

## **A Behavioral Analysis of Controversial Topics in First Language Acquisition: Reinforcements, Corrections, Modeling, Input Frequencies, and the Three-Term Contingency Pattern**

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*Due to the antibehaviorist trends that were predominant during the recent decades in the field of language development, it has been generally doubted, overlooked, or simply denied that parental reward/punishment, corrections, imitation, and other learning-theoretical phenomena do have any impact during the course of language transmission/acquisition. R. Brown who collected the most encompassing corpora of mother-child interactions supported this trend by providing authoritative assertions as to the absence of these phenomena. To reevaluate these assertions which had been generally accepted without independent evaluations, the transcripts of Brown were reanalyzed employing equivalent samples of the interactions of Adam and Eve with their mothers. Equivalence was defined on the basis of Mean Length of Utterance which ranged between 1.4 and 4.2 morphemes. Adam was between 27 and 35 months old and Eve between 18 and 27 months during the time of data collection. Thirty-nine teaching techniques of the mothers and 37 learning strategies of the children were differentiated. The teaching techniques included conditioned positive reinforcement, obvious linguistic corrections, conditioned punishment, several forms of less obvious corrections, and various forms of modeling. Frequencies of techniques as well as frequencies of specific linguistic constructions in the input were counted. Patterns of interactions were established by means of transitional probabilities between the techniques and strategies. With the exception of obvious conditioned punishment, high frequencies of specific teaching techniques and of types of linguistic input were encountered. The interactions between the mothers and the children exhibited not only a considerable degree of structure, that is, the patterns occurred with a frequency that by far surpassed chance*

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*cooccurrences, but they also appeared largely to be instructionally highly meaningful. One dyad often employed an overt form of the behavioristic three-term contingency pattern of stimulus-response-reinforcement. It is, therefore, concluded not only that the learning opportunities for the children were overwhelmingly rich but also that learning-theoretical conceptualizations can be useful in describing at least part of the phenomena observable during the process of language transmission/acquisition. Since only a small part of the differentiated phenomena could be readily accounted for by learning theoretical conceptualizations, it is furthermore concluded that these conceptualizations do not seem to be sufficient though they appear to be necessary to account for some aspects of language transmission/acquisition.*

## INTRODUCTION

The controversies between behavioristic and nativistic accounts of language and language development are well-known and need not be repeated here. It is also becoming generally accepted that the extreme nativistic propositions advanced during the last decades conflict with the available evidence. On the other hand, the probably most extensive exposition of a behavioristic account of language behavior (Skinner, 1957) was not built on pertinent factual support either and relied largely upon extrapolations from animal research. Broadly conceived and extensively elaborated programs of behavioristically and neo-behavioristically motivated psycholinguistic research do, however, exist as exemplified by the work of Baer and associates (Baer & Guess, 1973; Guess & Baer, 1973; Guess, Sailor & Baer, 1974), Mowrer (1958, 1960), Osgood (1963), and Staats (1971, 1974). These older endeavors have recently been supplemented especially by Whitehurst and associates (Whitehurst, 1976; Whitehurst & Merkur, 1977; Whitehurst & Vasta, 1975) and K. E. Nelson and associates (Nelson, 1977; Nelson & Bonvillian, 1973). Whereas these investigators could produce impressive evidence as to the malleability of language behavior, the evidence was collected mostly in the laboratory, based upon experimental designs, and its ecological relevance to language acquisition in the natural environment is therefore doubtful. This might be one reason why it was generally not accepted as counterevidence against claims that behavioristic principles are not pertinent to explain naturally occurring first language learning. Especially the pronouncements of Brown and his associates regarding the absence of reinforcements (Brown & Hanlon, 1970), the nonexistence of syntactic corrections (Brown, Cazden, & Bellugi, 1969), and the ineffectiveness of input frequency (Brown, 1973) were widely and uncritically accepted without independent evaluations. The impressive results of Bandura and associates (e.g., Bandura & Harris, 1966; Odom, Liebert, & Hill, 1968) had similarly little

effect upon theoretical preconceptions even though effects of modeling have often been reconfirmed.

In contrast to this laboratory and experimental evidence, many ecologically valid findings have been accumulated on how children acquire their language in the home and on how mothers interact with their language learning children (e.g., Broen, 1972; Cross, 1977; Moerk, 1974). Whereas these findings are rich and impressive, there exist at least two basic problems concerning their application to learning-theoretical conceptualizations. First, they generally lack one feature that is of utmost importance for behavioristic theories, that is, that of contingency/contiguity analysis. Reinforcements, corrections, modeling, or frequency effects can only be meaningfully conceptualized if the target behaviors are ascertained together with their antecedents or consequences. And, as the conceptualization of most of these terms implies, these contingencies have to be reasonably close in time (though certainly not immediately consecutive) to justifiedly employ the terms in question. If long intervals are tolerated between presumed causes and effects, as in the repeatedly employed crosslagged correlational analyses, both the long time-lag and the correlational methodology make assumptions about cause-effect relationships very tenuous. The interactional structures presupposed in the above-named behavioristic conceptualizations are of differential complexity: Simplest is the case of modeling and imitation, where a two-term contingency suffices. For corrections, a three-term contingency should be explored: the mistake, its correction, and its immediate effect upon the child. In the case of reinforcements and frequency effects, multiunit contingencies are implicated. In the case of reinforcements they are: the behaviors, the repeated reinforcements, and the increase in the frequency of the reinforced behaviors. In the case of frequency effects they are: the repetitions of the input and their effects in first partially correct attempts and finally fully correct productions by the child.

The second problem is even more basic. Since most investigators subscribed to a cognitive/antibehavioristic position, they showed little interest in the behavioristically relevant categories of verbal behavior. Few tabulations of even simple frequencies of the pertinent phenomena, such as reinforcements, corrections, or input repetitions exist. The existing tabulations stem from very few researchers, (especially Brown, 1973; Moerk, 1978; Savic, 1975) of whom only Brown's voice carried weight in the U.S. research community. The present, almost consensual rejection of these principles rests, therefore, basically upon the conclusions of a single author.

