DEVELOPMENTAL ASPECTS OF VERBAL AND VISUAL MEMORY CODES

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Abstract

The present study investigated the development of verbal and visual processes in short-term sequential memory for pictorial material. Different groups of Ss from Grades I, III, and V were given eight trials on a serial recognition task with Acoustically Dissimilar (AD), Acoustically Similar (AS), or Abstract (A), pictures. The AD pictures had distinctive-sounding names, the AS pictures had acoustically similar names and the A pictures were abstract reconstructions of the components of items from the first two lists. Each S was presented with five items from one of the three lists, one by one. After presentation S had to point to the pictures he had seen, in the order in which they had been presented, on a panel bearing the complete set.

Performance was highest for list AD, followed by list AS and A respectively, and improved with increasing age on all lists. The difference between lists AD and AS within each grade was statistically reliable only for Grade III. List A was significantly different from list AD within each grade level but was not different from list AS in any grade. A supplementary analysis of performance on list A alone, which included only those Ss who reported using no labelling strategies for these items, revealed that the Grade V Ss were not different from Grades I and III. These results, along with the results of serial position analyses, were interpreted as providing further support for the influence of both verbal and visual processes in picture memory.

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Chapter 1

This study investigated short-term recognition memory for three types of pictorial material in children of three different age groups, the aim of the study being to examine developmental aspects of the effects of visual and verbal (naming) memory processes. A general review of the current literature on visual memory will set the perspective for the subsequent discussion of pictorial memory in particular. It will be shown that research dealing with processing of visual material has led to two types of theoretical formulations for describing the way in which visual information is retained in short-term memory (STM). One type of theory emphasizes verbal or auditory speech-motor encoding of information (e.g. Sperling, 1963; 1967) while the other suggests that both verbal and visual encoding processes are involved in the retention of visual information (Posner, 1967). Research on the retention of meaningful pictures is more readily interpretable in terms of the second approach.

Studies which deal with children's retention of pictorial material indicate the use of the visual code only until speech has developed, after which the available verbal code becomes predominant (Conrad, 1971; Flavell, 1970). Since strong evidence for the existence of a visual code is available from a number of studies with adults, the conclusion from these developmental studies seems incomplete. However, little attention has been directed toward examination of the visual code in children after the verbal code has developed. Thus, the purpose of the present thesis is to investigate, developmentally, the function of both visual and verbal processes in memory for pictorial material.

Verbal and Visual Short-Term Memory Codes

Sperling (1963, 1967) postulates that stimulus material, even when visually presented, is encoded in an auditory speech-motor or verbal form and is then retained in an auditory store through continued rehearsal. Support for this theory comes from studies on confusion errors in STM and interference effects with acoustically similar material. For example, Conrad (1964) and Wickelgren (1965) found that errors in recall of visually presented letters were highly correlated with listening errors to the same letters under masked conditions. Similarly, decreased retention over short time intervals has been reported for lists of letters (Conrad & Hull, 1964) and words (Baddeley, 1966) constructed from acoustically similar items.

While Sperling's model is capable of accounting for experimental results of the type just cited, other writers have noted that the model is incomplete as a description of visual information processing. Posner (1967), without refuting Sperling's model, has pointed out that both verbal and visual codes may be used to retain information in STM. Thus verbal encoding is not a necessary condition for storage of visual material; in addition, certain information may be stored as images. In this case, "an image is a relatively direct representation of the stimulus which might include serial position and other detailed information which would not appear in a verbal description of the stimulus (Posner, 1967, p. 50)." Evidence in support of this approach comes from studies of visual search tasks with letters (e.g. Chase & Posner, 1965 cited in Posner, 1967), reaction time differences associated with comparisons of letters with the same name or identical characteristics (Posner, Boies, Eichelman, & Taylor, 1969) and retention of spatial information for presented letters (den Heyer & Barrett, 1972; Taylor & Taub, 1972). The results reported by den Heyer and Barrett (1972) serve as one demonstration of the existence of both visual and verbal modes of representation in STM. They presented the subjects (Ss) with a 6 x 4 item matrix containing randomly positioned letters and required that they simultaneously retain both the position and identity of the items over a 10 sec. retention interval. This interval was filled with one of three different types of interpolated activity; a verbal task involving addition of digits, a visual task involving discrimination between dot patterns, and a no-activity control. The results showed that the type of interpolated task was selective in affecting the type of information loss, with visual interpolation interfering with retention of position information and the verbal task interfering with retention of item information. The presence of two separate codes, one for visual retention and the other for verbal, is thus clearly implied.

