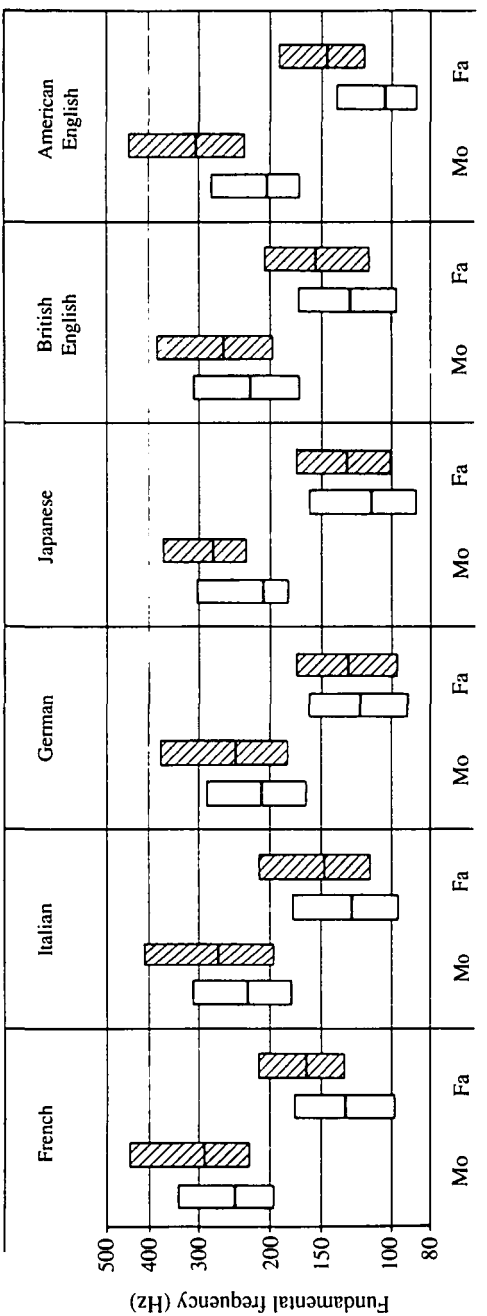

Fig. 3: Cross-language comparison of fundamental frequency (f_0) characteristics of mothers' (Mo) and fathers' (Fa) speech to adults and to infants. For each bar, the bottom line represents the mean f_0-minimum, the top line represents the mean f_0-maximum, and the intersecting line indicates the mean-f_0 per utterance. The extent of the bar corresponds to the f_0-range. □, Adult-directed speech; ▨, infant-directed speech.

utterance duration, and pause duration were all significant at the 0·01 level or less, with two minor exceptions: for the univariate test on the measure of change in f_0-variability in Italian, $p = 0{\cdot}03$, and for the test of change in f_0-maximum in German, $p = 0{\cdot}02$. The only prosodic feature that did not change consistently in the predicted direction in A–I speech relative to A–A speech was f_0-range. Univariate tests on the parameter indexing change in f_0-range revealed that mothers, $t(29) = 3{\cdot}45$, $p < 0{\cdot}01$, but not fathers, $t(29) = -0{\cdot}026$, $p = 0{\cdot}79$, significantly increased their mean f_0-range in speech to infants. The change in mean f_0-range was not significant for any of the language samples except American English, $t(9) = 2{\cdot}53$, $p < 0{\cdot}03$.

A second set of analyses tested for differences in the extent of prosodic modification in infant-directed speech related to the gender or the language of the speaker. A 2 (gender) × 6 (language) MANOVA was performed on the seven prosodic parameters. Given the absence of specific predictions regarding gender- and language-specific effects, as well as the number of tests to be conducted, a conservative alpha level of 0·01 was employed for each comparison. The multivariate analysis revealed significant main effects of both gender, $F(6, 43) = 3.87$, $p < 0{\cdot}01$, and language, $F(30, 174) = 2.14$, $p < 0.001$. The interaction between gender and language was not significant.

