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A two-part experiment was conducted to determine if consistent, predictable differences exist in teacher encoding ability (composed of the ability to formulate messages containing the essential information, to anticipate information needs of the listener, and to modify or recode the message from listener feedback). Twenty-eight teacher-encoders each taped instructions for a verbal task and a geometric task for sixth and twelfth grade levels in a controlled series. Students from these grade levels decoded the messages. Analysis of the resulting student scores showed significant differences in teacher encoding ability, and that the order in which the teacher taught the lesson had made a difference. (Sixth grade students did more poorly on decoding if the instructions they received had been recorded after the instructions for twelfth grade students had been recorded.) Multiple linear regression analyses were performed for each task (verbal and geometric), and each known teacher characteristic was assessed. It was found that known teacher characteristics did not predict differential success in encoding. Analyses of the instructions for each task (the message) was also conducted, revealing that redundancy and clarity tended to increase encoding effectiveness, although not significantly. (A schematic model of the teacher-child communication system is included.) (SM)

# ENCODING ABILITY IN TEACHER-STUDENT COMMUNICATION GAMES

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For the past year, Dr. David Olson of the Ontario Institute for Studies in Education, along with his students and colleagues, has been working on a project to study effective teaching from the point of view of the communication process. That is, the teacher as an encoder has the responsibility of phrasing a message so that it may be readily understood by the student listeners. This emphasizes the core of the instructional process because it focuses on the specific teaching act rather than on peripheral aspects of teaching such as the friendliness of the teacher.

A schematic (and simplified) model of a teacher-child communication system is shown in Figure 1. The four major components of this system are: 1) the teacher or encoder; 2) the student or decoder; 3) the message; and 4) feedback. To illustrate how this model might work: a teacher is trying to teach a lesson on geometry. He has in mind a set of objectives for the class, they should sit still, smile, and learn the derivation of $\pi$ . He picks up cues formally or informally of the extent to which the class (or individuals in the class) measure up to these objectives. If there is a discrepancy between child performance and his objectives, he generates a message; i.e., teaches a lesson or issues a command. This message is formulated in terms of his perception of the discrepancies between what the children are doing and what they should be doing and in terms of his knowledge of the children and the subject matter being taught. He again obtains feedback from the class as to the success of the encoding, monitors the discrepancy and continues recoding the message until the feedback from the performance of the child corresponds to his objective.

From this kind of a model we can infer that the most critical factors in this teaching-communication process are:

1. the ability of the teacher to formulate messages containing the essential information,
2. the ability to anticipate the information requirements of the

listener,

3. the ability to modify or recode the message in the light of feedback from the listener.

We have tried to look at these aspects of the problem in a series of experiments. The basic methodology that we have employed has been that of a two-person communication game; i.e., one person acts as an encoder and one as a decoder.

In one experiment arising from this model, we sought to assess the manner in which altering the formal structure of the message affected the decodability of the message for a child. One group of Grade I children heard the following taped message: "Put the small white triangle with the star on it into the upper left space of the form board." The message heard by the second group contained the same amount of information as the first message, but was elaborated by the addition of redundancy, pauses and pre-structuring before the message was played. Surprisingly, there was no difference in the performance of the groups with both getting 71% of the message correct on the average. However, these results were shown to be a function of the way children were dealing with the task. If the task was modified so that the children needed to rely less on short term memory, these factors led to significantly better decoding.

In another study we manipulated the degree of feedback permitted between the teacher and the learner with Grade 6 students playing both roles. One student (the encoder) tried to describe a chain of rectangles to another Grade 6 student (the decoder) who attempted on the basis of that instruction to draw the rectangles. We controlled feedback by permitting the speakers four different types and amounts of feedback: 1) could neither see nor hear the listeners' reactions; 2) could see their faces with the accompanying grimaces, nods, etc.; 3) could hear the listener say simply yes or no; and 4) could both hear and see the listener they were attempting to teach. The results as shown in Figure 2 indicate that the efficiency of communication is a direct function of the degree of feedback permitted (within the narrow range of feedback in this experiment) and that the visual and auditory components of the feedback appear to be additive.

