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ABSTRACT

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FINAL REPORT

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VISUAL AND AURAL LEARNING IN URBAN CHILDREN

Joanna P. Williams
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PREFACE

The research described in this report represents the contributions of many people, notably David V. Williams and Ellen L. Blumberg, both of whom participated in the research in all stages. John S. deCani advised on the statistical analyses.

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SUMMARY

A total of 320 subjects in five grades (two, four, six, eight, ten) and from two types of school settings (middle-class and disadvantaged) were studied. Subjects learned eight-pair lists of familiar nouns in a standard paired-associates task. Each subject learned two lists, one presented visually and the other, aurally. Performance on the visual task was superior to that on the aural task, and subjects in higher grades performed better than those in lower grades. Overall, the middle-class subjects' performance was superior to that of the disadvantaged children, but there was a complex interaction indicating that there were no differences between these groups at the fourth- and sixth-grade levels. Discrepancies in reading ability and in motivational set were discussed as to their possible relevance in interpreting the data.

INTRODUCTION

Learning as a function of stimulus modality:

Verbal learning can be achieved through two modalities, visual and auditory. The long tradition of verbal learning, from the time of Ebbinghaus, has been built for the most part on the basis of visual presentation. Practically none of the research has used aurally presented stimuli. Yet it is difficult to think of any other context besides that of verbal learning in which the effectiveness of both of these presentation modes can be assessed. Moreover, a thorough description and an adequate theory of verbal learning processes really requires investigation of both modalities.

One fundamental question concerns the relative efficiency of learning from visual and from auditory material. Interest in this topic has come for the most part from concern with the processes involved in learning to read. In this context, two or three relevant studies have been done comparing learning rate under visual and aural presentation for normal and retarded readers. But the studies are few, suggestive but not at all conclusive.

Budoff and Quinlan (1964), for example, presented meaningful words to second-graders in a paired-associates (PA) paradigm, and found that aural presentation was superior for both average and retarded readers. Other data also suggest that aural presentation may be better, at least at early ages, but the evidence is not conclusive. Katz and Deutsch (1963), using a serial learning paradigm, presented contradictory data; they found that poor readers learned more rapidly via visual presentation. They suggested that disadvantaged children could not utilize aurally presented information efficiently.

Day and Beach (1950) have suggested that visual presentation would be superior when the material to be learned is difficult and/or unfamiliar. If this were so, it would be expected that the comparison of visual and aural learning would depend on age: given the same material to learn, older subjects would find the task less difficult than would younger subjects, and thus visual presentation would be relatively less effective at higher grade levels. There was, in fact, one large-scale study (Cooper and Gaeth, 1967) that indicated that the relative effectiveness of the two modes in a PA paradigm does depend on age level. While Cooper and Gaeth's results supported to some extent the above hypothesis, their findings were not clear-cut, and the question is far from settled.

The youngest Ss included in the Cooper and Gaeth study were fourth-graders, older than the Ss in the other studies mentioned above; moreover, they were all from middle-class schools. There were other procedural differences between this study and the others mentioned; perhaps the most important difference was that the Cooper and Gaeth data were collected from groups rather than from individuals.

In fact, any direct comparisons among the few available studies are difficult to make because of the great variation in paradigms, materials, and subjects (Travers, 1967).

Shulz (1969), has reported an extensive series of experiments which do use the same materials, subjects (college students), and procedures. However, his experimental situation was one in which the amount of exposure time for the visual and the auditory modes was equated. Thus his work is not directly relevant for a comparison of the relative efficiency of the two modes as they ordinarily occur. That is, visual presentation does in fact have stability over time, whereas aural presentation does not.

Learning as a function of group differences:

In recent years there has been a great deal of interest in learning efficiency as it relates to group differences. When learning proficiency is assessed in terms of performance on standardized achievement tests or intelligence tests, middle-class children are generally superior to disadvantaged children (Stodolsky and Lesser, 1967). While most of the evidence comes from such data, there are a very small number of recent studies which deal with laboratory learning paradigms. These are important because the tasks involved demand new learning and do not depend heavily on past learning. In contrast to the findings with intelligence and achievement tests, in these "new-learning" tasks, disadvantaged children tend to perform as well as do middle-class children.