Only quite recently, can a change in this unquestioning acceptance of

this antibehavioristic stance be noticed. The first reevaluation seems to have been presented by Forner (1977). Next, Moerk (1980) utilized Brown's own data and came to conclusions about frequency effects that were diametrically opposed to Brown's reports. This trend of critically questioning and evaluating previous data and interpretations will be continued in the present study. Since obviously not all of the complex analyses can be accomplished in a single study, two partial goals have been chosen. It will be explored whether or not the phenomena proposed by behaviorists are to be found. In addition, a general impression of the intensity of the verbal interactions between the mothers and the children will be provided. This general impression will then be differentiated by providing observed and estimated frequencies of specific linguistic inputs. Finally, since contingencies are highly important in learning theoretical conceptualizations, it will be explored whether evidence for the main learning-theoretical pattern of stimulus-response-reinforcement can be found. Following the learning theoretical emphasis, adult-child-adult turn-sequences will be focused upon and only the more frequent patterns will be presented. More complex and temporally more encompassing phenomena will be discussed in forthcoming publications. Questions as to the effect of these input and feedback phenomena can in the present context at best be raised as interesting hypotheses. To answer them, differently designed analyses have to be performed.

## METHOD

The interactions analyzed are derived from the two dyads whose child partners have been made famous by Roger Brown under the names of Adam and Eve. For Eve, Brown's total range of interactions was used, spanning an age range from 18 to 27 months and an MLU range from around 1.5 to 4.0 morphemes per utterance. For Adam, an approximately matched sample was utilized, spanning an age range between 27 and 35 months and an MLU range between 2.0 and 2.5 morphemes. For both dyads the analysis began with the earliest transcripts collected. Of the 20 two-hour samples collected for Eve, every second one was used. The equivalent samples of Adam encompassed altogether 18 two-hour recordings of which also every second sample was utilized. The reasons for reanalyzing the transcripts collected by Brown were manifold: (a) the scope and longitudinal span of the transcripts cannot easily be matched,

(b) the quantity of information contained in them is great indeed, and (c) Brown and associates have presented many excellent analyses concerning the children's progress in their language skills. When the present investigations provide evidence concerning the processes of teaching and learning involved in language transmission, these process aspects can then be matched with the product aspects contained in Brown's and others' studies.

The overall approach to the analysis, of which only selected features will be emphasized in the present report, involved a differentiation of multiple aspects of the interaction. Each utterance was categorized according to its content as referring to either a new, old, or partially new topic, or as a return to an old topic after an unrelated subtopic. Illocutionary Force aspects were differentiated in order to specify the functional/pragmatic dimension of the interactions. Finally, as the main concern for the present report, 39 categories for maternal teaching techniques and 37 categories for children's learning strategies were established and all utterances were classified accordingly and computer-coded in their sequential arrangements. Since many utterances entailed more than one technique/strategy, multiple coding of up to three techniques/strategies per utterance was employed. The maternal teaching techniques and the filial learning strategies were defined in an identical manner with the exception of a few items. Those that are pertinent for the present goal will be introduced and explained in the Results Section. Many of the categories are well known from the literature on maternal language input (especially, Cross, 1975) and on children's language exercises (especially R. Clark, 1974; Weir, 1962). Only minor clarifying remarks will, therefore, be added when these categories are introduced. Detailed explanations of the coding procedures, the reliability problems, and the way they were handled are discussed in Moerk (1983) or can be obtained from the author. Due to the complexity of the task at hand, including a highly differentiated coding system, the minimum goal for reliability had to be lowered to 80 percent. Whereas for most samples the reliability was above 90 percent, for some few samples the percentages of agreement between various coders were only in the 80s. One point, however, is essential for the evaluation of the following results and it has to be emphasized here: Teaching techniques and learning strategies were only coded in regard to items that either of the children did not yet master fully. They represent, therefore, really opportunities for the improvement/acquisition of linguistic items.

## RESULTS

### The Overall Intensity of the Verbal Interactions

Before any finer differentiation of the interactional phenomena is to be attempted, a first general description of the overall intensity of the verbal interactions appears desirable. It is highly probable that the overall extent of the input and use of language forms would affect the acquisition and mastery of the child's language skills. This overall description and also all the subsequent tables entail two major aspects: a demonstration of the communalities between the two dyads and a contrasting discussion of the differences between them.

Some of the major communalities between the two dyads will be summarized first. The first point to stand out from Table I is the overall intensity of the interactions in both dyads. In the samples analyzed, some 10,000 to 11,000 utterances were exchanged between the partners in either dyad. Expressed in hourly frequencies in the rightmost column for each dyad, this results in between around 500 to around 650 utterances per hour. Since the average length of these utterances will lie somewhere between 3 and 5 words, computed from both mothers and children together, between 1,500 and more than 3,000 rehearsals of words occur on the average during these single hours of interactions. Many of these repetitions will pertain to well-known words so that they do not require much information processing capacities of the child. But just this fact will make it more probable that the less known or new words that are repeatedly employed have a higher chance to be retained in long-term memory.

Considering the syntactic learning possibilities afforded by these

**Table I.** Overall Differences in Input and Interactions Between the Two Mother-Child Dyads

Interactional aspects	Dyad with Adam			Dyad with Eve		
	<i>F</i>	%	Per hour	<i>F</i>	%	Per hour
Total Utterances <i>C</i>	7,256	62.7	403	4,067	41.8	203
Total Utterances <i>M</i>	4,313	37.3	239	5,667	58.2	283
<i>N</i> of Strategies <i>C</i>	10,719	56.3	595	6,491	39.2	324
<i>N</i> of Techniques <i>M</i>	8,323	43.7	462	10,068	60.8	503

interactions, a similar wealth of opportunities appears. As evident from Brown (1973, p. 124, Table 17) and from Table III, most utterances of the children and the mothers are based upon the semantic Agent-Action-Object pattern which is syntactically reflected in the S-V-O pattern. In both types of patterns, single elements are optional, at least in the case of young children. Combining this evidence with the data from Table I, it can be seen that the children have hundreds of opportunities per hour and thousands of occasions in the entire sample to exercise the basic sentence patterns either by hearing or by producing them.