Both of these experiments also indicated that there were vast differences in the way in which people would encode the same simple message. But we still had no idea if these differences were consistent, and no idea if they were predictable from other psychological factors. Therefore, the next step was to discover whether factors in the encoder could be used to predict how efficiently he would adapt to his particular listeners. The extent to which the messages are decodable by their intended audiences can be used as a measure of the efficiency of the communication. Among the variables we expected to differentiate degrees of encoding ability in teachers were: years of teaching experience, grade taught, field of academic training, clinical or counselling experience, length of the actual message, sex, and ability to take another's viewpoint as measured by Hunt's Conceptual Level test.

The experiment was conducted in two parts -- first, encoding of the messages by teachers to 'stooge' decoders and the taping of these messages; and second, decoding of the taped messages by groups of three real students. (See Figure 3). Each teacher-encoder was required to teach the same two lessons to two different stooge decoders. Since the decoder was sitting behind a screen and had been instructed not to talk to the teacher, there was no feedback for the teacher to use as a guide for his pupil's progress.

One task, labelled the verbal task, required the teacher to teach a list of 12 single nouns so that the student would be able to recall them in one hour. The words are listed in Table I and as can be seen, there are several possible ways to structure this material to make it easy to remember. The second task was called the geometric task. Here, the teacher had to describe the series of four rectangles as shown in Figure 4 so that the student could accurately reproduce them on his sheet of paper which contained only the top rectangle.

After the teacher had taught both of these tasks to a Grade 6 student, he was then asked to teach the same lesson, but this time to a student in Grade 12. The order of both grades and tasks taught first were counterbalanced to control for practice effects. Altogether, there were four different orders in which the teachers taught the lessons. Rather than limit teaching time to a specific number of minutes, it was suggested that most teachers take about 10 minutes to teach both tasks, but there were wide variations in time spent in teaching.

After taped transcripts of 35 teacher's lessons had been made, the appropriate lessons were then played to Grade 6 and Grade 12 students in groups of three. For each encoder, there were six decoders (3 in each grade) making a total of nearly 200 decoders. The taped messages were played in the same order for all decoders. That is, they heard the verbal message first, and then the geometric message. Then they were asked to write down as many of the 12 words as they could remember -- in any order they wished. I.Q. scores were obtained for each decoder from the school records; this was felt to be necessary since any decoder variance might be the result of the decoder's intelligence rather than the effectiveness of the encoder.

Before going into the results in detail, it should be mentioned that the choice of these particular tasks was somewhat unfortunate. The verbal task was too easy for both grades with many students getting a perfect score (mean score was 10.5 words), and the geometric task was quite difficult, especially for the Grade 6 decoders since ¼ of them scored zero on this task. Therefore, the experimental results are not as clear-cut as they might have been because of misjudgment of the difficulty of the task.

A three-way analysis of variance was performed on both the verbal scores and the geometric scores of the decoders. The encoder effect was significant in the verbal task further substantiating the fact that there is a wide variation in how effectively different people encode the same facts. Moreover, there is a consistency over messages indicating that encoding ability is a general "teaching" characteristic. This is shown by the significant correlations in Table 2 between decoder scores on the verbal and geometric tasks, and between verbal scores for Grade 6 and Grade 12 decoders. The grade effect showed that the order in which the teacher had taught the lessons (i.e., Grade 6 or 12 first and verbal or geometric task first) had made a difference. The Grade 6 students did more poorly on both tasks if they were taught <u>after</u> the Grade 12 students. From this, we infer that teachers had difficulty in simplifying the messages for younger decoders in the absence of feedback.

Since the analyses of variance had shown that there were significant differences among the encoders and this difference was consistent in our tasks, it was hoped that some of this variation might be accounted for by the variables we had collected information on such as academic background, grade taught, years of teaching experience, etc. Four multiple linear regression analyses were performed (one for each grade and task) and the contribution of each predictor variable was assessed. However, none of our known teacher characteristics predicted this differential success in encoding.