For example, studies by Zigler and his associates (e.g., Zigler and DeLabry, 1962; Zigler and Kanzer, 1962) have shown no difference in overall performance on a learning task between the two social classes, even though there were significant differences as a function of social class in terms of the effectiveness of various types of reinforcers (tangibles vs. intangibles).

Also, Rohwer et al. (1968) found no difference between first-, third-, and sixth-grade subjects from high-strata and low-strata schools on a paired-associates task (in a study unrelated to the visual vs. aural learning question). On the other hand, while Semler and Iscoe (1963), who also studied paired-associates learning, did not find a difference in eight to ten-year-old children, high-strata subjects did better at the five and six-year-old level. There was no race difference when the age factor was disregarded, however (despite significantly different WISC IQ's).

Purpose:

There were two major purposes of this research. The first was to examine the relative efficiency of visual and aural learning over a range of grade levels much wider than that covered in previous experiments. Children at five grade levels were compared as to their ability to learn pairs of meaningful words under both visual and auditory presentation.

Paired-associates learning has been investigated in several studies because it is closely related to many of the tasks that children must perform in the school setting. For example, recent analyses of the processes involved in reading have stressed the development of grapheme-phoneme relationships, which in many important ways can be understood in terms of the PA paradigm (e.g., Williams, 1968). Jensen (1968) has stressed the value of this paradigm as an analytic method in the study of individual and group differences in learning ability. Thus it would be most useful to investigate further the relative degree of learning proficiency in different school strata in this basic task, not only because of the light it might shed on the visual and aural "aptitudes" of the two populations, but also because of the relevance of the results to the design of educational methods and materials. It was of interest to the present writer because it provided an appropriate basic task for comparing visual and aural abilities in the two populations.

The second major purpose was to compare the performance of children from high-strata and low-strata schools. Thus the experiment contributed to the evaluation of the important question as to the relative "new-learning" abilities in middle-class and disadvantaged children. It also, of course, provided data comparing these populations on visual and aural learning.

METHOD

Subjects.

Subjects were three hundred and twenty Caucasian Philadelphia public school children in grades two, four, six, eight, and ten. Half of the subjects were drawn from middle-class schools and half from lower-class schools. These schools were identified on the basis of standardized test scores and parent occupational and educational levels, and thus they differed in ways associated with the distinction between "advantaged" and "disadvantaged." Equal numbers of males and females were randomly assigned to each of the ten cells.

A total of 22 subjects were eliminated from the study: nine because of experimenter error (equipment failure), and thirteen because of failure to understand the task after repeated directions.

Materials.

The word lists were composed of pairs of familiar three and four-letter nouns found in pre-primer and primer materials. The pairing was done randomly, with the restrictions that pairs that formed a compound word (e.g., toy-box) and words that formed common pairs (e.g., cat-dog) were avoided. Four eight-pair lists were constructed, and there were an equal number of three-letter and of four-letter pairs in each list. The word lists are presented in Table 1.

Design and procedure.

The lists were paired so that each subject learned one list in the auditory mode and one list in the visual mode. Half the subjects in each cell received lists A and B, and half, lists C and D. The order of lists and modes was balanced in each cell. The lists were presented to each subject individually for ten trials in the "recall" ("study-test") paradigm. That is, first there was a learning trial during which each pair of stimulus and response words was presented. A test trial followed during which only the stimulus word was presented. The subject's task was then to say the appropriate response word. On each trial the words were presented in a different random order constant for all subjects. The visual items were typed in a primer-face on Ektagraphic slides and presented by a Carousel slide

projector on a rear projection screen. Timing was accomplished by coordinated tape signals to the projector. The auditory items were tape-recorded and presented through a stethescope headset. All items were presented at 2.5-second intervals. Learning and test trials were separated by 2.5-seconds with a ten-second inter-trial interval. Between conditions there was a three-minute break. The complete experimental session lasted approximately 30 minutes.

RESULTS

Figure 1 presents the mean number of correct responses over all ten trials as a function of grade level, social class, and modality. Data from the two sets of word lists have been combined. Although there were some small differences among the lists, they did not interact with any of the experimental variables, and the data from all the lists can be considered together.

Table 2 presents the analysis of variance of these data. The main effect of each of the three variables was significant beyond the .01 level. That is, performance was superior (1) at the higher grade levels, (2) in the middle-class, and (3) for visual presentation.