As far as the most basic aspect of the dyadic interactions is concerned, it can be concluded that with rehearsals that reach the hundreds or even the thousands per hour, a high number of trials is provided for the child; a number which would lead to speedy learning even in species less intelligent than the human child.

Turning to filial learning strategies and maternal teaching techniques, this first impression is strongly supported. As evident from Table I, mothers employ around two teaching techniques per utterance and children use three learning strategies per every two utterances. As will be remembered, the techniques and strategies were defined as pertaining only to incompletely mastered linguistic items, i.e., they serve to introduce, clarify, or rehearse some new, rare, or not yet fully mastered element or construction. The frequencies encountered under these headings indicate therefore more specifically the teaching/learning episodes the children encounter, as contrasted to the total number of utterances discussed above, wherein no differentiation as to well known versus imperfectly mastered items was made. The hourly frequencies of the combined strategies and techniques are between 800 and 1100 for Eve and Adam, respectively. For the total sample they range from over 16,000 to over 19,000 for the same two children.

Whereas these overall frequencies are impressive in themselves, they have to be contrasted with the small range of items the child in the age range of two to three years is learning. These are: (a) two basic sentence frames, the full verb and the copula sentence, (b) a quite restricted range of prepositional and noun phrases, and (c) a vocabulary somewhere in the range of a few hundred to one thousand words. This comparison of items to be learned with hourly learning opportunities indicates that the rehearsal frequencies even of specific linguistic constructions and specific vocabulary items must be considerable indeed.

Several potentially important differences between the dyads can be seen in Table I too. They are more obvious in the comparison of the percentages and these will therefore mainly be relied upon in the

discussion. For the total numbers of utterances, a reciprocal frequency distribution between the children and the mothers in the two dyads is evident: The percentages for the child versus the mother stand in a relationship of 3:2 in Adam's dyad, whereas they are 2:3 in Eve's dyad. Eve's mother is a good deal more active in her contributions to the conversations than her child, whereas in Adam's case it is just the reverse. In absolute numbers too, Eve receives around 25 percent more input than Adam, whereas Adam surpasses Eve both relatively and absolutely in the production of utterances.

A similarly reciprocal contrast is found in respect to the learning strategies employed by the children and the maternal teaching techniques. The relationship between filial strategies and maternal techniques is 5:4 in Adam's dyad and in Eve's dyad it is 2:3. Expressed as percentages, Eve's mother contributed 61 percent of all instructional/learning endeavors whereas Adam's mother contributes only 44 percent. The absolute numbers of maternal techniques differ somewhat less between the two dyads but they are still clearly in Eve's advantage. In contrast, both relatively and absolutely, Adam surpasses Eve considerably in the use of learning strategies. These contrasts are in good accord with the informal impression gained from the transcripts, that Adam was more left to his own devices in his attempts to acquire language.

It will be remembered that Eve was younger but linguistically on a similar level to Adam at least as measured by Brown's MLU (mean length of utterance in morphemes). It is therefore tempting to speculate that Eve's faster progress was due to the higher involvement of her mother in the language transmission process. On the other hand, the causal factor could lie in the children, i.e., their age, sex, verbal fluency, or any other difference could have led to the mothers' differential behavior. The present correlational data of two subjects do not permit the elimination of either interpretation. The investigator's informal impression from the transcripts, especially regarding the interactional contingencies, wherein the feedback of Eve's mother generally seemed to fit Eve's productions better, would support the hypothesis that the mothers were at least partly the causal factors.

Summarizing the data in Table I, both similarities and differences between the two dyads need to be considered. The similarities consist mainly of the overall high frequencies of input and exercise as well as of learning strategies and teaching techniques specifically. Nevertheless the dyads differ too, not only in general interaction frequency wherein Adam's dyad surpasses Eve's by between 10 and 20 percent, but also in the differential predominance of the individual partners. In Eve's dyad,



the mother is clearly predominant in overall volubility and even more so in the support she provides in the form of teaching techniques. This higher level of supportiveness will be encountered in several of the following tables. When evaluating these findings, it has to be kept in mind that both dyads represented upper middle class life styles, at least as the intellectual level is concerned. If families from widely differing backgrounds were compared, larger differences and lower communalities might be expected.

### *The Major Categories of Maternal Instructional Techniques*

After a general impression of the interaction phenomena has been gained, a finer differentiation of the interaction types is advisable. Since behavioristic aspects are emphasized in the present analysis, the behavioristic emphasis upon input, i.e., upon the possibly causative behaviors of adults will be retained. Such a focusing for a specific emphasis does, however, not imply that the child's learning strategies are considered less important. The 39 teaching techniques of the mothers that were differentiated are summarized in Table II under a few more overarching headings; the latter being chosen for data reduction purposes and because they have been emphasized in behavioristic or at least behavioristically oriented theories. Since these overarching headings subsume up to 10 subcategories, a detailed description of the full extension of the terms can not be provided here. They can be found in

**Table II.** Instructional Techniques Employed by Two Parents

Technique	Adam's mother		Eve's mother	
	<i>F</i>	%	<i>F</i>	%
Expansions	673	3.53	623	3.27
All imitations	790	4.15	1642	8.62
All self-repetitions	2335	12.26	2729	14.33
All initiating models	924	4.85	1191	6.25
Obvious corrections	232	1.22	245	1.29
Syntactic analyses				
across partners	1159	6.09	1393	7.32
Vocabulary rehearsal				
across partners	605	3.18	832	4.37
Conditioned positive reinforcement	75	.39	474	2.49
Conditioned negative reinforcement	75	.39	122	.64

Moerk (1983) and can also be obtained from the author together with specific rules for the coding of the utterances.

