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Consistency in the pattern of change in mothers' speech: some discriminant analyses*

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ABSTRACT

This study demonstrates a striking absence of variability in the speech which mothers address to children of the same age within the 1- to 5-year range. Speech to children of 1 ; 0, 1 ; 8, 2 ; 3 and 5 ; 0 years was analysed for aspects of syntactic, semantic, pragmatic and discourse structure. Discriminant function analyses showed that the age of the child to whom a mother was speaking could be predicted very accurately from her speech. The rate at which mothers' speech changed was greatest when the children were 1 ; 8–2 ; 3, and least when they were 2 ; 3–5 ; 0. These trends in the evolution of the maternal speech register are interpreted as responses to concurrent changes in children's language behaviour.

INTRODUCTION

Many studies document the numerous simplifications which adults introduce into their speech when addressing language-learning children. This process appears to hinge, in part, on cues from the children which indicate both their comprehension of particular messages and their linguistic capabilities in general (Bohannon & Marquis 1977, Gleason 1977, Sachs, Brown & Salerno 1976, Snow 1972, Bohannon 1978, Glanzer & Dodd 1975). For example, Snow (1972) found that unless the children being addressed were actually present, mothers produced speech which possessed some elements of 'motherese' but which was not fully typical. Furthermore, it has been reported that the mean length of adult

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utterances varies according to the amount of explicit comprehension feedback given by the children (Bohannon & Marquis 1977) and even the sheer amount of their participation in a conversation (Glanzer & Dodd 1975).

This responsiveness on the part of adults would lead one to expect rather large changes in their speech as children undergo their relatively rapid transformation from language neophytes to language masters. Furthermore, since many aspects of this transformation appear to be universal across children (e.g. see Brown 1973), one might expect to observe a similarly universal pattern of change in adult speech in response. There is solid evidence to support the claim that adult speech to children changes greatly in many ways as children age (e.g. Baldwin & Baldwin 1973, Bellinger 1979, Blount 1972, Broen 1972, Fraser & Roberts 1975, Gleason 1973, Longhurst & Stepanich 1975, Nelson 1973, Phillips 1973, Snow 1972; see reviews by DePaulo & Bonvillian 1978, Gleason & Weintraub 1978, Snow 1977, Vorster 1975). However, these studies all examined the properties of adult speech in isolation from one another and so did not address the issue of patterns of change. Anecdotal reports that 'everyone does it' in reference to the use of the baby-talk register are common, but we do not know the degree to which everyone does it 'in the same way' when speaking to children of the same age, i.e. whether the co-occurrence relationships among the many aspects of the baby-talk register are consistent across speakers over time.

The purpose of this study is to determine whether or not mothers' speech follows a consistent pattern of change across speakers as children get older. The strongest support for the hypothesis that it does would be the demonstration that one can predict the age of the child to whom a particular mother is speaking simply by comparing the co-occurrence relationships which characterize her speech to the co-occurrence relationships which are known to characterize the 'typical' speech which mothers address to children of various ages. If there is little or no overall consistency in the speech which mothers tend to address to children of a certain age, then the accuracy with which the children's ages can be predicted from samples of mothers' speech will not exceed the level of chance. If, however, it does, we may conclude that the evolution of maternal speech style follows a stereotyped course as children age.

METHOD

Subjects

A cross-sectional sample of 40 mother–child pairs participated in this study. The sample was divided into four groups of 10 pairs on the basis of the child's age: 1;0 ($M = 12{\cdot}2$ months, $SD = 0{\cdot}6$), 1;8 ($M = 20{\cdot}0$, $SD = 0{\cdot}8$), 2;3 ($M = 27{\cdot}0$, $SD = 2{\cdot}3$), and 5;0 ($M = 60{\cdot}1$, $SD = 3{\cdot}5$). These particular ages were chosen because they are generally thought to correspond to landmark acquisitions on the road to language competence: production of the first word, production of the first syntactic combinations, control over most sentence modalities as well as the ability to create complex sentences, and mastery of most of the essential grammatical constructions. It was felt that, if mothers' speech changes as children's linguistic abilities change, targeting children of these ages would increase the likelihood of detecting differences between groups of mothers. The original design called for observing a group of 2;6-year-old children and their mothers. However, children of precisely this age proved difficult to find and the mean age of the third oldest group ended up three months on the young side.

The female : male ratio in the four groups was 7:3, 6:4, 8:2, and 4:6, respectively. All pairs were white and members of either the local university or professional community.

Procedure

Each mother–child pair was observed under semi-structured conditions in a laboratory 'playroom' setting. The mother was asked to involve her child in several specified tasks which were known from pre-test or normative data to be too difficult for the average child of that age to complete without aid. The mother was told that an observer behind a one-way mirror would be tape-recording her interaction with the child, but she was not told until after the session that mothers' verbal behaviour was the focus of the study.

Each session, which lasted 30–60 minutes, depending on the child's endurance, was recorded on a two-channel audiotape. The output of the four wall-microphones in the playroom was mixed and fed into one channel of the tape recorder while the observer's running description of the interaction was fed into the second channel. The output of a tape which marked the passage of each 15 sec interval was fed into both channels.

