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Didactic Adjustments in Fathers' and Mothers' Speech to Their 3-Month-Old Infants[1]

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Vocal dialogues of 3-month-old infants with their mothers and fathers were recorded during dyadic interactions in the laboratory. Six-minute speech samples were analyzed for syntactic-lexical and temporal-melodic features. Both parents adopted strikingly similar speech registers. Segmentation, reduction in syntactic complexity, repetitiveness, and slow tempo were more marked than reported for parental speech to children above 1 year. However, rather than providing proper linguistic models, parents utilized simplified patterns of expressive melodic contours as the most salient units of speech. This tendency is interpretable as age-specific adjustment to infants' integrative capacities. Structural similarities between maternal and paternal baby talk by far outweighed a few quantitative differences. The intuitive nature of recourse to basic nonverbal properties of vocal communication, together with universality across sex, favors the assumption that baby talk is a part of species-specific didactic support to infant communicative development.

Although parental speech to young children has been a primary domain of linguistic research as an "admirable design to aid children in language

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learning'' (Snow, 1972), it has also become a valuable tool for the study of prelinguistic social communication (M. Papoušek & H. Papoušek, 1981; Snow, 1977, Stern, Spieker, Barnett, & MacKain, 1983) and for detailed analyses of intuitive didactic adjustments in parents (H. Papoušek & M. Papoušek, 1984; M. Papoušek, 1983; M. Papoušek & H. Papoušek, 1984), as well as for comparative studies of paternal and maternal parenting capacities (e.g., M. Papoušek, H. Papoušek, & Bornstein, 1985; Phillips & Parke, 1981; Rondal, 1980). The present study focuses on parental speech to 3-month-old infants and compares mothers' and fathers' ability to adjust their speech to the specific communicative constraints of presyllabic infants.

The parent–infant dyad represents an interacting system with polar disparities in the perceptual and productive communicative skills of each member, in their amount of integrated experience, and in their capacity to interchange with human culture. Such disparities predestine a didactic situation par excellence (H. Papoušek & M. Papoušek, 1983, 1984, 1987), in which vocal communication might play a crucial role. Parents, and even unrelated adults of both sexes, do exhibit a strong propensity to talk to infants (Fernald & Simon, 1984; Rheingold & Adams, 1980), but instead of confining themselves to nonlinguistic means of communication adequate to speechless subjects, they treat infants as partners capable of intentional conversation (Mörtl, 1983; Snow, 1977). To adult observers, the content of parental messages is understandable and reveals caregiving attitudes, insight into infants' feelings, and also didactic intentions (Mörtl, 1983; Rheingold & Adams, 1980; Snow, 1977). However, the meaning and didactic significance of these messages for such young infants becomes evident only if the present knowledge of infant perceptual and cognitive capacities is taken into consideration, and the vocal interchange analyzed in detail together with the entire interactional context (H. Papoušek, M. Papoušek, & Koester, 1986; M. Papoušek & H. Papoušek, 1984). For this purpose, speech is to be seen as a behavior of highly complex structure not only on phonological, lexical, or syntactic levels but also on the prosodic level (Crystal, 1973); correspondingly, speech allows multilevel approaches to structural and comparative analyses (M. Papoušek & Sandner, 1981).

A growing number of studies comparing maternal and paternal speech to language-learning children have counterbalanced the former one-sided interest in maternal speech; however, they have mainly concerned speech to older infants or children (for survey see Snow & Ferguson, 1977). Fathers have been reported to spend less time with, and

talk less to, children (Friedlander, Jacobs, Davis, & Wetstone, 1972; Rebelsky & Hanks, 1971), particularly during the mothers' presence in triadic interactions (Golinkoff & Ames, 1979; Parke, Grossmann, & Tinsley, 1981; Pedersen, Yarrow, Anderson, & Cain, 1979). In spite of that, both parents offer a redundant linguistic input (Blount & Padgug, 1977; Golinkoff & Ames, 1979; Hladik & Edwards, 1984; Hummel, 1982) and adopt highly similar "simplified speech registers" (Ferguson, 1977), i.e., a type of speech with differential structural modifications that are appropriate for the listener or the social context. In child-directed speech, such modifications include syntactic simplicity, concrete vocabulary, grammatical and articulatory accuracy, verbal repetitiveness, a high proportion of questions, and various conversational or language-teaching features. According to other authors, fathers seem to complement mothers in speech adjustment insofar as they respect less the children's abilities, make more demands (e.g., by asking more informative questions), and thus raise their children's performance (Gleason, 1975; Gleason & Weintraub, 1978; Malone & Guy, 1982; McLaughlin, White, McDevitt, & Raskin, 1983; Rondal, 1980). In both cases, the simplification of parental registers is viewed as a plausible adjustment to children's constraints in perceptual and productive linguistic skills at the beginning of speech acquisition.

Scarce evidence from longitudinal studies of maternal speech points out that speech to prelinguistic infants, although surprisingly similar in some of the syntactic or lexical features, is different in quality. Following up two mother–infant dyads from 3 to 20 months, Snow (1977) has stated that the observed prelinguistic adjustments in baby talk could best be accounted for by an explanation that mothers adopt a conversational mode, with insistent and skilled attempts to communicate reciprocally. Phillips (1973), who compared maternal speech to 8-, 18-, and 28-month-old infants, noted a greater variability in syntactic features, as well as a greater emphasis on exaggerated intonations in speech to the youngest age group. This notion has been corroborated by a developmental study on prosodic features in maternal speech to a small sample of neonates and 4-, 12-, and 24-month-olds (Stern et al., 1983). The authors found a particular prosodic organization in speech to 4-month-olds as compared with the other age groups, with peak values in pitch measures and repetitiveness.