Univariate tests revealed significant differences in the extent of prosodic modification between mothers' and fathers' speech on three parameters: (1) Mothers increased the mean f_0-maximum/utterance by 4.83 semitones in A–I speech, while fathers' mean f_0-maximum/utterance increased by only 2.96 semitones, resulting in a significant difference in the change in f_0-maximum parameter, $F(1, 48) = 8{\cdot}55$, $p < 0{\cdot}01$; (2) Mothers increased the mean f_0-range/utterance ($\bar{x} = 1{\cdot}74$ semitones) more than did fathers ($\bar{x} = -0{\cdot}10$ semitones), resulting in a significant difference in the change in f_0-range parameter, $F(1, 48) = 8{\cdot}87$, $p < 0{\cdot}01$; (3) Fathers increased the mean pause duration by a greater amount ($\bar{x} = 580$ msec) than did mothers ($\bar{x} = 180$ msec), resulting in a significant difference in the change in pause duration parameter, $F(1, 48) = 15{\cdot}32$, $p < 0{\cdot}001$. Univariate effects of gender were not significant for any of the other prosodic parameters.

Univariate tests on the language factor revealed significant effects for three of the prosodic parameters indexing changes in fundamental frequency in A–I speech: (1) change in mean-f_0, $F(5, 48) = 7{\cdot}14$, $p < 0{\cdot}0001$ (2) change in f_0-maximum, $F(5, 48) = 3{\cdot}82$, $p < 0{\cdot}01$; (3) change in f_0-minimum, $F(5, 48) = 6{\cdot}96$, $p < 0{\cdot}0001$. Post hoc tests were conducted in order to determine which groups contributed to these language main effects. Tests of all pairwise comparisons, using Tukey's *W* procedure, revealed significant differences ($p < 0{\cdot}01$) between American English and other languages in the extent of prosodic modification in infant-directed speech. In particular, American English parents increased the mean-f_0 in A–I speech relative to A–A speech significantly more than did parents in all other languages except Japanese.

While American and Japanese parents were similar on the f_0-mean parameter, the Americans increased the f_0-maximum in A–I speech significantly more than did the Japanese. American English speakers also increased the f_0-minimum in A–I speech significantly more than did speakers of British English, German, and Italian, No other reliable differences among language groups were found in the *post hoc* tests.

DISCUSSION

Remarkable consistency across languages was found in the patterns of prosodic modification in adult speech to preverbal infants. In French, Italian, German, Japanese, and British and American English, both mothers and fathers spoke with higher fundamental frequency, greater f_0-variability, shorter utterances, and longer pauses in speech addressed to preverbal infants than in speech addressed to adults. Across languages, male and female speakers adopted a common strategy, elevating both the f_0-baseline and the f_0-peak in their speech to infants, as shown in Fig. 3. Interesting variations in this common pattern of f_0 elevation also emerged in the data. Mothers tended to expand their f_0-range in speech to infants, while fathers used the same mean f_0-range in both adult- and infant-directed speech. Comparisons among language groups revealed that American English speakers tended to use more exaggerated prosody when interacting with an infant than did speakers of other languages.

The one hypothesis of the study to receive only partial confirmation was that mean f_0-range would increase in speech to infants across languages. Expanded f_0-range in infant-directed speech has been documented in previous research on American, German, and Chinese mothers (e.g. Garnica, 1977; Fernald & Simon, 1984; Grieser & Kuhl, 1988), as well as American and German fathers (Papousek *et al.* 1987; Warren-Leubecker & Bohannon, 1984). The results of the present study, while confirming most of these earlier findings, reveal that they cannot necessarily be generalised to other languages, nor to fathers' speech in general. While f_0-range expansion in speech to infants was indeed characteristic of most mothers in this study, Japanese women did not show this pattern. Nor did fathers consistently modify f_0-range, although four out of five American and British fathers increased their mean f_0-range in A–I speech relative to A–A speech.

In order to interpret these findings on the expansion of pitch range, it is necessary to consider what the f_0-range measure represents. While the f_0-range of all speakers in all languages was elevated in infant-directed speech, as illustrated in Fig. 3, this was not accomplished merely by transposing the normal prosodic patterns of adult-directed speech a few semitones upward. The variability of prosodic patterns was much greater in speech to infants, as indicated by the finding that the standard deviation of the mean-f_0 in A–I