After the transcripts of the sessions had been prepared, samples of mothers' speech were selected for analysis. In order to eliminate bias in the sampling process, the data base for each mother consisted of the first 100 codable utterances which occurred following the three minute mark of the session.

Coding

Mothers' speech. Twelve aspects of mothers' speech were considered in the analyses reported. They formed a subset of a much larger number of measures which were originally coded. Both empirical and theoretical considerations guided the selection of these 12 variables from the complete set. First, as in other studies using discriminant function analysis (e.g. Bartak, Rutter & Cox 1977, Carpenter, Strauss & Bartko 1973), a variable, to be included, had to change significantly over groups, though the shape of the function was immaterial. (The frequency of some of the speech features selected increased or decreased linearly, others in a saltatory fashion, over the age range.) Secondly, from among those variables which satisfied this empirical criterion, an effort was made to select variables from each of the following levels of linguistic structure: syntactic, semantic, pragmatic, and discourse, in order to compare the relative importance of these levels in discriminating speech to children of different ages. A final consideration was the relevance of a variable to the theoretical controversies which structured discussions of maternal input at the time the data were collected and analyzed (e.g. the importance of speech relating to the here-and-now, the impact of discrepancies of different sorts between deep and surface structure).

The variables used are the following:

(1) Dependence on the verbal context: the percentage of utterances which cannot be interpreted in isolation from their verbal context, i.e. without retrieving information encoded in one or more previous utterances (hereafter VERBCONTEXT).

(2) The frequency of reference to objects which have only a 'hypothetical' existence in the sense that they are not present in the nonlinguistic context (HYPOTHETICAL).

(3) The percentage of utterances which are directive in illocutionary force (DIRECTIVE).

(4) The percentage of directives phrased in interrogative syntax (e.g. *Can you put these in the box?*) (INTERROGATIVE).

(5) The percentage of directives phrased in declarative syntax (e.g. *These blocks have to be picked up.*) (DECLARATIVE).

(6) The percentage of utterances which are indirect speech acts (INDIRECT ACT).

(7) Mean length of utterance in words (MLU).

(8) The percentage of utterances which contain two or more clauses (MULTICLAUSE).

(9) The percentage of utterances which are single words (SINGLE WORD).

(10) The percentage of information transmissions designed to attract the child's attention (ATTENTION).

(11) The frequency with which the overt forms of utterances lack information which is implicit in the nonverbal context and which provides the frame within which the information explicitly encoded should be interpreted. For example, a mother might comment that *The star is hard* to a child who is attempting to place a star into a formboard. The star is 'hard', however, only in the context of certain tasks. It might be quite easy for a child to identify the star in an array of objects. The message the mother intends to convey is something like 'The star is hard to place in the formboard'. She deletes the infinitival complement on the assumption that the child is fully cognizant of the context within which her comment should be interpreted (NONVERBCONTEXT).

(12) The frequency with which mothers' utterances constitute part of a syllogism-like inference which lacks one of the premises and/or conclusion. The missing information must be inferred, as it is not specified in either the immediate linguistic or nonlinguistic context. For example, in response to the child who, labouring over the placement of a puzzle piece, asks *Where does it go?*,

the mother replies *Well, it has straight edges.* The second premise, not overtly expressed, but necessary if the child is to grasp the mother's point, is 'Pieces with straight edges go around the outside'. The child must then integrate these two pieces of information to infer the implied conclusion 'Therefore, that piece goes around the outside' (SYLLOGISTIC).

Children's speech. One aspect of the children's speech was coded: the mean length (in words) of the utterances which each child produced during the same period from which his or her mother's utterances were sampled.

Reliability

Intra-coder reliability was assessed by re-coding, after approximately one year, the 100 utterance samples of 12 mothers (three randomly selected from each of the four groups). The percentage agreement between the original and the re-coding averaged 80·7 for the 12 variables (median of 84·8). The separate values were as follows: VERBCONTEXT: 94·0; HYPOTHETICAL: 77·1; DIRECTIVE: 85·3; INTERROGATIVE: 89·4; DECLARATIVE: 61·4; INDIRECT ACT: 75·5; MLU: 98·7; MULTICLAUSE: 98·0; SINGLE WORD: 95·0; ATTENTION: 84·3; NONVERBCONTEXT: 59·4; SYLLOGISTIC: 50·0.

Organization and logic of the analyses

As outlined in the introduction, the strategy used for predicting the age of the child being addressed by a particular mother was to compare her speech to that typically used by mothers to address children of various ages. To make this comparison, it was first necessary to characterize the speech 'typically' used to address children of various ages. Then the speech of the mother about whom a prediction was to be made had to be characterized along the same dimensions. Finally, it was necessary to decide which group of mothers the target mother most resembled in terms of speech style.