Either the predictor variables were simply irrelevant or perhaps some limitation in this experiment prevented such a relationship from showing. For example, the multiple linear regressions were performed on data from only 28 teachers; perhaps increasing the number of teachers would also increase the predictability of some of the variables. Also, the ceiling effects which were inherent in the tasks probably acted to eliminate differences between good and bad messages since even a bad message was easily learned in the verbal task. Another important factor which would reduce differences among the teachers was the enthusiastic response of the student decoders, even to the most uninteresting and unimaginative message. In one extreme case, the teacher just recited the list of words twice in a slow measured pace and the students sat there busily rehearsing in an effort to learn all the words.

The two predictor variables which did contribute significantly to the regression equations were not unexpected. Knowledge of the mean decoder I.Q. increased prediction in the grade 6 geometric task and knowledge of the message length improved prediction in the Grade 6 verbal task.

To determine the major differences between a good and a bad message, we examined the transcripts of Grade 6 messages for the 3 best and 3 worst encoders. Although no conclusions can be drawn from such a small sample, certain trends did emerge. For example, the good teacher put a fair amount of redundancy into the message so that if the listener didn't understand it the first time, he had another chance. In the geometric task, good encoders labelled the rectangles by appropriate numbers and signalled clearly when one rectangle was finished and the next one was to be started. The poor encoder tended to mix referents and would confuse his instructions as to whether the student was to draw a particular line of a rectangle or the whole rectangle.

In the verbal messages, again the amount of redundancy differed in the good and bad messages. In the 3 good messages, each critical word was repeated an average of 11.6 times whereas in the poor message this average fell to 4.5 times. So for tasks involving long term memory, redundancy is important. The good messages were generally longer than the poorer ones. More important probably is the effect of organization on memory. The good encoders restructured the verbal material in some manner, (e.g., categorization) and then consistently used this recoding. Poor encoders used incomplete or inconsistent recodings and were frequently ambiguous as to which words were critical for the subject to learn.

One of the interesting observations made while collecting the teachers' encodings was the wide variation in the method used to encode the 12 words in the verbal task. There are several possible methods to structure this material; for example, mnemonics, categorization, narrative, and drilling. Although it was not possible to assess which recoding scheme was most effective in this experiment, it would be interesting to know whether some methods are more effective than others. This could easily be done by producing 3 or 4 alternative encodings of the same material and playing each tape to a group of students, and will probably be the next step in this programme of research.

In summary then, we have found that the problem of instruction or teaching is accessible from the perspective of communication theory. While we have found that there is some consistency in our teachers' ability to encode in a manner appropriate to the requirements of the listeners and that some ways of formulating these messages produce a higher level of performance than others, thus far we have had no success in predicting teachers' communicating ability from any background or personality characteristics. Dr. Ross Traub in our Institute is currently working on a scale that would measure these teaching abilities more directly; perhaps it will predict our teachers' success or lack of it.