In general, the categories are well known, either from Brown's own studies or from other investigations of maternal input, especially those of Cross (1975, 1977), but the variety of the functions of these categories might be less self-evident. Both maternal Expansions and Imitations often involve a subtle corrective force. In Expansions the mother provides elements omitted by the child and thereby makes the utterance more complete and mostly more appropriate in respect to the rules of the language. Equally, in her Imitations without Expansions, the mother employs more advanced phonetic patterns, she might rearrange the word order somewhat, or make any of a large number of possible minor improvements. The corrective force of the mother's utterance is nevertheless camouflaged in these two categories by its rewarding aspect, since repetitions/imitations generally imply agreement/acceptance of the preceding utterance. Yet the improvements, being juxtaposed to the child's less accomplished forms, are easily discernible and can be attended to by the child at will. The first two categories integrate therefore a corrective and rewarding force and are related to the categories Obvious Correction and Conditioned Positive Reinforcement in the same table.

Maternal Self-repetitions are, in rare cases, identical and mostly include a range of systematic variations. These diverse variations emphasize in turn specific instructional contents. Initiating Models, too, vary from the introduction of simple labels, to adjectival elaborations, and to dependent adverbial clauses. Both Maternal Self-repetitions and Initiating Models can function as linguistic models for the child. But the first category entails also the aspect of rehearsal while in the second category the model is introduced the first time. The relation between the first two categories of Table II and the present two categories could be described as post-modeling versus pre-modeling. That is, in the case of Expansion and Imitations, the mother models the correct form as feedback, after the child's attempt. In contrast, she models the correct form in her Self-repetitions and Initiating Models, generally before the child had attempted the construction. All four types of behaviors contain much linguistic information.

Conditioned Positive Reinforcement and Conditioned Punishment was conceived narrowly as praise/acceptance and criticism/rejection, respectively. That is, it was defined psychologically and not functionally as a behavior that increases the frequency of a preceding response. Since learning curves were not yet explored, this latter definition could not have been used. In addition, it might also be difficult to delimitate the exact

type of response whose frequency is increased since most utterances of the child consist of many units and the same reinforcement can increase the frequency of anyone of them, of several of them, or only of the response class, such as answers to questions, without leading to an increase in the frequency of specific items that were part of the response. In contrast, verbal praise/acceptance and verbal criticism/rejection can be defined relatively unambiguously at least in their more obvious forms, and this psychological definition serves also to avoid the danger of circularity that is always high when using a purely functional definition in the Skinnerian sense. The pertinent utterances consisted mostly of a "yes" versus a "no" in response to the linguistic form of an utterance, as against the affirmation of a truth statement or its denial. "Good," "well said," "not. . .but," and similar utterances fulfilled the same functions and were also coded as Conditioned Positive Reinforcement and Conditioned Punishment, respectively.

Since the results in Table II are relatively straightforward and the numbers speak for themselves, only a few summarizing remarks are required: Modeling processes are by far predominant. They are largely combined with repetitiveness, as seen from the fact that the frequency of Maternal Self-repetitions is double or triple that of the next most frequent categories in the case of both children. It can not be demonstrated here but has generally been encountered during the study of the transcripts that the mothers took apart and recombined their own syntactic structures in this process of Self-repetition, or they replaced elements therein so that the instructional contribution derivable from these repetitions is more profound than mere modeling and repetition. Both mothers seemed to perform in their repetitions the analytic work required to help their children grasp the structure of their utterances. In contrast to the large frequencies and percentages encountered with the repetitive utterance types in Table II, Initiating Models, which require probably more information processing capacity from the child, are provided less frequently by both mothers. Obvious Corrections, with their potentially negative effects for the motivation of the child, are even rarer. But in agreement with the facts encountered in the study of Self-repetitions by mothers, Syntactic Analyses across Partners are the second most frequent items for both mothers. This category encompasses repetitions of content with changed syntactic form, largely what linguists would subsume under the broad category of "optional transformations." In the present study these phenomena were subdivided into two categories: (1) One was labeled Optional Transformations in a more narrow sense. Changes in Illocutionary Force, such as from assertions to questions,

from requests to refusals, etc., were the critical feature for this subcategory. (2) The other was labeled Frame Variations, which consisted of changes in the syntactic frame of consecutive utterances with retained content but without a change in Illocutionary Force. Both these categories will be encountered in Table IV. Vocabulary Rehearsals across Partners, signifying repetitions of vocabulary items that were new or rare for the child in question, appeared on the average between 30 and 40 times per hour, a fact that might make more readily explainable the relatively fast acquisition of vocabulary. Finally, positively tinged feedback surpassed negative feedback as seen in the comparison of Expansions plus Imitations versus Obvious Corrections and in the comparison of Conditioned Positive Reinforcement with Conditioned Punishment. Perhaps most impressive is the fact that obvious negative feedback follows extremely rarely the child's attempt to master some linguistic skill. Corrections are generally masked as approving imitations and expansions.

Whereas identical patterns predominate in Table II, the differences between the two mothers shall not be slighted. Eve's mother employed percentagewise a good deal more of the instructive techniques and she provided around seven times more Conditioned Positive Reinforcement. But she also reacted more often with Conditioned Negative Reinforcement, even though its relative amount is still below one percent. These differences support again the impression that Eve's mother was more systematically and alertly involved in the language transmission process than Adam's mother.

### **Input Frequencies of Specific Linguistic Contents**

Table III provides a contrast and a complement to the other three tables of this paper. Whereas these tables are mainly focused upon the methods of teaching and learning of a first language, with some minor considerations of interactional intensity and content, Table III focuses fully upon the linguistic elements of the instruction. Of the wide range of possible linguistic contents, syntactic aspects were selected for presentation since the formal aspects of language acquisition have lately been neglected and are still largely unexplored (cf., e.g., Cromer's, 1981, argument).