speech was significantly larger than in A–A speech (see Appendix: Table 5). When speaking to an infant, parents made frequent use of exaggerated wide-range intonation which typically spanned 1–2 octaves, as shown in Figs. 1 and 2. However, another quite distinctive and common type of f_0-contour is also illustrated in Fig. 2. In speech to infants, mothers and fathers frequently used short, high, narrow-range vocalizations, generally rising in pitch, such as 'hmm', 'unh', or 'eh' across languages, 'yeah' in English, 'gel' in German, or the post-particle '-ne' in Japanese. The function of these tag vocalizations is apparently affective, since they are often used to reassure or to encourage a response from the child. The frequent occurrence of these high narrow-range tag vocalizations, used in conjunction with exaggerated wide-range vocalizations, affected the prosodic profile of infant-directed speech in several ways. First, the mean f_0-minimum was elevated in A–I speech, since the tag vocalizations were generally spoken in the upper region of the speaker's f_0-range. Secondly, the variability in mean-f_0 and f_0-range was increased, as a result of parents' use of both wide- and narrow-range vocalizations in A–I speech, in contrast to the more consistent use of intermediate f_0-range vocalisations in A–A speech. Thirdly, the mean f_0-range measure reflected the averaging of these wide- and narrow-range vocalizations in speech to infants, which masked the actual differences between the use of f_0-range in A–A and A–I speech. For example, the two speech samples from the Japanese father shown in Fig. 2, although dramatically different in prosodic structure, differ only slightly in mean f_0-range. Since the exaggerated 1·5 octave f_0-contour used in the father's first vocalization to the infant is averaged with the narrow-range tag vocalization that follows, the mean f_0-range is essentially identical for A–A and A–I speech. This point should be considered when interpreting the finding that fathers did not expand their f_0-range in speech to infants. In fact, many vocalizations in fathers' speech to infants across languages were greatly exaggerated in intonation, although the wide f_0-range of these expanded pitch contours was offset by the frequent use of tag vocalizations which were narrow in f_0-range.

The gender difference in parents' use of expanded f_0-range in this study can be accounted for by the fact that mothers increased their peak-f_0 relatively more than did fathers when speaking to an infant. There has been relatively little research investigating differences between mothers' and fathers' speech, and none with a cross-linguistic perspective. While a few studies have examined the syntactic and semantic characteristics of mothers' and fathers' speech to children in English (e.g. Golinkoff & Ames, 1979; McLaughlin, White, McDevitt & Raskin, 1983; Hladik & Edwards, 1984) French (Rondal, 1980), and German (Papousek *et al.* 1987), the results have been equivocal, with some studies emphasizing similarities and others emphasizing minor differences. Research on patterns of parent–infant interaction in American families reveal consistent differences between mothers'

and fathers' behaviour, however, with fathers typically providing more stimulating physical activity, while mothers are more involved with caretaking and tend to be more rhythmic and containing in their play with the infant (e.g. Yogman, 1982). These findings suggest that qualitatively different gender-specific styles of interaction could have contributed to our finding that mothers increased their f_0-maximum more than fathers. However, since the interactional contexts in which parental speech was recorded were controlled in this study, it was not the case that mothers and fathers were engaged in fundamentally different activities with their infants. An alternative explanation is that mothers in many cultures are indeed more expressive than fathers in their use of intonation with infants, independent of the interactional context.

The analysis of language-specific variation in the prosody of speech to infants in this study revealed that intonational modifications in American English were significantly more extreme than in other languages. Whilst this result may reflect genuine cultural differences in the tendency to exaggerate intonation while addressing children, two alternative explanations should first be considered. First, this difference could be an artifact resulting from the experimenter/language confound mentioned earlier. Since the experimenter who supervised the recording sessions was a native speaker of American English, but not of the other languages studied, the American subjects may have felt more at ease in her presence, and may have therefore been more expressive with their infants. However, the fact that adult-directed speech in American English did not differ prosodically from the other languages argues against this explanation, since an experimenter effect should have influenced both A–A and A–I speech. A second possibility is that reactivity effects were responsible for the exaggerated behaviour of the American subjects. Bronfenbrenner (1979) has observed that American mothers speak much more to their infants when they know they are being observed than when they are unaware of the observer. It is quite possible that such reactivity effects work in opposite directions in different cultures, consistent with prevailing display rules. For example, Japanese mothers may reduce their emotional expressiveness in the presence of an observer, in order to appear more restrained and polite, thus attenuating the expansion of f_0-range (see Fig. 3). American mothers, in contrast, may intensify and exaggerate their activities with the infant, in order to 'show off' the baby to the observer, a practice that would be regarded as inappropriate in Japanese culture.