Modifications of maternal prosody, such as high overall pitch, slow tempo, stricter rhythmicity, and exaggerated intonation, are among the most commonly cited attributes of baby talk to children of all ages, but

they are mostly based on anecdotal evidence. Systematic investigation of the structure and role of prosodic features in baby talk again concerned speech to older children (Garnica, 1977; Remick, 1976), only sporadically included fathers (Jacobson, Boersma, Fields, & Olson, 1983; Warren-Leubecker & Bohannon, 1984), and has just begun to focus on baby talk to presyllabic infants (Fernald, 1982; M. Papoušek, 1983; M. Papoušek & H. Papoušek, 1984; M. Papoušek et al., 1985; Stern, Spieker, & MacKain, 1982; Stern at al., 1983) and to newborns (Fernald & Simon, 1984).

A rise in average pitch has been found to be less impressive than expected (about three semitones above the average pitch in adult-directed speech) (Fernald & Simon, 1984; Jacobson et al., 1983) and to be slightly smaller in mothers than in fathers (Warren-Leubecker & Bohannon, 1984), a change that may be hardly sufficient to mark speech addressed to the infant. Better markers may be found in the patterns of expanded pitch excursions in individual utterances, as shown in Figure 1; these lead to expansions of the overall pitch range at the higher frequency end, and consequently to the reported rise in average pitch. These simplified, exaggerated, and repetitive intonation contours are in fact the most salient prosodic features, and they have already been analyzed in much detail (Garnica, 1977; Fernald & Simon, 1984; M. Papoušek et al., 1985; Stern et al., 1982).

In the present study, we compare mothers and fathers with respect to both syntactic-lexical and temporal-melodic features of speech addressed to 3-month-old infants. In the same vein, we want to find out in what proportion parents modify the prosodic and the proper linguistic features and how these parental modifications differ from respective modifications of speech reported in relation to older infants. According to the present authors (M. Papoušek & H. Papoušek, 1981), parental speech adjustments may serve rather broad adaptive functions—for instance, as didactic support for perceptual, integrative, and communicative development during early infancy. Moreover, a potential similarity between mothers and fathers in investigated speech adjustments may raise interesting questions. Either it can result from intrafamilial attunement and thus call for analyses of intrafamilial correlations for all investigated variables, or the similarity can indicate a cross-sexual universality in parental adjustments, and at least a partial preadaptedness. In contrast to Ferguson's assumption that parental speech adjustment is transmitted culturally (Ferguson, 1964), such a finding would offer evidence of factors selected during evolution that tend to be universal across sex, age, and cultures.

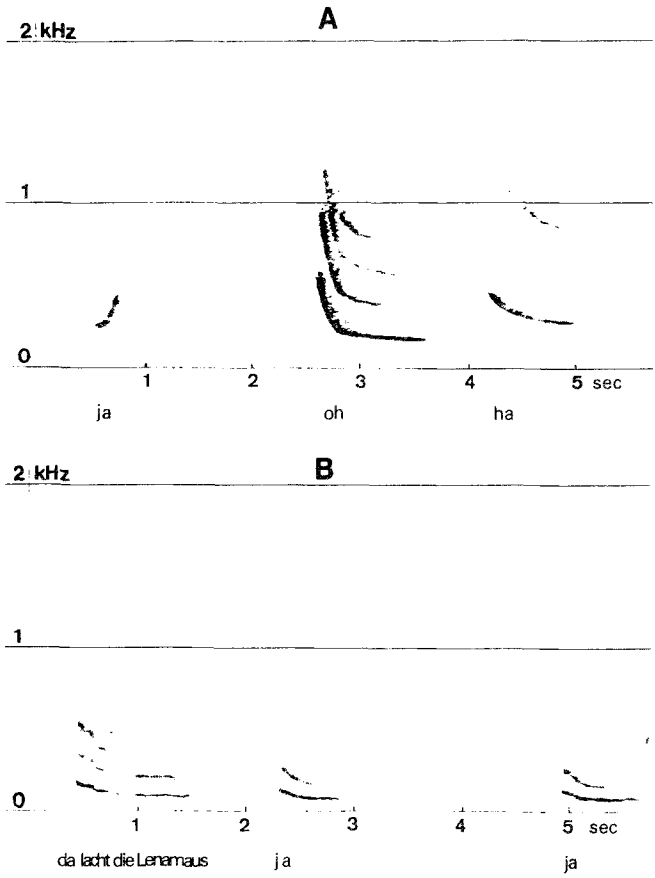

Fig. 1. Narrow-band spectrograms from maternal (A) and paternal (B) utterances (Kay Elemetrics Digital Sonagraph TM 7800). Band width 11 Hz; frequency range 0–2 kHz.

METHOD

Subjects

The subjects were German-speaking mothers and fathers of 14 3-month-old healthy infants (mean age 12.6 weeks; 6 boys, 8 girls), recruited from birth announcements in the local newspaper. In all cases, mothers were the primary caretakers, while fathers participated in caretaking activities only during weekends and evenings.

Procedure

Speech samples were taken from a study of parent–infant interactions primarily designed to explore infant responses to a brief termination of eye-to-eye contact with the parent. The families were invited to the laboratory, where each parent was asked to enjoy his/her infant's company alone, talking to and playing with the infant as they would normally do at home. Infants were seated in an infant chair facing the parent. The parents had been instructed to close their eyes after 2 minutes in response to an acoustic signal, to continue interacting for 2 minutes with eyes shut and without changing other behaviors, and then to reopen their eyes to another signal. After a brief warm-up period, a total of 6 minutes of parent–infant interactions was simultaneously filmed and recorded on audiotapes (Sony Lavalier microphone, Uher 4200 Report).

Evaluation of Audiorecords

Analyses and results of the experimental manipulation will be reported elsewhere. The present study focuses entirely on father–infant and mother–infant vocal communication and is thus based on audiorecord analysis alone. Initially, each of the 2-minute conditions (baseline, closed eyes, and recovery) was analyzed separately to examine potential effects on features of parental speech. Since no significant differences were found among the three conditions in this case, speech samples were subsequently pooled for each total 6-minute interaction.

Auditory Evaluation. Evaluation of the vocal communication samples was done by trained, musically experienced observers, and was based on definitions, categories, and reliabilities that had been developed in a detailed perceptual-acoustic analysis of vocal communication in another sample and reported earlier (M. Papoušek, 1983; M. Papoušek & H. Papoušek, 1984; M. Papoušek & Sandner, 1981) (for detailed listing see the Measures section).