The subheadings of Table III can be presumed to be largely self-explanatory since they correspond closely to standard grammatical terminology in their form and meaning. The only exception is the category Complex Sentences which includes, besides multi-clause constructions,

**Table III.** Observed and Estimated Population Frequencies of Various Types of, and of Overall Linguistic Input Provided by Two Parents

Adam							SNP	
Time unit	S-V-(0) sentences	Copula sentences	Questions	Complex sentences	Concord	1 element	2 $\geq$ elements	
Hour	131	54	126	22	60	108	7	
Day	1313	537	1262	217	600	1076	69	
Week	9191	3759	8834	1519	4200	7532	483	
Month	39390	16110	37860	6510	18000	32280	2070	

  

Eve							
Time unit	S-V-(0) sentences	Copula sentences	Questions	Complex sentences	Concord	1 element	2 $\geq$ elements
Hour	141	62	65	34	40	110	4
Day	1414	624	647	343	400	1104	39
Week	9898	4368	4529	2401	2800	7728	273
Month	42420	18720	19410	10290	12000	33120	1170

**Table III.** Continued

Adam								
Time unit	VP		ONP		Prepositional phrases	Adverbs	N-Pr. equivalence	Total input in all counted categories
	Full verb only	Full verb + auxiliaries	1 element	2 $\geq$ elements				
Hour	74	76	59	26	52	43	22	860
Day	737	763	589	263	523	428	222	8599
Week	5159	5341	4123	1841	3661	2996	1554	60193
Month	22110	22890	17670	7890	15690	12840	6660	257970

  

Eve								
Time unit	Full verb only	Full verb + auxiliaries	1 element	2 $\geq$ elements	Prepositional phrases	Adverbs	N-Pr. equivalence	Total input in all counted categories
Hour	66	77	47	49	56	39	24	814
Day	660	771	473	494	564	390	242	8140
Week	4620	5397	3311	3458	3948	2730	1694	56980
Month	19800	23130	14190	14820	16920	11700	7260	244200

also sentences with complex non-finite constructions and with multiple subject–noun, object–noun, and verb phrases. But the time units presented in the first column of Table III need brief discussion: Only frequencies per hour were actually ascertained by computing the averages from all the hours of input analyzed for Adam's and Eve's mothers. All the other frequencies are estimates, based upon a day of ten hours of verbal interactions, a week of seven equal days and a month of 30 days. The problems of estimating frequencies for larger intervals are obvious if only hour-long and probably nonrandom samples are available. They and the precautions taken to balance possible overestimates and underestimates have been discussed in Moerk (1983). In spite of such precautions, the possibilities for errors are certainly considerable and the estimated frequencies presented in Table III have, therefore, to be considered only as first and very preliminary approximations. They are presented in spite of their preliminary nature, since it appears that the intensity and extensive nature of the input has largely been disregarded in theoretical discussions of the dynamics of first language transmission/acquisition.

If the estimates provided approximate even to a certain degree the actual frequencies of mother–child interactions in middle-class homes, and since the estimates were conservative the actual frequencies may be higher, then the theoretical implications of the data provided are profound indeed. With around 250,000 instances of the counted items per month, and by far not all items that represent linguistic information were counted, the input per year would approximate three million instances of the counted items. Such immense input could not only account for the relative speed of language acquisition, but it might also return the focus of theorists from cognitive hypothesis testing models to more rote learning explanations as suggested by Jespersen (1924) and Nelson (1981) concerning formulaic speech and by Bolinger (1975) for most idioms and collocations. It being known that the generally used vocabulary, even in conversations between adults, lies only in the range of around 1,000 items and that the range of topics discussed with small children is obviously much narrower, much repetition of specific phrases and sentences (with only minor alterations) has to occur in this abundance of input. Additionally, the topics are often situationally restricted since many mother–child discussions pertain to daily repeated routines. That many phrases will thereby be repeated, with just a sufficient number of minor alterations to make sentence constituents and sentence structure more obvious, can confidently be concluded.

Whereas this astonishing intensity of the input deserved to be emphasized, most of the information in Table III shall not be repeated since its implications are straightforward. Only a few items shall be selected whose importance might easily be overlooked. On a relatively basic level, it is seen that around twice as many full-verb sentences are provided as input than copula sentences. In conformance with this input, reports of children's language development (e.g., Brown, 1973) also show that full-verb sentences are either employed earlier by children or at least much more commonly than copula sentences. On a more specific level, it has been generally found that two- and more-word subject-noun phrases appear long after two- and more-word object-noun phrases. Since the grammatical complexity of both types of phrases appears identical and since children employ single-element noun phrases very early in both sentence positions, this phenomenon defied explanation on the basis of cognitive complexity. As the input relationships of four to one or even of 12 to one between more-word object-noun and subject-noun phrases indicate, their differential use by children could quite readily be due to this differential input frequency. This argument is supported by the recent demonstration of Moerk (1980) that children attempt new constructions, or old constructions containing new vocabulary items, frequently after repeated successive modeling by the adult. If such densely repeated models are found only rarely in the input, as is probable in the case of the rare two- or more-word subject-noun phrases, the child might not try these constructions until relatively late.

In emphasizing overall frequencies and relative frequencies in their possible impact upon acquisition processes and speed of acquisition, it is, however, not suggested that input frequency is the only or even the most important variable affecting processing and acquisition. In agreement with Moerk (1980), acoustic distinctiveness might be assumed to account for the relatively late appearance of concord in children's sentences, which is frequent in adult input but generally expressed in relatively unstressed word-final morphemes. Brown's (1973) emphasis upon grammatical complexity almost certainly will be relevant for the late appearance of complex sentences in child speech, although in this case the situation might be more complicated. Complex sentences might not only be difficult for the young child to process, they are also less often employed by adults in their input; probably just because the latter have experienced that young children cannot easily process them even on a receptive level. The late appearance in child speech would therefore be attributable partially directly to the children's problems in producing

them and partially it would be due, following an indirect path, to the adults' less frequent use of these complex constructions.