A statistical method which permits one to make these determinations is discriminant function analysis. At base, this is equivalent to multiple regression except that the criterion or dependent variable is categorical rather than continuous, so subjects can be sorted into discrete groups. (In the present study, the groups represent particular values of a continuous variable, child age.) Because several predictor variables are considered in terms of their relationships both to one another and to the criterion variable, discriminant analysis is well suited to the problem of identifying the co-occurrence relationships which define speech styles. Like many multivariate methods, it is based on an optimizing strategy. The predictor variables are assigned weights and combined to form one or more orthogonal linear components (termed DISCRIMINANT FUNCTIONS). The weights are assigned such that the average scores on the composites achieved by the subjects in the different groups are as different as they can possibly be. The limit on the magnitude which the between-group differences can reach is the extent to which the subjects' scores on the predictor variables co-vary with the variable which defines group membership.

The predictive capability which one acquires with discriminant analysis stems from the fact that one can take an individual subject's scores on the predictor variables, derive scores for this subject on the composite functions and use these function scores to classify the subject into one of the groups, i.e. to 'predict' which group he or she is most likely to be a member of. This is done by calculating the probability that the subject's function scores were sampled from the distribution of scores achieved by the members of each of the different groups; in other words, by determining the probability that a subject who actually belonged to each of the groups would achieve the particular function scores of the subject in question. This subject is then predicted to be a member of the group associated with the highest probability. (Note that in the present study, predicting the group membership of a mother is equivalent to predicting the age of the child to whom she is speaking.) As mentioned, discriminant analysis maximizes the relationships (specifically, the multiple correlation) between the predictor variables and the criterion variable. This maximization will be somewhat specific, though hopefully not too much so, to the particular sample of subjects whose data were used to derive the functions (the 'derivation' sample). Therefore, the predictions will generally be biased in favour of the researcher if these subjects are the same ones for whom group membership is predicted on the basis of their function scores. The usual strategy for eliminating this bias is to derive the functions using the data from only part of the sample and to classify the remaining subjects on the basis of their scores on these functions. If the functions are accurate in classifying these test cases of 'unknown' group membership, one may conclude that the structure which they describe does characterize the behaviour of the population of subjects under study, not just the behaviour of the subjects in the derivation sample. This split-sample technique can thus be used to test the general discriminative utility of the functions. Except when the relationships between the predictor variables and the criterion variable (and among the predictor variables themselves) are extremely stable throughout the population as a whole (i.e. not idiosyncratic to the subjects used to derive the functions), one should not expect that the predictions of group membership for subjects in a 'test' sample will be as accurate as those for the subjects in the derivation sample. In the present study, finding that the accuracy of the predictions for the mothers in the test sample approximates the accuracy of the predictions for the mothers in the derivation sample will constitute strong evidence for consistency across mothers in the evolution of the speech style used to address language-learning children.

In the analyses reported here, the validation procedure was carried out in the following way. The discriminant functions were derived using the data from seven randomly chosen mothers from each of the four age groups ($N = 28$). The functions were then used to predict the group membership of the 12 'unknown' cases (i.e. the remaining three mothers in each group). Since the actual group membership of these cases was known, the accuracy of the predictions could be readily assessed.

To be sure that the level of predictive accuracy achieved in the validation analysis was reliable and not dependent on the particular group of mothers used as the derivation or test samples, this analysis was repeated twice (hereafter referred to as Repetition 1 and Repetition 2), each time using a different set of 12 mothers as the test sample. Three mothers from each group, none of whom had served as a test case in the original validation analysis, assumed this role in Repetition 1. Three of the remaining four mothers who had not served in this capacity in either the original validation analysis or in Repetition 1 did so in Repetition 2. Thus, 9 of the 10 mothers in each group eventually served as a test case. It should be emphasized that these 'repetition' analyses were not performed on independent samples of subjects. Since they assessed within-sample rather than across-sample consistency, they are not true replications.

Additional discriminant analyses were carried out using only a sub-set of the 12 predictor variables (NONVERBCONTEXT, SYLLOGISTIC, VERBCONTEXT, HYPOTHETICAL, INTERROGATIVE, DECLARATIVE and INDIRECT ACT). In contrast to the variables dropped (MLU, MULTICLAUSE, ATTENTION, SINGLE WORD and DIRECTIVE), these index some of the ways in which the content of an utterance can be abbreviated, obscured or left implicit. For instance, they indicate the frequency with which mothers force their children to recover anaphoric information, negotiate reference to objects which are not present in the here-and-now, determine the force and content of indirect speech acts, compute implied information, and so on. The purpose of reducing the set of predictor variables in this way was to see whether the accuracy in predicting mothers' group membership on the basis of these rather subtle and seemingly stylistic aspects of the pragmatic and discourse structure of their speech is as good as when the set of predictor variables includes measures of the more obvious and conceivably more child-age specific surface properties of mothers' utterances such as MLU, number of clauses per utterance, etc.