Interrater reliabilities (percentage agreements or, where appropriate, correlation coefficients) are given in parentheses after the respective variables throughout the Measures section. Where agreements between auditory and acoustic measurements could be determined, they are given as the second number in parentheses. Auditory evaluations included prosodic features such as melodic contour types (.96, .97) and melodic repetition (.95, .94).

The text for each speech sample was transcribed by a trained evaluator. A parental utterance was defined as a unit of speech embedded

in one global continuous prosodic pattern and separated from adjoining utterances by pauses that appeared as natural breaks (Cross, 1977). A prosodic criterion was chosen owing to the perceptual salience of prosodic contours in maternal speech to presyllabic infants (Fernald & Simon, 1984; M. Papoušek & H. Papoušek, 1981). This choice appeared more appropriate than either a criterion of grammatical completeness or a formal criterion of minimum pause length. Nonspeech vocalizations, such as humming, whistling, onomatopoeic sounds, or rhythmic noises, were also counted as utterances (.97). A total of 2,589 paternal and 2,723 maternal utterances were analyzed.

Videooscillographic Processing. For the analysis of temporal parameters, audiorecords were passed through an oscilloscope. The oscillographic display was videotaped from the screen in real time at normal speed. A time base providing an acuity of .02 seconds was inserted into the picture so that each of the 50 half-pictures that were recorded per second according to the European norm was marked by the inserted time code. Thus, frame-by-frame analysis of videotapes allowed the measurement of onset and offset times of utterances with a resolution of 20 ms. Interrater reliabilities among four independent evaluators ranged between .94 and .99; the average accuracy of measurement was ± .04 seconds. Previous comparisons between the oscillographic method and computer analyses of temporal parameters or measurements from polygraphic intensity displays had yielded high correlations, between .91 and .99. Owing to a considerable investment of time, temporal measurements were obtained only from the initial 4 minutes of each session.

Sonagraphic Processing. Audiorecords were processed through a Kay Elemetrics Digital Sonagraph TM 7800, using an 11-Hz narrowband filter, a frequency range of 0–2 kHz, and, in addition, a frequency scale magnification in order to improve the resolution for the frequency ranges of the male voices. Hard-copy spectrograms (Figure 1) were obtained for all parental utterances during the initial 2 minutes of each session. Fundamental frequencies were measured from contour displays of all voiced utterances at the point of perceived primary stress (prominent F_o), at the contour peak (maximum F_o), and at the contour trough (minimum F_o) (.91; average accuracy ± 6 Hz for male voices, ± 8 Hz for female voices). Measurements in Hz were transferred to a half-tone scale for further statistical computations.

Statistical Procedures

Because of the sample size and considerable interindividual variability in all parameters, the following nonparametric statistics were applied: the Wilcoxon matched-pairs signed-ranks test for comparisons of vocal parameters from father–infant and mother–infant interactions, and the Spearman rank correlation coefficient for determining the degree of intrafamilial correspondence between maternal and paternal data.

Measures

Linguistic Complexity

Mean Length of Utterance (MLU). Utterance length was determined by number of words (contractions—in German—such as "aufs" and slurred speech like "was'n" counted as two words) as well as by number of perceived syllables (contaminated syllables such as in the above examples were counted as one syllable). The mean number of words was calculated for all verbal utterances (.98); the mean number of syllables was obtained for all verbal and nonverbal utterances (.97). In addition, the ratios of 1-, 2-, 3-, and multisyllable utterances and of complex utterances with 10 or more syllables were computed.

Grammatical Sentence Types. Complete sentences, defined as grammatically self-contained units of speech, were assigned to four categories on the basis of syntactic structure alone, irrespective of intonation: statements or exclamatory sentences, explicit directives, yes/no questions, and wh-questions (.97). The remaining utterances, the majority in this study, were counted as fragments of speech.

Verbal Repetition. Every exact or varied repetition of the wording or phonological sound features of a preceding utterance within three utterances from the original was counted as one unit of repetition. Permissible variations included changes in word order; partial repetition of a semantically relevant part; the addition, deletion, or substitution of one (in utterances with less than five syllables) or two (in utterances with five or more syllables) semantically irrelevant words (e.g., "Wie geht's dir? . . . Ja wie geht's dir?"). A sequence of verbal repetitions bounded by more than two different utterances was called a verbal run. The length of a verbal run was defined as the number of repetitive utterances per run.

Lexical Content

Utterances with little or no content information were grouped into two broad categories: conversation-promoting utterances (interjections,

isolated question tags, emotional exclamations, calls) and play-promoting utterances (musical, rhythmic, imitative, or onomatopoeic sounds, laughter). The remaining utterances with distinct content were categorized as references to the physical context of the interaction, references to absent objects or events, and references to the infant. References to the infant were further differentiated as references to visual behaviors, vocal behaviors, motor behaviors, and behavioral-emotional states (.91). Special kin terms were phonologically simplified words typically produced in child-directed speech (in German, "Mama," "guckguck," "wauwau").

Temporal Structure

From the onset and offset times of parental utterances during the initial 4-min period, and the number of syllables of individual utterances, the following parameters were obtained: quantity of speech (number of utterances per min, and vocalizing time); speech segmentation (mean utterance duration and mean pause duration); overall speech rhythm (mean onset-to-onset interval between utterances as a measure of period length, and coefficient of variance of onset-to-onset intervals as a measure of regularity of the speech rhythm); tempo (speech rate and articulation rate); and prolongation of syllables (mean syllable duration obtained by dividing the duration of utterances by the number of syllables, and given as an average over all utterances as well as separately over 1-, 2-, 3-, and multisyllable utterances.

Melodic Structure

Melodic Contours. The global melodic contours of all voiced utterances were grouped into seven formal categories, comparable to those described by Fernald and Simon (1984): unidirectional (1) rising, (2) falling, (3) one-, or (4) two-level contours with no shift in the direction of pitch movement; bidirectional (5) bell-shaped, or (6) U-shaped contours with one shift; and (7) complex sinusoidal contours with two or more shifts (.96). No criterion of a minimum F_0 excursion was applied. Spoken utterances without voicing were scored as whisper. Terminal pitch movements were coded as rise, fall, or level (.91).