In addition to the similarities between the maternal inputs in specific linguistic items, the overall phenomena are in close accordance, too. Both sums are close to a quarter of a million per month, and the frequencies in most specific categories differ only by between 10 and 20 percent; a difference which might largely be attributable to chance factors. Three clear exceptions to this overall concordance are the categories Questions and Concord. Adam's mother asks more questions, that is, she insists more upon answers, i.e., specific semantic productions of her child. She also models around 50 percent more often Concord, i.e., the agreement in number and person between sentence elements, which entails a heavier emphasis upon bound morphemes. This indication of more advanced input on the side of Adam's mother seems to be contradicted by the predominance of Complex Sentences in the speech of Eve's mother. Since Complex Sentences is a broad category, more detailed analyses will have to be performed to establish whether Eve's mother taxes the processing capacities of her child in this case. Otherwise, a slight predominance in Eve's input in the most basic categories, such as S-V-O sentences and copula sentences, seems to appear. These differences are, however, so slight that they are best attributed to chance until contrary evidence is found.

### **Interactional Structures and the Three-Term Contingency Pattern**

Lastly, the structural aspects of verbal interactions shall be searched for analogues or equivalents to the standard behavioristic paradigm, the three-term contingency pattern of stimulus-response-reinforcement. A prerequisite for conceptualizing these conversational turns as stimuli and responses is the interactional dependency of the second item upon the first, whether this be an illocutionary dependency, such as a question-answer sequence, or an instructional sequence, such as an incomplete phrase and an expansion. Since both stimuli and responses, besides their functional equivalence of appearing in specific slots in a three-step Mother-Child-Mother interactional sequence much more frequently than expected by chance, can vary profoundly in their topographical aspects, any more narrow specification of them would be dysfunctional for dynamic analyses. Also, as explained above, the concept of reinforcement is psychologically conceived as praise and criticism, respectively, and not in the Skinnerian manner of an item that increases response frequency. That praise would increase response frequency and criticism



diminish it is highly probable from common sense experience and also from a wide range of behavioristic experimental studies. That praise and criticism are not the only ways how verbal behavior could be reinforced is self-evident, as it is understood that none of the present analyses claims exhaustiveness. When studying Table IV, the finding from Table II has to be taken into account that reinforcements defined in the present manner are relatively infrequent in verbal interactions. Moerk (1978) provided additional evidence supporting this conclusion. If specific items do not appear very frequently in a corpus, they necessarily have to be infrequent in patterned interactional structures. If, nevertheless, patterns appear or appear even quite frequently, then this is strong evidence of the importance of the pattern in question.

Table IV presents relatively extensive data on the interactional patterns of Mother-Child-Mother sequences since these approximate closest the behavioristic three-term contingency conceptualization, with the adult being considered the predominantly controlling and reinforcing partner. The left to right sequence in each row represents the temporal sequence of the utterances. Approaching the data first with the question whether a behavioristic three-term contingency pattern can meaningfully be differentiated in the flow of interactions, a fascinating contrast between Eve's dyad and Adam's dyad is encountered. Within the 25 most frequent interactions patterns of Eve and her mother, eight are encountered which end in the item Positive Reinforcement. Considering the linguistic items exercised in the turns preceding the conditioned positive reinforcement, or Positive Reinforcement as abbreviated in Table IV, the patterns make eminent sense, both linguistically/instructionally and from a behavioristic perspective; e.g., frequency rank 2 shows Vocabulary Rehearsal followed by Vocabulary Rehearsal and then by Conditioned Positive Reinforcement. This pattern seems to be eminently suited for vocabulary teaching since it combines repetition and praise. The pattern ranked 4th, Vocabulary Rehearsal followed by the child's Reduced Imitation and by maternal praise is almost identical with the preceding one with the only difference that the child imitates the modeled vocabulary item by retaining the main elements of the maternal sentence and omitting only minor functors. The pattern appearing as the 5th most frequent one is only slightly different from the above two. Frame Variation was defined as repetition of the meaning of a sentence accompanied by a change in syntactic form. The child imitates this maternal model as far as her limited capacities permit it, that is, with some omissions, and the mother praises her for this imitation. In other patterns that end with Conditioned Positive Reinforcement, the child might only

Table IV. Interactional Structures and the Behavioristic Three-Term Contingency Pattern

Eve's dyad	Frequency rank	Mother	Child	Mother	Frequency of pattern
	1	Vocabulary	Vocabulary	Vocabulary	53
	2	Vocabulary	Vocabulary	Positive reinforcement	30
	3	Frame variation	Vocabulary	Vocabulary	21
	4	Vocabulary	Reduced imitation	Positive reinforcement	20
	5	Frame variation	Reduced imitation	Positive reinforcement	19
	6	Frame variation	Uncodable	Uncodable	18
	7	Vocabulary	Vocabulary	Expansion	18
	8	Replacement	Vocabulary	Vocabulary	18
	9	Frame variation	Uncodable	Frame variation	16
	10	Morpheme perseveration	Uncodable	Frame variation	15
	11	Vocabulary	Uncodable	Vocabulary	14
	12	Item specification	Vocabulary	Vocabulary	14
	13	Morpheme perseveration	Uncodable	Morpheme perseveration	13
	14	Morpheme perseveration	Reduced imitation	Positive reinforcement	13
	15	Positive reinforcement	Vocabulary	Vocabulary	13
	16	Morpheme perseveration	Vocabulary	Expansion	13
	17	Frame variation	Vocabulary	Positive reinforcement	13
	18	Item specification	Mapping	Expansion	13
	19	Mapping	Vocabulary	Vocabulary	13
	20	Replacement	Reduced imitation	Positive reinforcement	12
	21	Replacement	Vocabulary	Positive reinforcement	12
	22	Vocabulary	Build up	Vocabulary	12
	23	Mapping	Reduced imitation	Positive reinforcement	12