Table 1 summarizes the relationships among the classes of discriminant analyses performed. Classes 1 and 3 are primarily exploratory in that the functions were derived using the data of all 40 mothers in the sample on the

TABLE 1. *Relationships among classes of analyses*

Number of dependent variables	Number of mothers from whose data functions constructed: Full sample	Partial sample
Full set of 12	Class 1	Class 2
Subset of 7	Class 3	Class 4

TABLE 2. *Standardized coefficients assigned to predictor variables on function 1*

	Classes of analyses							
	1	2			3	4		
Predictor variables		Initial	Repetition 1	Repetition 2		Initial	Repetition 1	Repetition 2
Nonverbcontext	−0·025	0·056	−0·072	0·026	0·212	0·296	0·221	0·094
Syllogistic	−0·018	0·109	−0·138	−0·095	0·196	0·234	0·067	0·214
Verbcontext	0·252	0·153	0·121	0·245	0·411	0·295	0·415	0·369
Hypothetical	0·088	0·278	0·155	0·217	0·219	0·407	0·154	0·161
Interrogative	0·055	−0·100	0·108	0·081	0·195	0·198	0·127	0·277
Declarative	0·227	0·056	0·184	0·233	0·335	0·146	0·316	0·500
Indirect act	−0·201	−0·043	−0·226	−0·464	−0·206	−0·106	−0·351	−0·208
MLU	0·309	0·404	0·253	0·010	*	*	*	*
Directive	0·020	−0·099	−0·019	0·217	*	*	*	*
Multiclause	−0·026	−0·212	0·019	−0·062	*	*	*	*
Single word	−0·130	−0·032	−0·130	−0·464	*	*	*	*
Attention	−0·293	−0·229	−0·468	−0·087	*	*	*	*

[*] A variable was not used in an analysis.

TABLE 3. *Means of mothers' scores on function 1*

	Classes of analyses							
	1	2			3	4		
Child age		Initial	Repetition 1	Repetition 2		Initial	Repetition 1	Repetition 2
1;0	−1·291	−1·191	−1·373	−1·215	−1·131	−1·145	−1·106	−1·180
1;8	−0·534	−0·582	−0·459	−0·657	−0·572	−0·442	−0·646	−0·539
2;3	0·734	0·503	0·915	0·747	0·453	0·190	0·499	0·569
5;0	1·091	1·270	0·917	1·126	1·249	1·397	1·253	1·150

assumption that using the largest data base available yields the best estimate of the relationship between the criterion variable and the predictor variables. As noted, however, using the functions (which describe these relationships) to predict the group membership of these same subjects yields an inflated estimate of the functions' predictive power. Accordingly, Classes 2 and 4 represent attempts to validate the discriminative power of the functions constructed from the different sets of predictor variables. As described earlier, there are three analyses reported for both the Class 2 and Class 4 validations: one initial and two repetitions.

In a discriminant analysis, the number of significant functions constructed (in the typical case, up to a maximum of one less than the number of groups of subjects; see Cooley & Lohnes 1971) depends on the number of dimensions along which the groups can be differentiated using the subjects' scores on the predictor variables. In each analysis performed, the first function derived was, by far, the most important, accounting for an average of 86·4% of the variance in the predictor variables. Therefore, the discussion will focus primarily on the characteristics of the first function in each analysis (although the predictions of mothers' group membership in each analysis were made using all the significant functions derived). Tables 2 and 3 present various kinds of information about the first function derived in each analysis. Table 2 presents the weights ('standardized coefficients') assigned to each predictor variable. The absolute value of a weight suggests the relative contribution of a variable to the discriminative power of a function. The mean scores ('centroids') achieved on the first function by the mothers in each group in each analysis appear in Table 3. These indicate the direction and magnitude of the group differences in mothers' scores on the first function.

RESULTS

General characteristics of the discriminant functions

Since the pattern in the differential weighting of the predictor variables on the first function remained consistent across all analyses, it will be discussed once rather than repeated for each analysis. It is evident from Table 2 that there were occasional perturbations in the size of the weights assigned to a variable but, on the whole, the rank ordering of the variable weights was stable. For the full set of 12 predictor variables which entered into the Class 1 and Class 2 analyses, W, Kendall's coefficient of concordance, was 0·746, $\chi^2\,(11) = 32{\cdot}82$, $P < 0{\cdot}001$. Similarly, for the 7 variables which entered into all 8 analyses, $W = 0{\cdot}660$, $\chi^2\,(6) = 31{\cdot}68$, $P < 0{\cdot}001$.

Repetition of the Class 1 analysis using a step-wise method of variable entry (Wilkes' selection criterion) indicated that DIRECTIVE and SINGLE WORD were the only variables whose inclusion in the functions did not significantly increase the amount of variance in the criterion variable, child age, which could be accounted for. A similar step-wise repetition of the Class 3 analysis indicated that all 7 variables included in the pragmatic/discourse subset accounted for significant portions of the variance in child age. (It should be noted that because these variables are highly intercorrelated, it is misleading to speak of their 'independent' contributions; see Darlington 1968.)