Fundamental Frequency. Means of maximum F_0, minimum F_0, and prominent F_0 as measured from spectrograms were computed from all voiced utterances during the initial 2-min period, i.e., from 67 utterances on average for each parent. F_0 excursions within utterances were obtained as the interval in semitones between maximum and minimum F_0 and

averaged over all utterances. The speech frequency range was defined as the interval, in semitones, between the highest and the lowest frequency produced in the 2-min sample.

Melodic Pattern Repetition. Every repetition of a specific melodic contour pattern within three utterances from the original, with or without variation of the theme, was counted as one unit of repetition. Permissible variations included audible modifications in pitch, pitch excursions, loudness, stress location, duration, and/or tempo, as long as the original melodic pattern was preserved. A sequence of melodic repetitions bounded by more than two different utterances was called a melodic run, the length of which was given by the number of repetitive utterances. Paired melodic-verbal repetitions were scored when a specific wording was repeated simultaneously with a specific melodic pattern (e.g., an isolated question tag "hm" with a rising contour).

RESULTS

Linguistic Complexity

Table I compares the mean scores of utterance length, grammatical sentence type, and verbal repetitions for mothers and fathers. In none of the 18 variables were there any differences between the groups. Both parents used linguistically simple, nondemanding, redundant utterances, typically with fewer than three words or fewer than four syllables; 63% of the utterances had no grammatically relevant structure, and a significant proportion were part of repetitive verbal runs (M_m = 43.9%, M_f = 46.6%). A closer investigation of the generally high intraindividual variability of utterance length revealed an asymmetrical distribution: On one hand, parents distinctly preferred the most simple 1- to 3-syllable utterances (M_m = 58.0%, M_f = 55.2%), and particularly monosyllables (M_m = 37.4%, M_f = 36.3%), while the remaining smaller proportion concerned multisyllable utterances with 4 to 21 syllables. On the other hand, even the most complex of these multisyllable utterances, those with 10 to 21 syllables, still made up a considerable proportion of parental speech (M_m = 5.4%, M_f = 5.7%).

Within the proportion of complete sentences, questions (M_m = 13.6%, M_f = 15.2%) were about as frequent as statements, and were more frequent than directives. The use of yes/no questions slightly exceeded that of wh-questions. Verbal repetitions usually occurred in short runs of two to three repetitive utterances. Repetitions more often

Table I. Mean Scores for Mothers and Fathers on Measures of Linguistic Complexity

Variable	Mothers	Fathers	r_s[d]
Length of utterance			
Words per utterance [a]	2.8	2.9	.45
Syllables per utterance[b]	3.8	3.9	.46
1-syllable utterances[c]	37.4	36.3	−.02
2-syllable utterances[c]	10.8	8.0	−.03
3-syllable utterances[c]	9.8	10.9	−.22
4- to 21-syllable utterances[c]	42.0	44.6	.19
10- to 21-syllable utterances[c]	5.4	5.7	.45
Grammatical sentence types[c]			
Fragments of speech	62.6	62.7	.27
Statements	13.9	12.5	.60[e]
Directives	9.8	9.4	.38
Yes/no questions	7.6	9.0	−.23
Wh-questions	6.0	6.2	.63[e]
Verbal repetition			
Utterances in verbal runs[c]	43.9	46.6	.07
Total repetitions[c]	27.3	28.1	.10
Exact repetitions[c]	17.7	17.9	.31
Modified repetitions[c]	9.6	10.5	−.15
Verbal runs per min	5.9	5.8	.49
Utterances per run	2.6	2.7	.15

[a]Computed for all verbal utterances.
[b]Computed for all utterances.
[c]Expressed as a percentage of all utterances.
[d]r_s = Spearman rank correlation coefficient determining the within-family correspondence between maternal and paternal data.
[e]$p < .05$.

provided exact copies of the original than variations. As to articulatory acuity, hardly intelligible speech was predominant in three mothers and six fathers, owing to slurred, whispered, or low-volume utterances.

Lexical Content

As Table II indicates, a striking correspondence between maternal and paternal speech was the prevailing finding for measures of lexical content as well. The majority of utterances from both parents were lexically ambiguous, and were either interjections, emotional exclamations, and calls, or musical, rhythmic, imitative, and onomatopoeic sounds (M_m = 60.8%, M_f = 58.7%). Thus, most utterances were lacking in concrete vocabulary and thus failed to provide a lexically and syntactically significant model of speech. Instead, they served to promote

Table II. Mean Scores for Mothers and Fathers on Measures of Lexical Content

Variable	Mothers	Fathers	r_s[c]
Contentless utterances[a]			
Conversation-promoting Interjections, calls, exclamations, tags	51.3	44.6	−.15
Play-promoting Musical, rhythmical, imitative, onomatopoeic sounds, laughter	9.5	14.1	.41
Content utterances[a]			
Physical context	4.6	8.6	.13
Absent objects or events	5.9	2.1	−.06
Infant behavior or state	28.3	30.2	.75[d]
Visual behavior[b]	23.2	21.0	−.09
Vocal behavior[b]	31.7	16.3	−.48
Motor behavior[b]	21.4	39.0	−.23
Behavioral-emotional state[b]	23.7	23.7	.12
Special kin terms	1.7	.7	−.08

[a]Expressed as percentage of all utterances.
[b]Expressed as percentage of references to infant behavior or state.
[c]r_s = Spearman rank correlation coefficient determining the within-family correspondence between maternal and paternal data.
[d]$p < .01$.

the ongoing conversation and playful interchanges conveying basic messages, such as calls for visual attention (e.g., calling by name, "guckguck," "hallo"); calls for an infant turn (e.g., isolated question tags such as "hm?" "gell?" "ja?"); approvals (e.g., "jaah!" "fein!"); or readiness for playful interchanges. The respective meanings of these utterances, however, were not carried so much by the wording itself as by the prosodic structure (see discussion on age specificity of parental adjustments). Therefore, the meaning could sometimes be derived only from the interactional context and from adjoining referencing utterances. For example, the same wording "ja" was once used in the context of calling for an infant smile with a rising contour, once in the context of rewarding an infant smile with a bell-shaped contour, or another time in the context of soothing with a falling contour.