While experimenter and/or reactivity effects may have contributed to the differences in infant-directed speech between American English and other languages, the more likely explanation is that cultures vary in the extent of prosodic modification typically used in adult speech to infants. It also seems plausible that the amount of exaggeration in the infant-directed speech of

middle-class American parents may fall at the far end of the continuum, given that this is an extremely child-centred culture in which the amplification of emotional expression is regarded as socially acceptable. Obviously, the small sample size within each language group limited the power of this study to reveal language-specific differences. The nature and extent of cross-cultural differences in parental speech styles need to be examined using larger numbers of subjects and more extensive speech samples. While the present study focused on global prosodic parameters, more fine-grained analyses of the various contexts of language use in different cultures, and the mapping of linguistic units onto intonation contours, would undoubtedly be more sensitive to subtle differences among languages in the use of prosody in speech to children.

The common pattern of prosodic modification in parental speech that emerges from these cross-language data is characterised by highly exaggerated intonation in both mothers' and fathers' speech to infants. If, as these data suggest, the use of exaggerated prosody is a widespread practice, what factors might motivate this common caretaker behaviour across such diverse languages and cultures? Fernald (1984) has proposed that these characteristic prosodic modifications are especially effective in communication with preverbal infants, and may serve three important developmental functions:

(1) The exaggerated f_0-contours of infant-directed speech provide salient auditory stimuli which ENGAGE AND MAINTAIN INFANT ATTENTION (Sachs, 1977). Psychoacoustic research with adults suggests that the relatively simple f_0-contours of infant-directed speech, considered as auditory patterns, may be processed and remembered more efficiently than the more complex and variable f_0-contours of normal adult speech (e.g. Divenyi & Hirsh, 1978). Studies of infants' selective auditory responsiveness have shown that infants respond more to their own mother's voice when she is speaking motherese (Mehler, Bertoncini & Barriere 1978; Glenn & Cunningham, 1983). Fernald (1985) demonstrated a more general infant listening preference for the prosody of infant-directed speech, even when spoken by strangers. Fernald & Kuhl (1987) found fundamental frequency to be a primary acoustic determinant of the infant preference for infant-directed speech.

(2) The prosody of infant-directed speech is used to MODULATE INFANT AROUSAL LEVEL AND COMMUNICATE AFFECT TO THE INFANT. Stern, Spieker & MacKain (1982) found that mothers use rising f_0-contours to engage an alert infant in interaction. When soothing a distressed infant, mothers use primarily falling f_0-contours and lower mean-f_0 (Fernald *et al.* 1984; Papousek *et al.* 1985). These results suggest that maternal prosody is finely tuned to infant affect, and that mothers use pitch differentially to regulate infant arousal. In speech to infants, several prosodic features known to convey emotional information are exaggerated well beyond the range of normal adult speech, providing prominent affective vocal cues for the infant

(Scherer, 1986; Stern, 1985). In a study of adult perception of speakers' communicative intent in infant-directed and adult-directed speech, Fernald (in press) found the prosodic contours of speech to infants to be significantly more informative. These findings suggest that the relationship of prosodic form to communicative function is highly salient in the melodies of mothers' speech, and that these characteristic intonation patterns are potentially meaningful to the preverbal infant.

(3) The prosodic modifications in infant-directed speech may FACILITATE SPEECH PROCESSING AND LANGUAGE COMPREHENSION. Studies of adult speech perception reveal that intonation facilitates selective auditory attention and speech segmentation (e.g. Wingfield, 1975; Nooteboom, Brokx & deRooji, 1976). Exaggerated prosody may help the infant to track and parse the speech stream, and provide acoustic cues to the syntactic structure of linguistic messages (Peters, 1983; Morgan, 1986; Hirsh-Pasek, Kemler-Nelson, Jusczyk, Wright & Druss 1987). Looking at the f_0-peaks of mothers' prosodic contours, Fernald & Mazzie (1983) found that in speech to preverbal infants, mothers use intonation to highlight important linguistic information such as labels for unfamiliar objects. If, as Gleitman & Wanner (1982) suggest, young children are predisposed to attend selectively to stressed words, then the prosodic highlighting of new labels in parental speech could yield important information to the child learning language.