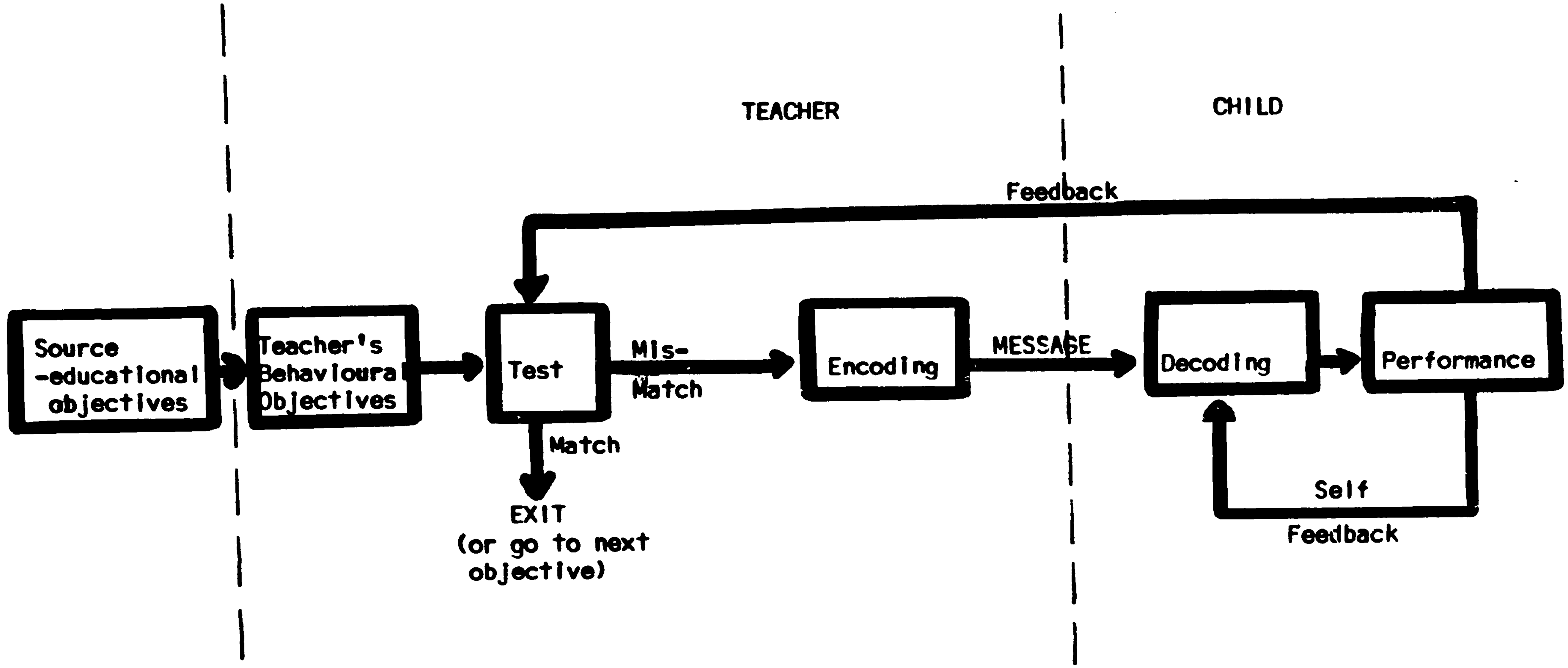