The remaining proportion of utterances were concrete only insofar as they predominantly referred to the present interactional context, i.e., especially to the infant's behaviors or state of well-being, and, infrequently, to the physical context of the laboratory session. Only rarely did utterances concern absent objects or past or future events. When referring

to the interactional context, mothers and fathers alike seemed to speak to themselves in many cases, reflecting the parents' focus of attention, evaluations, and intentions in relation to the infant's behavior, state, feelings, or even thoughts. While mothers and fathers did not differ in the degree of verbally expressed preoccupation with the communicative context, they tended to distribute their attention differently among two classes of infant behaviors, vocalizations and motor activity. Although not significant, there was an obvious trend in that mothers expressed more interest in vocal behaviors (M_m = 31.7% of infant-centered utterances, M_f = 16.3%, $p < .13$, Wilcoxon test, two-tailed), while fathers expressed more interest in motor behaviors (M_m = 21.4%, M_f = 39.0%, $p < .1$, Wilcoxon test, two-tailed).

The incidence of special kin terms was negligible in both parent groups and restricted to names ("Papa," "Mama") and some nicknames.

Temporal Structure

Comparative data for mothers and fathers concerning 13 variables of speech quantity, segmentation, rhythm, tempo, and prolongation of syllables are summarized in Table III. Again, correspondences in temporal features outweighed a few slight, although significant, differences between mothers and fathers.

Quantity of Speech. Both parents talked in equal amounts and continuously throughout the entire session, each producing approximately 200 utterances within 6 minutes. Utterances were short segments of speech averaging 1.1 seconds in maternal speech and 1.0 seconds in paternal speech, and bounded by pauses of .7 and .9 seconds, respectively. The insignificant trend in fathers to slightly shorter utterances and longer pauses resulted in a small but significant difference in the total vocalizing time. In both parents, however, the summed durations of all utterances occupied a considerable proportion of the interaction time (M_m = 61.2%, M_f = 54.0%), with fathers leaving somewhat longer pauses during which the infant could respond.

No differences were found with respect to beat and index of regularity of the overall speech rhythm. Tempo of articulation and tempo of speech were generally slow in both parents, corresponding to an increase in the mean duration of syllables. Prolongation of syllables was most pronounced in the predominant group of one-syllable utterances (M_m = .51 sec, M_f = .53 sec), decreasing with the number of syllables in utterances. The decrease of syllable duration with increasing utterance

Table III. Mean Scores for Mothers and Fathers on Temporal Measures

Variable	Mothers	Fathers	r_s[d]
Quantity of speech			
Utterances per min	34.7	33.2	.64[g]
Total vocalizing time[a]	61.2	54.0[e]	.52
Segmentation			
Utterance duration(s)	1.1	1.0	.61[g]
Pause duration(s)	.7	.9	.63[g]
Rhythm			
Onset-to-onset interval(s)	1.8	1.9	.63[g]
Coefficient of variance	.48	.49	−.42
Tempo			
Speech rate[b]	2.2	2.1	.15
Articulation rate[c]	3.6	3.9	−.13
Prolongation of syllables			
Syllable duration(s)	.37	.35	.26
in 1-syllable utterances	.51	.53	.47
in 2-syllable utterances	.41	.34[e]	.52
in 3-syllable utterances	.32	.27[f]	.46
in 4- to 21-syllable utterances	.25	.22[e]	.26

[a]Expressed as sum of utterance durations in % of total interaction time.
[b]*N* of syllables devided by total interaction time.
[c]*N* of syllables devided by total vocalizing time, exclusive of pauses.
[d]r_s = Spearman rank correlation coefficient determining the within-family correspondence between maternal and paternal data.
[e]$p < .05$, Wilcoxon matched-pairs signed-ranks test.
[f]$p < .01$, Wilcoxon matched-pairs signed-ranks test.
[g]$p < .05$.

complexity was more pronounced in paternal speech, leading to significantly shorter syllables in the 2-, 3-, and multisyllable utterances. These differences account for the insignificant trend in fathers towards slightly faster articulation (M_m = 3.6 syllables/sec, M_f = 3.9 syllables/sec).

Interindividual variability was considerable in all temporal parameters of parental speech (e.g., mean pause duration ranging from .5 seconds to 1.1 seconds in individual mothers, and from .3 seconds to 1.7 seconds in fathers; or syllable duration in one-syllable utterances ranging from .29 seconds to .81 seconds in mothers, and from .36 seconds to .87 seconds in fathers.

Melodic Structure

Fundamental Frequency and Speech Frequency Range. Seven measures of fundamental frequency (F_o) and frequency range are sum-

marized for mothers and fathers in Table IV. In both parents, the mean maximum F_o and the mean F_o at the point of primary stress of all voiced utterances were above the average modal speech frequency ranges reported in the literature for female and male speakers (185.0 Hz–261.6 Hz, i.e., 6 semitones, and 92.5 Hz–138.6 Hz, i.e., 7 semitones, respectively, Hirano, 1981), while the mean minimum F_o remained well within the reported ranges. The overall frequency ranges, although significantly smaller in fathers' than in mothers' speech (M_m = 25.4 semitones vs. M_f = 20.9 semitones, $p < .01$), were greatly expanded in both groups of parents. The expansion of pitch ranges was minimal at the lower end of the frequency scale and was extraordinary at the higher end. F_o excursions of melodic contours averaged over all voiced utterances were 7.4 semitones in mothers and 6.7 semitones in fathers.