In general, the predictor variables which contributed most to the discriminative power of the functions were VERBCONTEXT, HYPOTHETICAL, MLU, DECLARATIVE (all positively weighted), INDIRECT ACT and ATTENTION (both negatively weighted). In other words, the mother who achieved a high score on the first function produced speech that was characterized, on the syntactic level, by long utterances; on the semantic level by few attempts to gain her child's attention, but by many references to objects which were not present in the here-and-now; on the pragmatic level by frequent use of declarative surface forms to convey directive intent, though by relatively few indirect speech acts overall; and, on the level of discourse, by utterances which could not easily be interpreted without retrieving information from their verbal contexts. These are generally the trends which one would expect from a reading of the literature, though the greater prevalence of indirect speech acts in the conversation addressed to the younger children is, perhaps, somewhat surprising at first glance. It was due mostly to the greater production by these mothers of relatively explicit 'lexicalized' (Ervin-Tripp 1977), routine-like forms such as *Can you put the blocks away?* or *Do you wanna put the blocks away?*.

Relationship between mothers' function scores and child age

In each analysis, the mothers' scores on the first function were related positively and monotonically to the age of the child being addressed (see the group centroids presented in Table 3). It is evident that the relationship between child age and the magnitude of the mothers' function scores is not linear, in that mothers' function scores increased an average of 0·081 per month when the children were between 1 ; 0 and 1 ; 8; 0·161 when they were between 1 ; 8 and 2 ; 3, and only 0·018 when they were between 2 ; 3 and 5 ; 0. A more illuminating way to assess differences in the degree to which mothers belonging to adjacent groups are discriminable would be to see where the mean function scores of the mothers in a particular group would fall (in terms of standard deviations from the mean) in the distribution of scores of mothers in adjacent groups. This strategy uses information about the kurtosis of the reference distribution, i.e. its within-group variability, as well as the magnitude of the differences between the group means. By this method, over all analyses, the mean score achieved on the first function by the mothers in the 1 ; 8 group exceeded the mean score of the mothers in the 1 ; 0 group by an average of 2·63 standard deviations of the 1 ; 0 distribution. The typical score of the mothers in the 2 ; 3 group was an average of 7·14 standard deviations above the 1 ; 8 mean, while the corresponding figure for the

2 ; 3 and 5 ; 0 groups was 1·54 standard deviations. Hence, the adjacent groups which appear most different in speech style are the mothers addressing the 1 ; 8- and 2 ; 3-year-olds. In contrast, the adjacent groups which appear to be most similar are the mothers of the 2 ; 3- and 5 ; 0-year-olds.

Clearly, the ratio of between- to within-group variability in the mothers' scores on the first functions was very high. In fact, taking account of variation across groups in child age left an average of only 8% of the variance in the mothers' scores to be accounted for by other factors. This is illustrated dramatically in Fig. 1, a plot of the mothers' scores on function 1 and function 2 in the Class 1 analysis. The mothers in the different groups tended to cluster rather

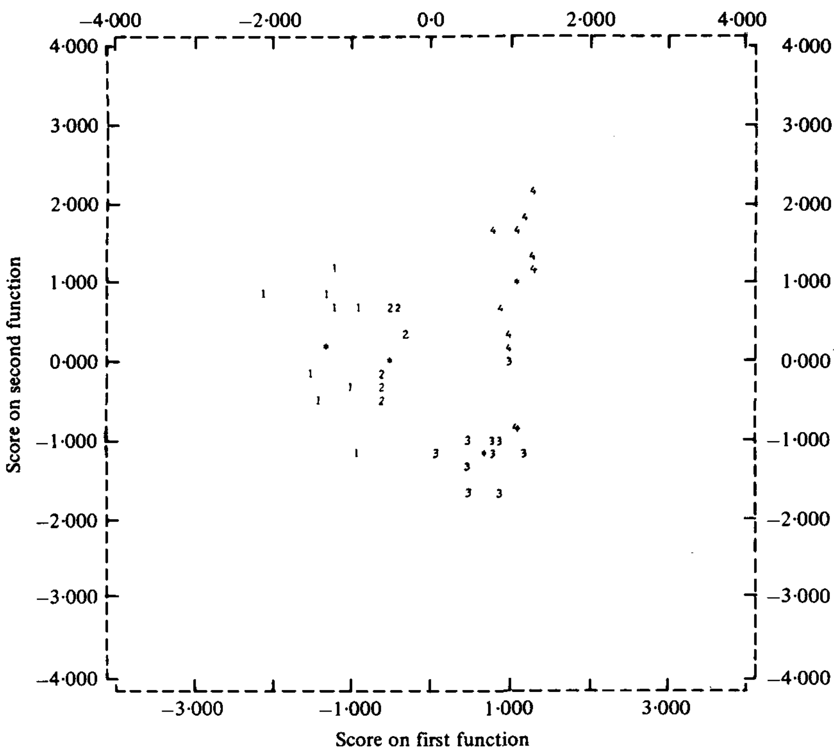

Fig. 1. A plot of mothers' scores on the first two functions: Class 1 analysis. Mothers of the children 1 ; 0, 1 ; 8, 2 ; 3, and 5 ; 0 years old are represented by the numbers 1, 2, 3 and 4, respectively. Group centroids are represented by asterisks. The function scores for some of the mothers within the 1 ; 0 and 1 ; 8 groups are so similar that they cannot be represented separately. Hence, for each of these groups, there are fewer than 10 individuals represented. While the mothers' scores on the first two functions are presented on the same scale, function 1, as noted in the text, was a far more powerful discriminator of groups than function 2.