There was a significant interaction between social class and grade. This interaction is complex and has been analyzed in detail. It can be seen in Figure 2 that the interaction between these two variables is due to, first, the interaction at the second- and fourth-grade levels. That is, the middle-class' performance is superior at the second-grade level, while at the fourth-grade level, the social classes do not differ. Secondly, there is an interaction at the sixth- and eighth-grade levels. Here, there are no differences between the two SES groups in the sixth-grade, but the performance of the middle-class group has increased at the eighth-grade whereas the performance level of the lower-class has decreased substantially. In summary, the two social classes do not differ at the fourth- and sixth-grade levels, but the lower SES group gave fewer correct responses at the second-, eighth-, and tenth-grade levels.

A separate analysis of variance was performed on the second-grade data and is presented in Table 3. The analysis

indicated that while there were no overall differences between mode and SES, significant at the .01 level. That is, the middle-class subjects performed better with visual stimuli and the lower SES group learned more effectively from auditory presentation.

Errors were also analyzed. Three categories of error were identified:

(1) Omission - No response at all was given
(2) Confusion - A response word in the list was given to an incorrect stimulus word.
(3) Intrusion - A response was given that was not from the list.

There were clear differences in the total number of errors in each category: a total of 18,423 omissions, 3131 confusions, and 556 intrusions. No statistical test is necessary to assess the significance of these differences.

Table 4 presents the total number of each type of error as a function of social class and modality. There were no significant relationships between social class and modality for intrusions (χ^2=.725, df=1) or for confusions (χ^2=1.51, df=1). There was a significant relationship for omissions (χ^2=8.98, df=1, $p<.01$), such that there was a greater proportion of visual omissions in the lower-class subjects. Further inspection of the data indicated that this relationship was a function of the inordinately large number of omissions at the second-grade level for these subjects.

In Figure 3, the total number of errors in each category as a function of grade is shown. It can be seen that the number of intrusions decreases as a function of grade level, as would be expected. Chi-square was used to test the significance of the decreasing trend by comparing the number of intrusions in grades two, four, and six with the number in grades eight and ten (χ^2=16.13, df=1, $p<.001$). A similar test showed a decrease in the number of omissions over grades (χ^2=524.25, df=1, $p<.001$). However, there was no such trend with respect to number of confusions (χ^2=.50, df=1).

DISCUSSION

Learning as a function of stimulus modality:

The results were straight-forward with respect to this

variable: overall, visual presentation led to performance superior to that of aural presentation. Because of the difficulty of making generalizations among the few extant studies, so disparate are they in task requirements, materials, and subjects, no prediction was made as to the relative effectiveness of the two modalities. For example, these data are in agreement with Cooper and Gaeth's (1967) finding that from grade four to grade twelve, visual presentation of CVC trigrams was superior to aural presentation. However, those investigators also used simple nouns as stimuli, and in this case, at the higher grade levels at least, auditory presentation was superior. There were many procedural differences between the Cooper and Gaeth study and the present one, including the fact that they collected their data from groups of subjects in the classroom, a setting in which it is notoriously hard to control attention. This difference may well be important in explaining the fact that their data showed an interaction of modality and grade level, while the present experiment did not.

A comparison of the present data with the results of Budoff and Quinlan (1964) presents a similar problem. Those investigators concluded that aural presentation was superior; their subjects were second-graders, both retarded and average readers. Indeed, in the present study, the lower-class second-graders also showed a slight superiority for aural presentation.

At the present time, there is such a dearth of data that general conclusions about the relative effectiveness of the two modalities should be made tentatively.

The differences at the second-grade level may reflect discrepancies in reading ability. Here, there was a significant interaction between mode and social class. That is, the middle-class subjects performed better with visual stimuli and the lower-class subjects performed better with aural stimuli. In much of the literature comparing the two modalities, reading skill is not considered. Budoff and Quinlan (1964), for example, concluded that aural presentation was superior on the basis of data from a study in which the visual presentation consisted of printed words. Katz and Deutsch (1964) and Hall (1969), on the other hand, concluded that visual presentation was superior in studies in which the visual stimuli were pictures. Further work is currently in progress which focusses on these relationships.

Learning as a function of group differences:

Performance of the lower SES group was not as good as that of the middle-class subjects, when all the data were taken together. However, there were no differences as a function of class at the fourth- and sixth-grade levels. At these levels, the hypothesis that disadvantaged children perform as well as middle-class children on tasks emphasizing "new-learning" is clearly supported. The significant difference as a function of social class in the second-grade may well be accounted for in terms of discrepancies in reading ability, and it does not seem reasonable to draw conclusions on the basis of the second-grade data.