Melodic Contours. The most surprising congruence between maternal and paternal speech was found in the distribution of global melodic contour types, in a prevalence of the simplest contours, and in the choice of terminal pitch contours (see Table IV). Both parents exhibited a strong preference for unidirectional contours (M_m = 65.4%, M_f = 66.9%). In contrast, complex sinusoidal contours, the most common contour type in adult-directed speech, were exceptional (M_m = 11.7%, M_f = 10.0%). The only significant difference concerned a more frequent use of whisper in fathers (M_m = 4.8% vs. M_f = 14.6%, $p < .05$).

Melodic Pattern Repetition. Melodic repetitiveness by far exceeded the extent of verbal repetitiveness in the speech of both parents, as documented by significantly higher scores in the categories total utterances in runs, total repetitions, modified repetitions, and utterances per run (see Tables I and IV). Fathers significantly differed from mothers in the amount of melodic pattern repetition, particularly concerning the proportion of modified repetitions. The proportion of utterances in melodic runs was 70.7% in mothers versus 62.0% in fathers ($p < .01$); 50.3% of utterances in mothers versus 42.6% in fathers ($p < .01$) repeated preceding melodic patterns; 38.3% versus 29.4% of utterances ($p < .05$) repeated a preceding theme in a varied form.

A considerable proportion of paired repetitions occurred in which a specific melodic pattern was more or less consistently paired with a specific wording. This is of particular interest because such pairings mostly concerned utterances with conversation-promoting lexical content that were particularly suitable to carry respective prosodic messages.

Table IV. Mean Scores for Mothers and Fathers on Melodic Contour Measures

Variable	Mothers	Fathers	r_s[d]
Melodic contour			
Whisper[a]	4.8	14.6[e]	.64[g]
Unidirectional[b]	65.4	66.9	−.21
One- or two-level	13.9	14.0	−.39
Rise	30.7	28.6	.15
Fall	20.8	24.4	−.05
Bidirectional[b]	23.0	23.1	−.09
U-shape	6.0	7.6	.14
Bell-shape	17.0	15.5	−.09
Complex multidirectional[b]	11.7	10.0	−.09
Terminal pitch change[b]			
Terminal rise	36.0	36.3	−.06
Terminal fall	38.0	38.2	.17
Terminal level	26.0	25.6	−.64[g]
Fundamental frequency F_0 (Hz)			
	d″	des′	
Overall maximum F_0	620.3	280.2	.47
	e′	e	
Mean maximum F_0	329.6	167.8	.31
	c′	d	
Mean prominent F_0	261.6	144.6	.79[h]
	a	B	
Mean minimum F_0	217.7	111.0	.27
	des	E	
Overall minimum F_0	140.6	84.4	.17
F_0 excursion per utterance[c]	7.4	6.7	.13
Speech frequency range[c]	25.4	20.9[f]	.54
Melodic pattern repetition			
Utterances in melodic runs[a]	70.7	62.0[f]	.20
Total repetitions[a]	50.3	42.6[f]	.29
Exact repetitions[a]	12.0	13.2	−.28
Modified repetitions[a]	38.3	30.2[f]	.69[h]
Paired melodic-verbal repetitions[a]	21.5	20.9	.01
Melodic runs per min	7.1	6.3	.52
Utterances per run	3.6	3.5	.35

[a]Expressed as percentage of all utterances.
[b]Expressed as percentage of voiced utterances.
[c]Expressed in semitones.
[d]r_s = Spearman rank correlation coefficient determining the within-family correspondence between maternal and paternal data.
[e]$p < .05$, Wilcoxon matched-pairs signed-ranks test.
[f]$p < .01$, Wilcoxon matched-pairs signed-ranks test.
[g]$p < .05$.
[h]$p < .01$.

DISCUSSION

Mother and Father as Redundant Sources of Linguistic Stimulation

In this study, both quantitative and qualitative aspects of speech to 3-month-old infants were compared in mothers and fathers during dyadic face-to-face interaction. It was found that fathers talk as much as mothers do to their presyllabic infants, that they modify their syntactic-lexical and temporal-melodic speech characteristics in strikingly similar ways, and that they both adopt a simplified register that appears at first glance to be identical to the baby talk register generally reported in speech directed to older infants and children. That is, a global description of short, well-segmented, syntactically simple, repetitive utterances delivered at a slow rate, with increased overall pitch and exaggerated intonation applies just as well to baby talk at the presyllabic age.

Age Specificity of Parental Adjustments in Baby Talk

The present study concerns only one age group of infants; in spite of that, we want to comment on age-dependent differences in parental speech adjustments for two reasons. First, we can compare our data with results from longitudinal research (e.g., Stern et al., 1983) and with other authors' data on parental speech to language-learning children. Second, some of our findings as such indicate adjustments to specific needs and capacities of presyllabic infants.

1. Reduction of syntactic complexity as expressed in a low mean length of utterances (MLU) and a high incidence of verbal repetitions is more marked in our sample than previously reported for speech to either newborns (Fernald & Simon, 1984; Phillips & Parke, 1981; Rheingold & Adams, 1980) or older infants (Golinkoff & Ames, 1979; McLaughlin et al., 1983; Rondal, 1980) (see Table V). These findings in part diverge from the previous notion that parental MLU is consistent throughout the first 18 months (Snow, 1977). Conversely, they are in accord with longitudinal data from Stern et al. (1983) demonstrating a peak in verbal repetitiveness in speech to presyllabic infants. These aspects need further investigation because the studies by Stern et al. (1983) and Snow (1977) are based on very small samples and use slightly different definitions of utterances.