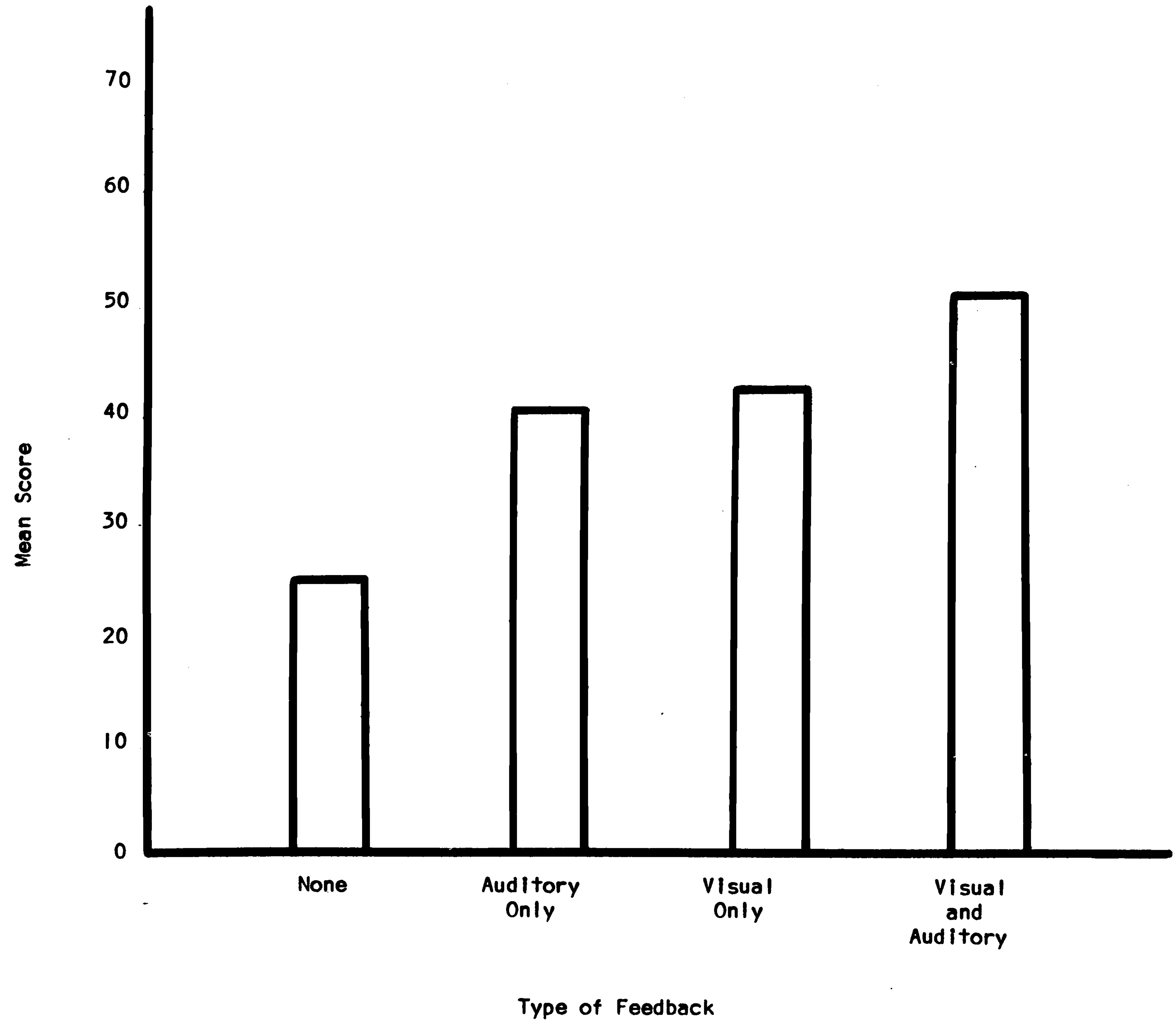