tightly, and these clusters, defined by the age of the child being addressed, occupied distinctly different locations in the plot. In fact, in this analysis, the 10 mothers who made up the group addressing the 1 ; 0-year-olds had a median probability, based on the aspects of speech assessed in this study, of 0·992 of belonging to that group. The median probabilities that the mothers addressing the 1 ; 8-, 2 ; 3-, and 5 ; 0-year-olds belonged to their respective groups were 0·990, 0·996 and 1·000.

Relationship between mothers' function scores and child MLU

Fig. 2 juxtaposes the curves relating mothers' mean function 1 score to child age and child MLU to child age. The similarities in the shape and time-course of the two curves are striking. In both cases, the change over child age was monotonic but apparently nonlinear, with 1 ; 8–2 ; 3 years as the period of most rapid increase. Change in the multivariate index of mothers' speech appeared to be related more to change in the complexity of the children's speech than simply to their age. The correlation between mothers' function 1 score and child MLU, with child age partialled out, was 0·59 ($P < 0{\cdot}01$); and between mothers' function 1 score and child age, with child MLU partialled out, 0·11 (n.s.).

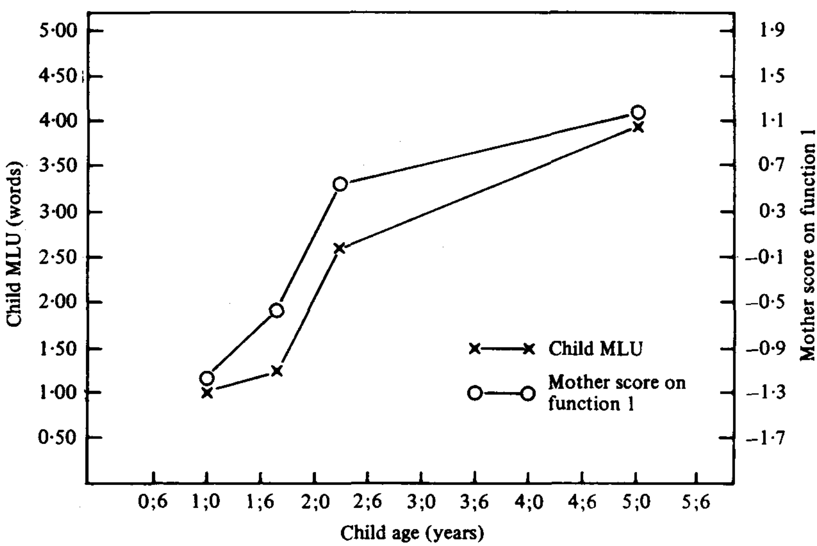

Fig. 2. Mothers' mean score (over all analyses) on function 1 and child MLU plotted against child age. Since function scores and MLU are measured in different units, the fact that the mothers' mean function 1 score is greater than child MLU at all child ages is not meaningful. The beginning points of the scales for these two variables were chosen such that the two data points at child age 1 ; 0 would be nearly coincident, making it easier to compare the curves.

Predictions of mothers' group membership

The predictions of group membership were very accurate in both the exploratory (i.e. Classes 1 and 3) and validation (i.e. Classes 2 and 4) analyses (see Table 4). Generally, the predictions involving the mothers on whose data the functions were based (the derivation sample) were slightly more accurate than the predictions for the mothers whose data did not contribute to the derivation

TABLE 4. *Accuracy of predictions of mothers' group membership*

Analysis	Derivation sample	Validation sample
Class 1	37/40 (92.5%)	
Class 2		
Initial	28/28 (100%)	10/12* (83.3%)
Repetition 1	26/28 (92.9%)	11/12* (91.7%)
Repetition 2	26/28 (92.9%)	6/12*** (50.0%)
Class 3	39/40 (97.5%)	
Class 4		
Initial	28/28 (100%)	9/12** (75.0%)
Repetition 1	25/28 (89.3%)	9/12** (75.0%)
Repetition 2	25/28 (89.3%)	11/12* (91.7%)

*$P \leqslant 0.0001$, **$P \leqslant 0.0004$, ***$P \leqslant 0.06$.

of the functions (the validation sample). Nevertheless, in all analyses but one (Class 2: Repetition 2), these latter predictions were much more accurate than would be expected by chance alone. (Since there are 4 groups of mothers, the probability that the group membership of a mother in the validation sample would be predicted correctly by chance is $P = 0.25$; the expected number of correct predictions by random assignment to groups would be 12×0.25, or 3. The probability levels indicated in Table 4 were determined by expansion of the binomial).