2. The extent of phonological-syntactic simplicity of parental utterances becomes even more obvious when the intraindividual distribution of utterance length is considered. The predominant group of 1- to

Table V. Measures of Syntactic Complexity: Relation to Infant Age

Study	Infant age (months)	Subjects *N* M[a]	Subjects *N* F	MLU (Words/utt.) M	MLU (Words/utt.) F	Repetition (% utterances) M	Repetition (% utterances) F
Fernald & Simon, 1984	0	24				9	
Phillips & Parke, 1981	0	5	5	3.8[d]	3.3[d]		
Rheingold & Adams, 1980	0	74[b]		4.9		6[c]	
Golinkoff & Ames, 1979	19	12	12	4.2[d]	4.2[d]	15	16
McLaughlin, White, McDevitt, & Raskin, 1983	18	8	8	3.6	3.4	7	11
	30	8	8	4.2	4.0	4	8
	42	8	8	4.7	3.9	3	4
Rondal, 1980	18–36	5	5	4.4	5.1	2[c]	4[c]
Snow, 1977	3–18	2		4–5[d]			
Stern, Spieker, Barnett, & MacKain, 1983	0	6		3.1[d]		19	
	4	6		4.0[d]		26	
	12	6		3.6[d]		14	
	24	6		4.6[d]		8	
This study	3	14	14	2.8	2.9	27 18[c]	28 18[c]

[a]M = mothers, F = fathers.
[b]Male and female adults at newborn nursery.
[c]Exact repetitions only.
[d]Morphemes per utterance.

3-syllable utterances is extremely simple and is characterized in most cases by a lack of a syntactically relevant structure as well as by a lack of concrete vocabulary. Another smaller, but significant, group of utterances with 10 or more syllables is more similar in structure to adult-directed speech such as reflections or comments concerning the infant's feelings, attention, or needs, or the parent's intentions. Obviously, parents either adaptively reduce the length in utterances directly addressed to the infant or use syntactically complex sentences that remind one of self-directed monologues. Thus, the majority of utterances fails to provide those adequate models of syntactically salient, lexically concrete speech that have been found appropriate for children who already use some words (Snow, 1972).

3. In the same vein, parents fail to emphasize distinct and accurate articulation of syllables or words, as they typically do when addressing language-learning children (e.g., Newport, 1976). In three mothers and six fathers, the prevailing mode of speaking was slurred or hardly

intelligible low-volume speech; this pattern occurred intermittently in most parents.

4. The overall incidence of grammatically well-formed sentences, particularly the incidence of questions, is much lower than expected from previous research (e.g., Snow, 1977), if a strict grammatical criterion is applied (see also Keller, Gauda, Miranda, & Schölmerich, 1982; Stern et al., 1982). A high proportion of questions has been among the most frequently cited characteristics of baby talk at all ages; however, this notion has been based on a confounded grammatic-prosodic criterion in most cases, including noninterrogative final rise contours. Interestingly, the correlation between grammatical sentence type and melodic contour is particularly low in speech to presyllabic infants (H. Papoušek et al., 1986), and wh-questions typically differ from yes/no questions in contour type (Stern et al., 1983). Rise contours, on the other hand, may have broader functions, which may be easily overlooked if one focuses on syntactic functions of prosody alone.

5. In terms of lexical content, elaborate nicknames and phonologically complex onomatopoeic utterances are frequent, while phonologically simplified special kin terms (Ferguson, 1964) are exceptional in speech to 3-month-olds. Vocabulary is seldom concrete. Instead, various forms of syntactically isolated interjections, question tags, calls, and imitative or other nonspeech sounds prevail in baby talk to presyllabic infants, accounting for the high incidence of one- to three-syllable utterances. They function as conversational expressions of attention-eliciting, quieting, or soothing interventions, or as expressions of pleasure, surprise, nurturance, concern, approval, disapproval, uncertainty, or inquisitiveness. It is noteworthy, however, that these interjections are by definition ambiguous in lexical content, relying almost exclusively on prosodic patterns. Although interjections are a regular part of affective speech among adults, in baby talk they become autonomous units of speech and the main carriers of primarily prosodic messages (H. Papoušek et al., 1986; M. Papoušek & H. Papoušek, 1984) (see number 8 below).

6. As to the prosodic organization of baby talk, parents in our sample slow down the overall tempo of articulation even more than in speech to newborns (Fernald & Simon, 1984). Again, the slow tempo is particularly striking in the most frequent and linguistically simple one- to three-syllable utterances that are highly suitable for an elongation of vowels and, thus, for the most extensive modulations of pitch.

7. As apparent from perceptual and sonagraphic analyses, the resulting melodic contours in these utterances are in most cases simple, smoothly gliding melodic patterns with a high degree of pitch continuity

and widely expanded pitch excursions, mainly at the upper end of the frequency range. Clearly, this differs remarkably from adult prosody. These findings are in full accord with acoustic analyses of the prosody in maternal speech to newborns (Fernald & Simon, 1984), and with longitudinal analyses suggesting that melodic contours are by far the most salient units of parental speech to infants and most pronounced at the infant's presyllabic age where dyadic face-to-face interactions are most intense (Stern et al., 1983). Interestingly, parents restrict themselves to a limited set of prototypical melodic patterns that are repeated almost twice as frequently as the wording of utterances (H. Papoušek et al., 1986; M. Papoušek et al., 1985).

8. As to the functions and meaning of melodic contours in presyllabic vocal communication, it becomes most obvious in the case of the one- to three-syllable utterances that melodic patterns are no longer tied to syntactic-grammatical structures but have become independent sources of information exemplifying a preponderance of the more basic and universal expressive functions of prosody (Crystal, 1973; M. Papoušek & H. Papoušek, 1981). These functions may be derived in part from adjoining content-utterances that comment on the communicative context and not only reflect parental sensitivities to infant signals and state but reveal parental didactic tendencies such as eliciting visual attention, encouraging or rewarding active turns in the interaction, readiness to play, monitoring, or soothing (H. Papoušek & M. Papoušek, 1987; M. Papoušek & H. Papoušek, 1984). How these relate to specific melodic patterns and to infant vocal behaviors has been analyzed and discussed in detail (H. Papoušek et al., 1986; M. Papoušek et al., 1985). In addition, most parents emphasize the syntactic functions of prosody as well by enhancing and simplifying intonation patterns in sentences, thus anticipating the prevailing type of prosodic organization found in speech to older children (Garnica, 1977).

On the basis of the preceding arguments we conclude that parental speech to 3-month-olds differs qualitatively in structure from speech to older children who are at the age of most rapid language learning. Segmentation, reduction in syntactic complexity, repetitiveness, and slow tempo are more marked in speech to the youngest infants. However, rather than serving primarily to facilitate language comprehension and acquisition on phonological, lexical, and syntactic levels, these characteristics support the enhancement and patterning of melodic contours as the most salient units of speech, those that are most frequently and regularly repeated and used consistently with respect to context and contingency on infant vocal behavior.