24	Frame variation	Mapping	Positive reinforcement	12
25	Vocabulary	Reduced imitation	Vocabulary	11
Adam's dyad				
1	Vocabulary	Vocabulary	Vocabulary	40
2	Morpheme perseveration	Vocabulary	Vocabulary	29
3	Morpheme perseveration	Vocabulary	Morpheme perseveration	27
4	Morpheme perseveration	Uncodable	Frame variation	20
5	Morpheme perseveration	Replacement	Morpheme perseveration	21
6	Vocabulary	Vocabulary	Morpheme perseveration	18
7	Item specification	Vocabulary	Vocabulary	20
8	Morpheme perseveration	Morpheme perseveration	Vocabulary	17
9	Vocabulary	Replacement	Morpheme perseveration	15
10	Vocabulary	Replacement	Vocabulary	17
11	Optional transformation	Replacement	Morpheme perseveration	15
12	Morpheme perseveration	Replacement	Morpheme perseveration	16
13	Item specification	Chaining	Morpheme perseveration	15
14	Morpheme perseveration	Build up	Expansion	16
15	Expansion	Reduced imitation	Morpheme perseveration	16
16	Vocabulary	Uncodable	Frame variation	13
17	Morpheme perseveration	Vocabulary	Replacement	14
18	Morpheme perseveration	Labeling	Simple imitation	15
19	Morpheme perseveration	Mapping	Morpheme perseveration	12
20	Morpheme perseveration	Replacement	Expansion	14
21	Frame variation	Reduced imitation	Morpheme perseveration	13
22	Quotation	Two person sentence	Quotation	14
23	Replacement	Reduced imitation	Optional transformation	12
24	Optional transformation	Vocabulary	Vocabulary	13
25	Item specification	Two person sentence	Quotation	13
	Vocabulary	Vocabulary	Simple imitation	13

repeat the vocabulary item, patterns 17 and 21, or she may Map an environmental structure upon a linguistic structure, which the mother then praises, pattern 24. Or the mother might use a different instructional technique, such as the Replacement of single items in the same syntactic construction to make the underlying structure more obvious, patterns 20 and 21, which the child then repeats partially, for which she is praised. The principles in all these cases are quite similar and it appears justified to conclude from these patterns of interactions between Eve and her mother that the three-term contingency pattern is approximated quite closely in this dyad, if reinforcement is conceptualized in the psychological sense discussed above.

General experience, theoretical considerations, and evidence from the interaction patterns of Eve and her mother suggest that other instances might approximate the behavioristic three-term contingency pattern too. First, everyday experience suggests that imitation of a preceding statement or of other behavior often implies its approval/acceptance. This imitation is often uttered with a falling intonation pattern, indicating this approval, and in the case of Eve and her mother it often signals that a sequence is completed to the satisfaction of the mother. In other cases, the interactional dynamics are even clearer when this imitation is immediately followed or preceded by praise or by a "yes," indicating this agreement. In both cases, whether with or without an obvious rewarding utterance, the imitation can have an approving, i.e., rewarding, connotation. If this argument is accepted, the patterns presented in Table IV suggest that for Eve and her mother a good deal more than 50 percent of the most common patterns approximate the behavioristic three-term contingency sequence.

The interactional patterns of Adam with his mother present a stark contrast to those encountered with Eve. No single pattern of the more frequent ones presented in Table IV ends with a conditioned positive reinforcement provided by the mother. Even the reinforcement possibly implicit in the mother's repetition of the child's preceding words is only encountered in the few patterns that center upon vocabulary rehearsal. Vocabulary repetition could, however, also be based upon mere semantic constraints, that is, if people continue talking about the same topic, they are prone to repeat vocabulary items. Without specific study of each of the interaction instances, little assurance exists even in this case of vocabulary repetition that it actually had a reinforcing function, indicating the mother's praise and agreement. The overall impression derived from the study of the interactions of Adam and his mother is that reinforce-

ments and therewith three-term contingency patterns were more conspicuous by their absence than by their presence.

Partly entailed by this absence of Skinner's three-term contingency patterns is the fact that the interactional sequences of Adam and his mother are more varied and more complex than those of Eve and her mother. They suggest often repair sequences and insistence upon intensive training of more complex patterns and especially of bound morphemes. But the detailed explication of these patterns would transcend the scope of the present paper and it will therefore be presented elsewhere.

A clearer impression about the importance of specific patterns, besides the report about their mere existence or the lack of it, can be gained from the right column of Table IV, which indicates the frequency of each specific pattern. The relatively low frequencies found for both dyads deserve a brief comment. With approximately 80 categories of instructional behaviors of child and mother together, around 80 to the third power or around half a million three-item-patterns are possible. Since only between 50,000 and 55,000 patterns were counted for the dyad of Eve and Adam, respectively, the probability for each specific pattern to appear is quite low. If the interactions were completely random, then the frequency of each pattern would be expected to be less than one. Compared to these expectations under completely random conditions, the observed frequencies of 11 up to 53 provide strong evidence of the systematic nature of the interactions, even though it is obvious that considerable flexibility exists in both dyads. It could not be expected that each single pattern shown in Table IV, which appeared in the average only around once per hour, would have any strong impact upon language acquisition. But, it has to be kept in mind that many of the patterns presented are closely equivalent and that they can therefore be added together from the point of view of their psychological importance. If, e.g., in the case of Eve's dyad all the frequencies are added up of those patterns that end either in Positive Reinforcement or Expansion, i.e., where conditioned positive reinforcement is highly likely, one arrives at a frequency of 187 instances, that is almost ten per hour of interaction. If maternal vocabulary repetition would be added, these frequencies would be considerably higher. In addition, it has to be remembered that large numbers of similar patterns were found that were, however, not frequent enough to be included in Table IV. These considerations will result in an evaluation of the instructional importance of interaction patterns that is quite different from the first impression that results from the frequencies presented in Table IV.