The accuracy of the predictions in the validation analyses suggests that the functions are not simply statistical abstractions whose descriptive utility is limited to the specific sample on which they are based. Rather, the co-occurrence relationships which they describe appear to characterize the linguistic behaviour of mothers other than those in the derivation sample. Furthermore, the functions constructed from the reduced set of predictor variables (i.e. Class 3 and 4 analyses) were no less powerful than those constructed from the full set of variables. Apparently the speech addressed to children of different ages possesses patterns of pragmatic and discourse properties which are sufficiently distinctive to specify the age of the child.

Error analysis. In the eight analyses, the prediction of mothers' group membership was incorrect a total of 30 times. Because there are four groups of mothers, there are six possible prediction errors (i.e. the six ways of selecting two things from a set of four, ignoring order of selection). While only three of the six involve confusing adjacent groups of mothers (i.e. the mothers of the children 1 ; 0 and 1 ; 8, 1 ; 8 and 2 ; 3, and 2 ; 3 and 5 ; 0), 28 of the 30 errors were of this sort. Furthermore, these 28 were not divided equally among the three types. Not surprisingly, the frequency of the particular adjacent-group confusions was inversely related to the magnitude of the adjacent-group differences in mean function scores noted above: 17 (60·7%) involved misclassifying mothers of 2 ; 3-year-olds as mothers of 5 ; 0-year-olds or vice versa; 10 (35·7%) involved misclassifying mothers of 1 ; 0-year-olds as mothers of 1 ; 8-year-olds or vice versa; and the remaining error (3·6%) involved misclassifying the mother of a 2 ; 3-year-old as a mother of a 1 ; 8-year-old. This nonrandom distribution of errors, $\chi^2(2) = 13{\cdot}79$, $P < 0{\cdot}01$, is especially striking given that the age differences between adjacent groups of children are not equal and that the greatest number of errors involved those adjacent groups which differ most in age (the 2 ; 3 and 5 ; 0-year-olds) while the least number of errors involved those groups which differ least in age (the 1 ; 8- and 2 ; 3-year-olds).

A majority of the errors (19 of the 30) were the result of predicting that a mother was talking to a child who was younger than the actual target child was. However, this bias is not significant ($P = 0{\cdot}20$).

DISCUSSION

The fact that mothers' group membership could be predicted very accurately from brief samples of speech confirms the expectation that there is striking consistency across mothers (at least white, well-educated, upper-middle-class mothers) in the way they talk to children of the same age within the 1 ; 0–5 ; 0 year range. Ferguson (1977) has reviewed the evidence that most, if not all, languages provide a variety of modifications reserved largely for use when speaking to immature language-users, most notably children. The present study extends our understanding of this registral specialization by demonstrating that mothers' use of these various modifications is structured at any given child age by a distinctive set of co-occurrence relationships which encompass many levels of structure, ranging from syntactic to conversational. There is a diachronic aspect to this generalization, as it implies that the changes which occur in these co-occurrence relationships as children get older are relatively invariant across mothers. Children who are the same age and, therefore, at roughly similar stages of language acquisition, have access to linguistic data bases which are highly similar. In contrast, speech to children who vary in age shows a degree of variability which is related to the range of the children's ages and also to the particular ages which bound the range. It should be noted that discriminant analysis does not create structure in a set of data, but simply organizes information already present in a way which best serves a particular purpose. If the mothers in the separate groups had not shown any tendency to cluster but, instead, were scattered randomly throughout the multidimensional space defined by the predictor variables, discriminant analysis could not have saved the day by statistical legerdemain.

The differences observed in the discriminability of the pairs of adjacent groups of mothers suggest that the rate at which the mothers' speech changed was greatest when the children were between 1 ; 8 and 2 ; 3 and least when they were between 2 ; 3 and 5 ; 0. These findings are consistent with the univariate analyses reported by other researchers. Studying speech to children 1 ; 6, 2 ; 6, 4 and 6 years old, Fraser & Roberts (1975) found that the largest changes in MLU, grammatical complexity and lexical diversity occurred when the children were between 1 ; 6 and 2 ; 6. Though generally in the proper direction, none of the differences among the three older groups reached significance for any variable. Using a variety of syntactic and semantic measures, Phillips (1973) found that the differences in speech addressed to 0 ; 8- and 1 ; 6-year-olds were slight when compared to those she found between the speech addressed to 1 ; 6- and 2 ; 4-year-olds.

It is reasonable to suppose that this particular pattern of change in mothers' speech is related to concurrent changes in children's language. The $1\frac{1}{2}$- to $2\frac{1}{2}$-year period is commonly regarded as the interval during which the structural sophistication of children's linguistic efforts increases most dramatically and, indeed, it was during the 1 ; 8–2 ; 3 year interval that the children in the present sample made the greatest advances in terms of the mean length of their utterances (0·20 words per month during the 1 ; 8- to 2 ; 3-year interval versus 0·03 and 0·04 words per month during the 1 ; 0–1 ; 8 and 2 ; 3–5 ; 0 intervals, respectively; see Fig. 2). Although children obviously continue to acquire and perfect their linguistic skills after reaching $2\frac{1}{2}$ years of age, it is unlikely that their public language behaviour changes so drastically during any other one year period. Hence, if mothers yoke changes in their speech to changes in children's linguistic abilities, whether only generally or on the level of specific competences, one would expect their speech to undergo its most dramatic changes during this period of most rapid growth in children's language production. The present data bear out this prediction and are compatible with any theory of language development which predicts at least a general relatedness between mothers' and children's speech.