Didactic Adjustments to the Infant's Perceptual and Integrative Predispositions.

Evidence has been reviewed indicating that the acoustic properties of melodic patterns in baby talk are well adapted to the infant's auditory thresholds, discriminative capacities, preferences, and holistic processing modes (Fernald, 1984; M. Papoušek & H. Papoušek, 1981; Sachs, 1977). Since melodic patterns aid infants in the first months of life to track the speech directed to them among the variety of environmental sounds, to detect and recognize recurrent patterns in the flow of speech, and to become familiar with the most basic meaningful units of speech, they appear as an excellent didactic design. Moreover, the modes in which these units are delivered (i.e., simple stimulus structure, frequent repetition, slow tempo, predictable timing) fulfill basic prerequisites for successful learning and integration of experience in young infants (H. Papoušek & M. Papoušek, 1982, 1987; M. Papoušek, 1983). The proportion of constancy and variation in repetitive melodic patterns provides not only favorable conditions for eliciting and maintaining the infant's attention (McCall & Kagan, 1967) but also a rich source for fine-grain modulations of intensity, either enhancing or attenuating preceding stimuli (M. Papoušek et al., 1985; Stern et al., 1982), and for playful interchanges (M. Papoušek, H. Papoušek, & Harris, 1987). Other relevant prerequisites, such as contingency on infant vocal behaviors, adjustment to infant state, and communicative functions, will be reported elsewhere.

Differences Between Mothers and Fathers

When maternal and paternal baby talk to 3-month-old infants is compared with respect to the issues discussed in the preceding paragraphs, the overall result is a striking similarity in both quality and extent of didactic adjustments. Mothers and fathers are essentially redundant or homogeneous sources of didactic care in baby talk (M. Papoušek et al., 1985). Even where fathers have been put at a disadvantage by nature when trying to raise pitch, they succeed surprisingly well in producing enhanced melodic patterns and mean F_o values that are slightly less than one octave below that of the mothers. According to our data, this difference does not affect the quality of vocal interchanges. Interestingly, some fathers tend to compensate for their voicing difficulties by whistling in a frequency range of about two octaves above maternal maximum pitches.

The few significant differences are relatively small and quantitative in nature. They concern a somewhat shorter total vocalizing time in fathers, a slightly faster articulatory rate in all but the one-syllable utterances, a higher proportion of whispered utterances, and, consequently, a lower proportion of melodic pattern repetition. The only qualitative difference between maternal and paternal speech relates to the parents' focus of attention but does not reach significance. Fathers tend to verbally encourage more motor activity in infants, while mothers express more interest in vocalizations. These differential tendencies may indicate an anticipation of the stylistic differences between maternal and paternal behaviors previously observed in interactions with older infants and children (e.g., Lamb, 1977; Yogman, 1982) and traced back even to the neonatal age (Parke & Suomi, 1981). In their intuitive adjustments in baby talk, however, fathers encourage infant vocalizations just as much as mothers do, while mothers are just as playful as fathers (M. Papoušek et al., 1985, 1987).

In maternal speech, whispering is typically used intermittently as a contrastive feature equivalent to an extension of the frequency range at the lower end, as suggested by Garnica (1977). Some of the fathers, however, produced whispered utterances over long periods; these were interpreted as a symptom of insecurity since they cooccurred with other signs of discomfort, such as low volume speech, hardly intelligible speech, hurried articulation, and increased verbalization of uncertainty. On the whole, a wide range of individual differences was found for all variables in both groups of parents, with even more extreme differences among fathers. That is, some of the fathers seemed to surpass the very "best" mothers with respect to the extent of speech adjustments while others did not seem to be fully at ease with their role, at least in the laboratory environment, and may have been more sensitive to the potential strain of being observed. Clearly, the more parents were able to relax and enjoy their infant's company, the more distinct were their intuitive adjustments in speech.

Intrafamilial Attunement Between Mothers' and Fathers' Speech

Significant intrafamilial correlations were obtained for only 11 out of 67 variables. Interestingly, these variables belonged to the most salient characteristics, such as temporal patterning, rate of utterances, whispering, mean prominent F_o, and references to the infant. Other features, such as melodic contour types, were more adapted to variable infant characteristics, e.g., to the momentary interests or state of the infant. Appar-

ently, some parental couples had developed a certain family style of talking with their infant with a high degree of congruence between maternal and paternal baby talk features, which may have been influenced by the infant's temperament and developmental level, and/or by mutual imitation. From this perspective, one might have expected a higher degree of intrafamilial correspondence. However, the low incidence of significant positive correlations suggests that, on the whole, the finding of prevailing similarities between the groups of mothers and fathers is hardly accounted for by processes of intrafamilial attunement.

Baby Talk as a Biologically Preprogrammed Parenting Behavior

The manifold structural adjustments in parental baby talk would hardly be possible on the basis of conscious, rational control requiring more time and energy than intuitive control (H. Papoušek & M. Papoušek, 1983). Typically parents don't even realize that they modify their way of speaking in the presence of an infant. Ferguson (1964) has suggested that the manifestations of baby talk in various languages, particularly when addressed to the language-learning child, are culturally transmitted; indeed, this may apply to the phonological adjustments of special baby talk lexicons. However, the intuitive nature of parental speech to the youngest infants, along with a recourse to basic nonverbal structures of vocal communication that are universal across cultures, points to a biological preadaptedness in parents. Similar adjustments have been found early in ontogeny (Sachs & Devin, 1976) and in nonparents (Gleason, 1975; Rheingold & Adams, 1980). Clearly, more cross-cultural research is needed to explore this point further, although the present study adds further support to this hypothesis by demonstrating the universality of speech adjustments across both sexes. So far, the available evidence favors the assumption that baby talk is a species-specific characteristic of human didactic parenting and may, at least to some degree, have been selected as a preadapted parental capacity during human evolution.

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