Rohwer, et al. (1968) found no significant differences between high- and low-strata children in the first, third, and sixth grades. Rohwer's paired-associate materials consisted of pictures, not printed words, and those findings thus tend to support the hypothesis that the second-grade differences in the present study were due to differences in reading skill.

There was a substantial drop in the performance of the lower SES subjects at the eighth-grade level, and while the performances of these subjects was better at the tenth-grade level, it was still below that of the middle-class subjects. This drop may be related to discrepancies in the levels of general ability of the middle- and lower-SES groups, relative to the levels of ability of subjects in the other grades. It is considered more likely, however, that motivational factors are implicated. The junior high schools that the eighth-grade children attended represented a school setting very different from that found in the elementary schools. While no attempt was made to evaluate objectively the differences among schools, it was obvious that all the characteristic problems of the large urban secondary school were present in the junior high schools (and senior high schools) that the lower SES subjects attended. These differences may well have influenced the development of a different motivational set toward the experimental task.

It does appear that socio-economic class per se had no overall effect on the experimental task. However, because of the differences in the experiences and opportunities in the two groups, and because of the related motivational differences, it is difficult (unfortunately) to find a situation entirely free of these possible confounding factors in which to test the hypothesis that social class has no effect on associative learning.

The differences between the proportion of confusion errors over grades and the proportion of other types of error over grades suggest that confusion errors may be a "higher level" error than are omissions or intrusions. That is, they may represent an intermediate stage of learning: the first phase of paired-associate learning (Sheffield, 1946), that of response-learning, is completed, but the subject has not yet learned to associate the responses in the list with their appropriate stimulus words.

CONCLUSIONS

Visual presentation was superior to aural presentation in the paired-associate learning task used in the present experiment. Further experiments over a wide range of materials and procedures are necessary in order to draw sound conclusions about the generality of this finding.

The data indicated that different socio-economic groups may not necessarily perform differently on tasks of a type that do not rely heavily on past learning.

Further work is in progress which will explore the nature of the interaction between modality and social class at the second-grade level, and its relationship to reading ability.

TABLE 1

The Word Lists

List A	List B
rag-pen	end-rat
coat-fish	bear-name
dog-top	boy-zoo
hat-bus	cow-man
sun-ice	pig-cap
town-ball	hill-goat
food-snow	tree-door
bird-ring	girl-page

List C	List D
week-doll	cake-book
home-milk	air-job
game-year	time-king
cat-egg	room-duck
leg-bag	mat-hen
box-gun	wall-feet
rain-word	pot-car
dog-toy	bed-lap

Figure 1

Mean Number of Correct Responses as a function of Grade, Social Class, and Modality