The search for a consistent pattern of change in mothers' speech was based on the assumption that since adults seem to depend somewhat on child cues in modifying their speech, the general absence of individual differences across children in the basic aspects of language acquisition ought to be reflected in a relative absence of individual differences in the speech which adults address to children. However, this study was not designed to test the hypothesis that this is, in fact, the basis for the consistency since child age, not language level, was the criterion variable. However, it appears that, in the case of children who are progressing normally in language development, there is enough information in a mother's speech to predict the age of her child. Dutton & Gleitman (1979) present preliminary evidence that when a child's age and language knowledge are discordant, as in the case of some hearing-impaired children, mothers tend to adjust their speech on the basis of the child's language knowledge. This is consistent with the present finding that mothers' function scores appeared to follow child MLU more closely than child age. However, the search for a 'supervariable' of this sort, the child variable which is the basis for mothers' adjustment of their speech, seems ill-conceived as it does not appear that there is any single child variable which is the one most highly correlated with every aspect of mothers' speech. Newport, Gleitman & Gleitman (1977), Gelman & Shatz (1977) and Newport (1976) have shown that while certain discourse features of mothers' speech (e.g. deixis, expansion, and repetition) are well-tuned to child language level, syntactic features are not. Furthermore, some features of maternal speech appear to change more with child age than any measure of language level (see Cross (1977) for a detailed discussion of the various child indices with which particular aspects of mothers' speech are significantly correlated). The present study demonstrates that in spite of the fact that child age may not be the child variable which is most strongly related to all aspects of maternal speech included in the multivariate index, the relationships are sufficiently strong to specify the age of the child to whom a mother is speaking.

This study illustrates the potential utility of discriminant analysis in investigating various types of linguistic phenomena, especially inherently multivariate phenomena such as 'style', 'dialect', and 'register'. By definition, these imply stable sets of co-occurrence relationships among the many aspects of the speech of an individual or the members of a speech community. For instance, this technique could be applied with great profit to cases of disputed authorship. Previous attempts to 'assign' authorship by comparing the text in question to the known texts of candidate authors have generally proceeded on a univariate basis, relying on features such as vocabulary diversity, word-class distributions, derivational complexity of sentences, use of function words, sentence length, and so on (e.g. see Herdan 1964, Dolezel & Bailey 1969).

Similarly, we could learn much about the context-sensitivity of many aspects of speech by investigating whether it is possible to predict certain salient features of the situation a speaker is in by analyzing a sample of his speech and comparing it to the 'canonical' styles people tend to use in various situations. Some of the more obvious features might include formal vs. informal, high status vs. low status addressee, goal-oriented vs. phatic, or, as in this study, the relative linguistic maturity of the addressee.

Finally, discriminant analysis may aid the researcher who wishes to apply the 'case study' method to a particular linguistic problem. With this technique, he can identify individuals who 'stand out' from the crowd, achieving discriminant function scores which differ substantially from those achieved by other members of some relevant reference group. Fig. 1 shows that a few mothers appear to have used speech which differed from that typically used to address children of her child's age. One mother of a 2; 3-year-old spoke to her child as if he or she were a 5; 0-year-old, while the mother of one 5; 0-year-old used speech which was more like that usually directed to 2; 3-year-olds. There are, of course, many reasons why this may be. The child may have presented cues which were different from those provided by his age-mates (because of either advanced or delayed language development) and his mother responded appropriately to these cues; or the mother may have held idiosyncratic ideas (either innovative or deleterious) about the proper way to respond to her child's age-appropriate cues, and so on. The point is that close longitudinal study of such 'distinctive' mother–child pairs may shed new light on the ways in which the environment does or does not influence the course of children's language development, i.e. the tolerance of different aspects of this process to variations in input language (see Newport *et al.* 1977). While many studies indicate that the language produced by mothers of language-delayed or impaired children differs from that of mothers whose children are progressing normally (e.g. Buium, Rynders & Turnure 1973, Cramblitt & Siegel 1977, Wulbert, Inglis, Kriegsmann & Mills 1975), we cannot be sure that the atypicality of this speech is not a response to the children's language problems rather than their cause. The case approach would be based on the early identification of mothers who are generating input language which is statistically atypical, not children who are experiencing difficulty in acquiring language. Since few studies have focused on a sample selected for the distinctiveness of the parents' rather than the children's language (e.g. Schiff 1979), we know relatively little about the effects on a child's language acquisition of being exposed to an input language model which differs from the one most children hear. A prospective longitudinal study of such a sample may be the eventual strategy of choice for assessing the role of parental speech in children's language development.

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