After the discrepancies between the two dyads have been stressed in regard to their interaction patterns, one close conformity shall not be overlooked, especially since it is of importance for learning conceptualizations. This is the sheer repetitiveness of the interactions. Some form of repetition is already expressed in the first code of many patterns, as in the case of Vocabulary Rehearsal, Optional Transformations, Frame Variation, Replacement sequences, and obviously in the case of Morpheme Preservations and Expansions. The same codes appear often in the second and third positions of the patterns, so that it is evident that the most frequent triple patterns consist with only few exceptions of repetitive rehearsals containing up to four repetitions in one interactional pattern. This repetitiveness is mainly focused upon vocabulary items in the case of Eve, and in the case of Adam, the emphasis lies upon bound morpheme rehearsals. But, in both cases the same principle of massed rehearsal seems to be applied even if for different linguistic contents.

A careful study of Table IV and even more the close familiarity with the utterances underlying these interactional patterns suggests, however, an important point. Though those phenomena have been selected for discussion that fit into a behavioristic framework, this does not imply that all types of interaction patterns have been analyzed and that the behavioristic approach is necessarily most appropriate for the explanation of the processes of language transmission/acquisition. Whereas the principle of massed rehearsal seemed to apply in both dyads and the three-term contingency pattern appeared distinctly in the dyad with Eve, most of the specific patterns in both dyads are obviously not yet theoretically accounted for and even those discussed are not exhaustively accounted for. The study of the actual utterances suggests that for many of these patterns principles derived from cognitive theories, such as that of "the optimum level of discrepancy," that of pattern abstraction based upon similarities combined with differences in the input, or the contrast between data driven and conceptually driven processes (Norman & Bobrow, 1975) are more germane than behavioristic concepts. The preceding tables and especially Table IV can, therefore, be considered only partially explicated and interpreted.

## CONCLUSION

It is obvious that any conclusions drawn from a sample of two dyads have to be seen as very preliminary and more as attempts to conceptualize questions than as definitive statements about a field of study. It is

equally obvious that a single brief study, especially on topics that have not been well explored, cannot capture and interpret exhaustively all the phenomena of a field as complex as verbal interactions.

When combined with these cautious reservations, conclusions can nevertheless be drawn from the data. It certainly does not appear advisable to neglect behavioristic conceptualizations of learning and interaction dynamics when trying to explore naturally occurring language transmission/acquisition. Astonishing frequencies of linguistically informative items have been described and estimated for the total input. These input data appear to be often provided in the form of initially massed training. Informal time-series estimates, that were not yet elaborated for the present paper, suggest that this massed training might, for many specific items, be replaced by spaced rehearsal followed by long-interval reinstatements (Campbell & Jaynes, 1966); a rehearsal sequence that has been demonstrated to optimally counteract forgetting.

In addition to frequencies and rehearsal patterns, the feature of behavioristic conceptualizations emphasized so strongly by Skinner (1957), the three-term contingency pattern, seemed to fulfill an important function at least in the dyad with Eve as partner. Equally clearly, however, did it become evident from Adam's dyad that this pattern is not equally obvious or even present in all dyads or at all times of the developmental process. This finding is in close accord with the conclusions of Rosenthal and Zimmerman (1978) that reinforcement is not a necessary phenomenon in learning, as conceived in social learning theory (Bandura, 1971, 1977), although it can have motivational functions. More specifically, Ribes (1979) has shown factually and argued theoretically (Ribes, 1977) that reinforcement can often be discounted in the explanation of linguistic skill acquisition. While reinforcement might be needed to attract and maintain the attention and motivation of some learners, it might be superfluous for others or at later periods in the course of language acquisition.

The differential predominance of the three-term contingency pattern indicates a principle of general importance. If input phenomena are present in some dyads that could plausibly contribute to language learning, their presence alone does not yet even indicate that they actually do contribute to it. Interactional patterns that by far surpass chance expectations can lead one step further in indicating at least short-term cause-effect relationships. For longer-term cause-effect relationships, time series analyses will be employed in subsequent studies. But, even if both the presence of input items and their effectiveness in contributing to specific acquisitions for one child or several children are demonstrated, it

certainly cannot be concluded that the demonstrated input is necessary or sufficient either for the specific child and even less for all children. For a complex phenomenon such as language that appears in all cultures, it has to be presumed that its acquisition is highly overdetermined so that multiple paths lead to the same, or at least a highly similar, end-product.

Only tangentially related to classical behavioristic theory are the phenomena of modeling and imitation. They have repeatedly been explored since Brown and Bellugi (1964) described them, they certainly involve learning, but they are more germane to social learning theory as proposed by Bandura (1971, 1977) than to the strictly behavioristic approaches. Certainly, modeling and imitation entails an aspect of massed rehearsal, presenting at least two instances in close succession, but it also entails pattern matching which is closer to perceptual and skill learning, and very often a correctional force, i.e., expansions, is integrated with the approving imitation. To the knowledge of the writer, corrections could not easily be fitted into classical behavioristic theory and they are not emphasized either in social learning theory. For these corrections and for many of the interaction patterns involving replacements of words while frames are retained, or retained contents with lightly or profoundly changed syntactic frames, or simply discrepancies between filial and maternal utterances, the conceptual framework established in the field of cognitive psychology seems to be more closely appropriate and germane. It is even conceivable that phenomena will be encountered in the course of research for which no field of psychological research has yet elaborated the optimal conceptual frames.

The domain of investigation has changed very profoundly from the exploration of learning curves for simple contingencies with rodents and other lower animals to that of the learning of communicational systems which the various groups of mankind have evolved to describe their conceptualization of their entire external and internal world. It would, therefore, be astonishing indeed if the theoretical system established for one very simple domain would be sufficient for the new and profoundly expanded one. Neither does the shift of domains of description, however, imply that none of the conceptualizations of the simpler domain are usable and fitting for the new task. Heated arguments between various schools, emphasizing an either/or approach while trying to explain language development, therefore do not seem to be appropriate. More integrative approaches such as argued by Staats (1971, 1974) seem to hold much more explanatory power.



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