According to this model (Fernald, 1984), the characteristic prosodic patterns of infant-directed speech serve several different functions. Intonation in speech to infants is used to elicit attention, modulate arousal, communicate affect, and facilitate language comprehension, with a developmental progression from the most general attention-eliciting function in the early months to the more specific speech-processing functions in the second year. In the earliest period, the attentional/affective functions are primary, serving to orient the infant to the human voice and to maintain social interaction. Gradually, the infant's responsiveness to intonation becomes more differentiated. The preverbal infant may grasp meaning through prosodic contours months before language becomes linguistically meaningful. At this stage, the infant may perceive f_0-contours holistically, as meaningful units in themselves, without yet paying attention to linguistic units within the contour. In the second year, however, the f_0-patterns of parental speech may serve increasingly specific linguistic functions, drawing the child's attention to stressed words within the stream of speech. This progression is seen as continuous and cumulative: the ability of the older child to use intonation to parse language builds on the child's early and enduring attentional and affective responsiveness to f_0-patterns in parental speech.

The perspective described above emphasizes biological predispositions rather than cultural conventions as primary determinants of the use and

effectiveness of prosodic exaggeration in infant-directed speech. This biological emphasis leads to strong predictions about the universality of some form of intonational modification in adult speech to infants. If the use of this special speech register is indeed a powerful and effective strategy for communicating with preverbal infants, then we would expect this parenting behaviour to be widespread across cultures. The results of the present study are consistent with this prediction, revealing a common strategy of prosodic exaggeration in speech to infants across a variety of languages. However, the data also reveal cultural diversity in infant-directed speech, since the speech patterns of American parents were found to differ somewhat from those in other languages. These findings underline both the need for caution in generalizing from the substantial literature on early language input based on American English to other languages and cultures, and the need for carefully controlled cross-language research in non-Western cultures to test hypotheses about universal features of parental speech to infants.

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APPENDIX

TABLE 1. *Mean-f_0/utterance (in Hz)*

	Mothers' speech		Fathers' speech	
	To adult	To infant	To adult	To infant
French	242	288	128	160
Italian	223	266	123	146
German	207	241	119	127
Japanese	207	277	113	129
British English	222	262	127	155
American English	206	308	105	146

TABLE 2. *Mean f_0-maximum utterance (in Hz)*

	Mothers' speech		Fathers' speech	
	To adult	To infant	To adult	To infant
French	330	442	170	211
Italian	304	402	173	210
German	282	367	159	171
Japanese	301	364	158	173
British English	312	382	172	208
American English	281	450	138	190

TABLE 3. *Mean f_0-minimum/utterance (in Hz)*

	Mothers' speech		Fathers' speech	
	To adult	To infant	To adult	To infant
French	189	222	98	128
Italian	174	192	95	111
German	160	178	91	97
Japanese	180	227	86	101
British English	169	198	98	115
American English	170	232	88	118

TABLE 4. *Mean f_0-range/utterance (in semitones)*

	Mothers' speech		Fathers' speech	
	To adult	To infant	To adult	To infant
French	9·64	11·78	9·51	8·41
Italian	9·52	12·76	10·45	10·91
German	9·78	12·35	9·83	9·75
Japanese	8·98	8·12	10·55	9·34
British English	10·67	11·42	9·51	10·29
American English	8·70	11·34	7·78	8·32

TABLE 5. *Mean f_0-variability (in semitones)*

	Mothers' speech		Fathers' speech	
	To adult	To infant	To adult	To infant
French	2·63	3·88	2·60	3·25
Italian	2·48	3·38	2·22	3·18
German	2·09	2·84	1·95	2·53
Japanese	1·88	3·18	2·22	3·62
British English	3·46	3·98	3·20	3·90
American English	2·75	3·87	1·97	3·09

TABLE 6. *Mean utterance duration (in msec)*

	Mothers' speech		Fathers' speech	
	To adult	To infant	To adult	To infant
French	1730	1329	2396	1023
Italian	2039	1635	2939	1534
German	2573	1540	2228	1211
Japanese	2555	1261	2015	1186
British English	1934	1137	1823	1179
American English	2345	1345	2147	1077

TABLE 7. *Mean pause duration (in msec)*

	Mothers' speech		Fathers' speech	
	To adult	To infant	To adult	To infant
French	1095	1220	1138	1816
Italian	1171	1372	1099	1473
German	1193	1383	1122	1652
Japanese	1210	1428	1259	1518
British English	1896	1815	1657	2227
American English	1140	1312	1003	1855