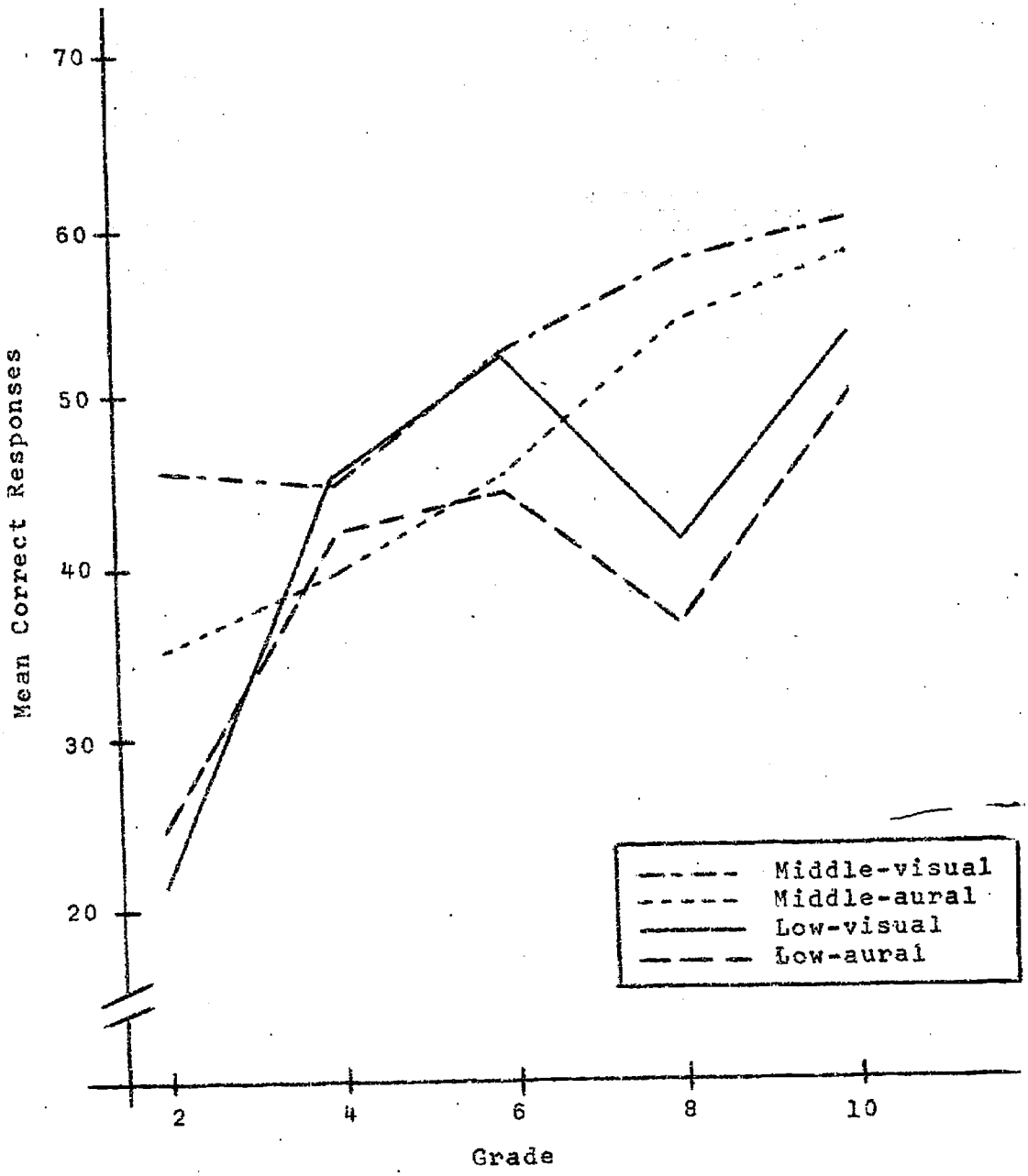


TABLE 2

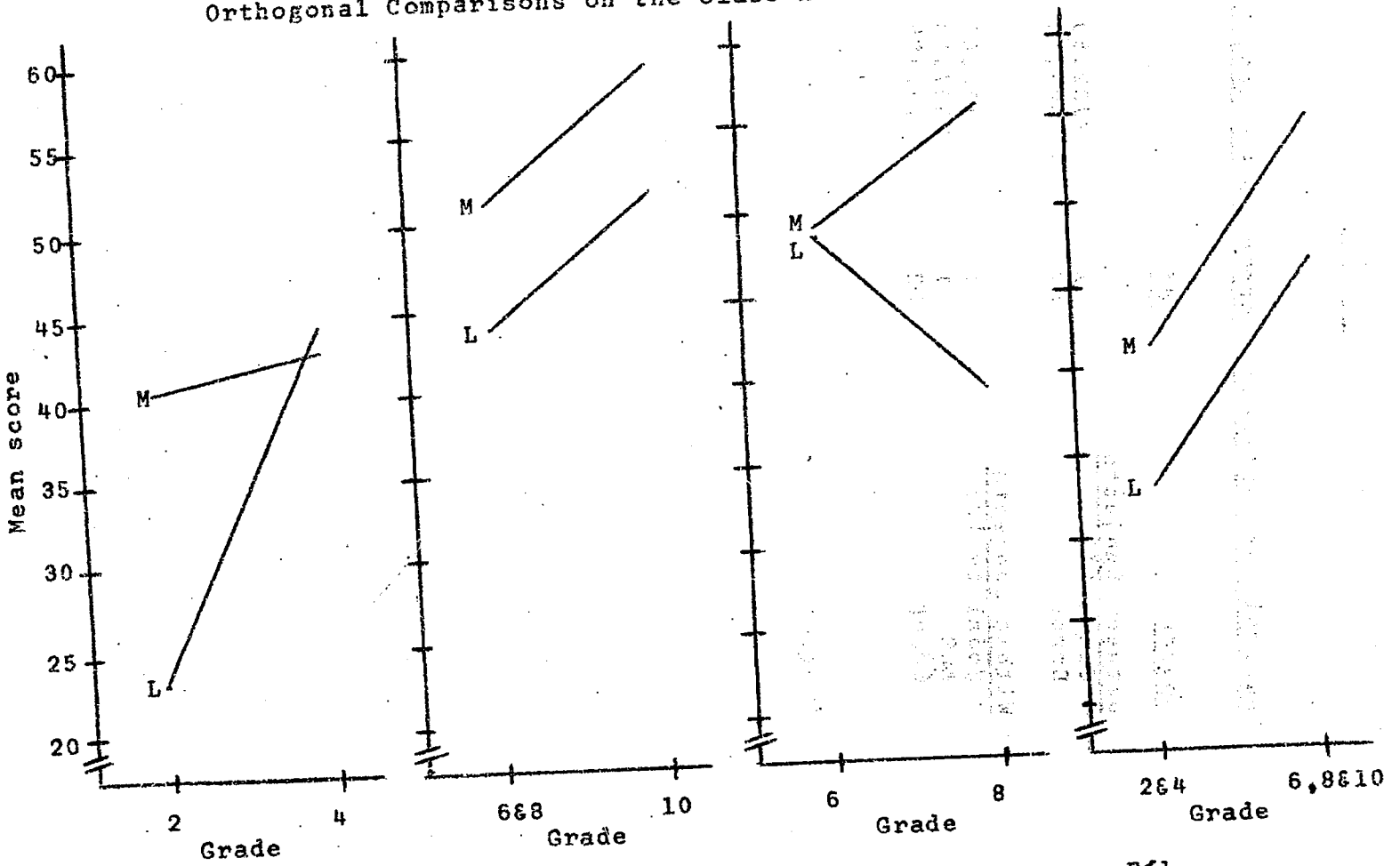
Analysis of Variance: Correct Responses over Ten Trials

Source	df	MS	F
Between Subjects			
Class (A)	1	10595.02	25.53**
Grade (B)	4	9950.15	24.91**
A×B	4	2473.06	6.19**
Error	310	399.40	
Within Subjects			
Modality (C)	1	3053.75	17.30**
A×C	1	180.63	1.02
B×C	4	97.08	<1
A×B×C	4	326.07	1.85
Error	310	176.55	

**p<.01

Figure 2

Orthogonal Comparisons on the Class x Grade Interaction



F=14.44
df=1,310; p<.01

F<1
df=1,310

F=10.24
df=1,310; p<.01

F<1
df=1,310

TABLE 3

Analysis of Variance: Correct Responses, Second-Grade

Source	df	MS	F
Between Subjects			
Class (A)	1	9782.50	24.46**
Error	62	399.85	
Within Subjects			
Modality (C)	1	438.82	2.46
AxC	1	1397.18	7.85**
Error	62	177.96	