Figure 1. A Schematic Model of the Teacher-Child Communication System

Figure 2. Mean Decoder Performance as a Function of Feedback Condition.



| | ENCODER | | DECODER |
|---|---|---|---|
| | Four orders in which messages are encoded: | | Order in which messages are decoded: |
| Teacher encodes four messages which are taped | 6G 6V 12G 12V<br>6V 6G 12V 12G<br>12G 12V 6G 6V<br>12V 12G 6V 6G | Three decoders in each grade listen to one teacher's lessons for that grade | 6V 6G Recall<br><br>12V 12G Recall |

6 - Grade 6
12 - Grade 12
G - Geometric Task
V - Verbal Task

Figure 3. Experimental Design

Figure 4. Series of Rectangles Encoded by Teachers in the Geometric Task.

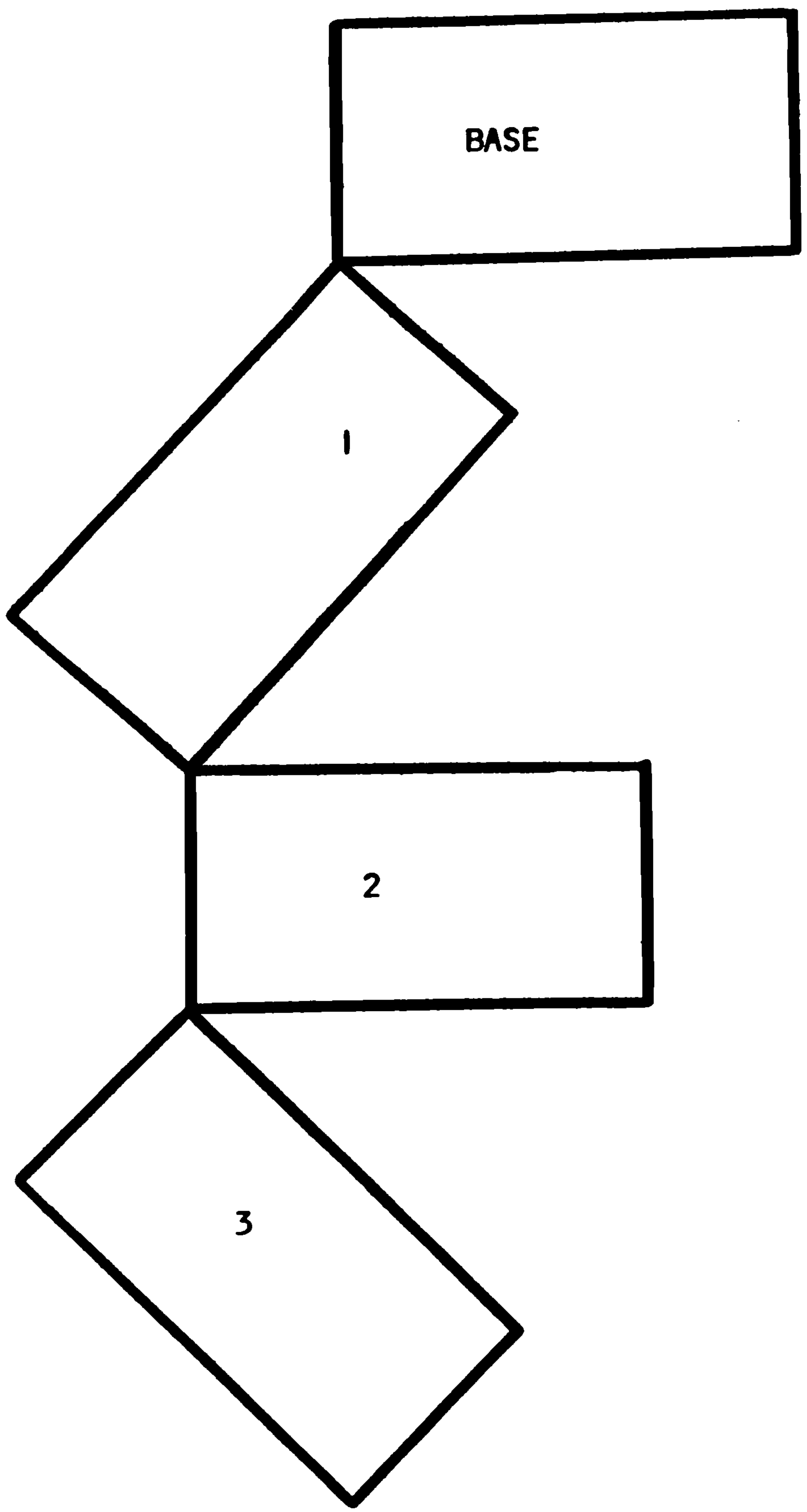



Table 1. List of Words Encoded by Teachers in the Verbal Task.

| |
|---|
| POTATO |
| GASOLINE |
| HILL |
| MILK |
| FIELD |
| PILL |
| FOREST |
| MANURE |
| HAMBURGER |
| PERFUME |
| HORSE |
| ROSE |

Table 2. Correlation Matrix for Mean Decoder Scores and I.Q.

| | Gr. 6 Verbal 1 | Gr. 6 Geometric 2 | Gr. 12 Verbal 3 | Gr. 12 Geometric 4 | Gr. 6 I.Q. 5 | Gr. 12 I.Q. 6 |
|---|---|---|---|---|---|---|
| 1 | | .367* | .535** | .312 | .305 | .160 |
| 2 | | | .252 | .042 | .577** | .101 |
| 3 | | | | .439* | .095 | .200 |
| 4 | | | | | -.218 | .268 |
| 5 | | | | | | .001 |

* $p < .05$

** $p < .01$