**$p < .01$

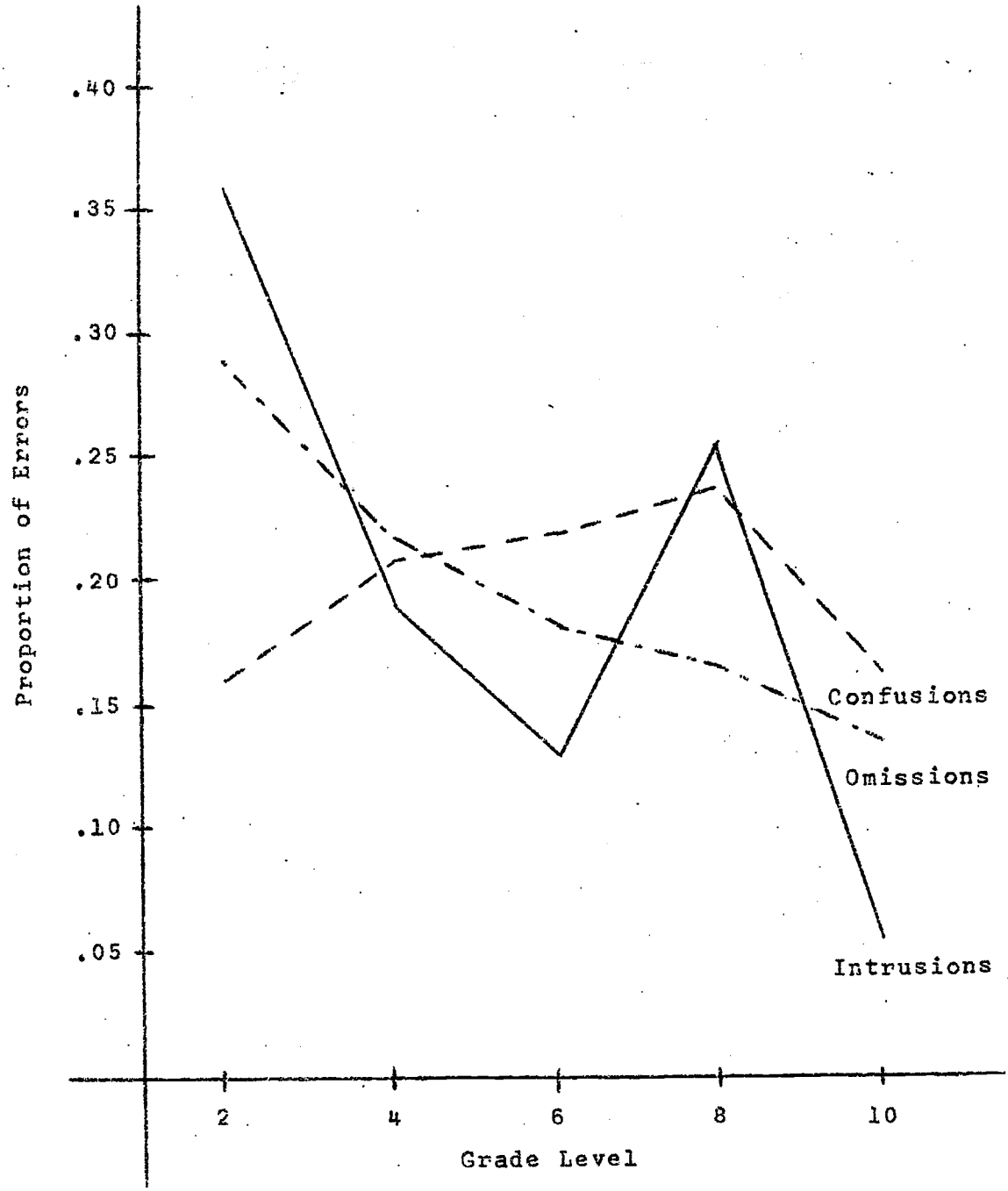
TABLE 4

Number of Errors as a Function of Social Class and Modality

Type of Error	Class	Visual Presentation	Aural Presentation
Intrusions	Middle	67	105
	Low	166	218
Confusions	Middle	638	869
	Low	724	900
Omissions	Middle	3743	4257
	Low	5110	5313

Figure 3

Proportion of Errors as a function of Grade Level



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APPENDIX

Directions for Visual Presentation

You are going to see some words on this screen, two at a time. Look at both words and try to remember both words together. Then you will see just one of these words. Your job will be to try and remember which word you saw with it before. As soon as you remember it, say it out loud so I can hear you. If you don't remember it, just wait and try the next one. For example, if one of the pairs you see is "elephant-candy," later when you see just "elephant" you say _____. You will have several chances to look at the two words together and several chances to see if you remember which two words you saw together. Okay?

Remember - first you look at the two words together and try to remember them.

Run first training trial.

DURING THE INTER TRIAL-INTERVAL, SAY: Now tell me the word that goes with each one.

Directions for Aural Presentation

You are going to hear some words through your earphones, two at a time. Listen to both words and try to remember both together. Then you will hear just one of these words. Your job will be to try and remember which word you heard with it before. As soon as you remember it, say it out loud so I can hear you. If you don't remember it, just wait and try the next one. For example, if one of the pairs you hear is "elephant-candy," later when you hear just "elephant" you say _____." You will have several chances to listen to the two words together and several chances to see if you remember which two words you heard together. Okay?

Remember - first you listen to the two words together and try to remember them.

Run first training trial.

DURING THE INTER-TRIAL INTERVAL, SAY: Now tell me the word that goes with each one.