These studies suggest, then, that even though acoustic or verbal encoding has been shown to exist for a variety of stimulus material, this does not seem to be a necessary condition for the retention of visual information. Visual encoding may apparently function together with or independent of verbal encoding in storage and retention of material in STM. What is the relevance of these two types of approaches for the study of picture memory? The evidence so far from a number of experiments favours the second approach, whereby pictures can be either stored in a nonverbal visual form or encoded verbally by means of their implicit labels, or both. These studies will now be examined in more detail.

Bahrick and Boucher (1968), using drawings of common objects, obtained retention measures for the names of the objects by a verbal recall test, which was followed by a visual recognition test either immediately or two weeks after presentation. No correlation between the recall of object names and accuracy of visual recognition was found; that is, failing to recall the object's name did not affect recognition of its drawing. The authors concluded that the visual and verbal components of these stimuli are retained independently. Additional evidence suggested that the verbal component appears to play a greater role in immediate than in delayed recall.

Further support for the operation of the visual code in memory for complex pictures comes from an experiment by Shaffer and Shiffrin (1972). They varied both the stimulus exposure time and the time between successive stimuli in a picture recognition task. Mean confidence ratings for recognizing a picture as "old" increased with exposure times of 0.2 to 4.0 sec. but were not affected by interstimulus intervals of 1.0, 2.0, and 4.0 sec. The failure to observe an increase in performance with increasing interstimulus times, along with the absence of recency effects in the data, led the authors to suggest that there is no analog of verbal rehearsal in visual STM. Differentiation of the two processing systems by this characteristic again suggests their functional independence.

Tversky (1969) used schematic faces with well-learned nonsense names as stimuli, thus making both visual and verbal encoding available to the S. A reaction time task was used, such that presentation of either a name or a face was followed by an item of the opposite type. The Ss had to respond "same" if both stimuli were of the same name or "different" otherwise. A set to encode the first stimulus either visually or verbally was induced by manipulating the Ss' expectations of whether the second stimulus would be a name or a face. Reaction times were slower for those pairs where the second presentation was in the unexpected modality as compared with expected occurrences. Tversky concluded that modality of encoding is under the control of the S, with the occurrence of visual or verbal encoding depending upon the anticipated use to which the information is to be put.

Finally, Paivio and Csapo (1969) manipulated the availability of visual and verbal codes by using three types of material—pictures, concrete words, and abstract words - presented at two different presentation rates. (The results involving abstract word lists are of no direct concern to the present investigation, so only the findings obtained with pictures and concrete words will be considered.) The fast rate, 5.3 items per sec., was designed to reduce verbal labelling of the pictures, leaving primarily the visual code available, whereas at the slow rate of 2 items per sec. both codes were presumed to be available. Pictures were superior to words in nonsequential tasks (free recall and recognition) at the slow rate, presumably because of the operation of both codes, and not inferior to words even at the fast rate. However, pictures suffered in sequential tasks (serial learning and memory span) but only at the fast rate, where the verbal code was unavailable. This result was confirmed when sequential retention was tested by a serial reconstruction task (Paivio & Csapo, 1971). The findings are in accord with the approach that both visual and verbal codes are ordinarily present for retention of pictorial material, but are functionally distinguishable in terms of their capacity for information processing. Thus the verbal code is more specialized for sequential processing and the visual code for parallel processing of information in the spatial sense.

Several conclusions can be drawn from the above studies. First of all, it is apparent that both verbal and visual codes are available and utilized in visual STM for the storage of pictorial material. However, the functions of the two codes appear to be different, in that the visual code is more effective for nonsequential storage of pictorial information. As the Shaffer and Shiffrin (1972) data indicate, visual rehearsal is less prevalent than verbal rehearsal and thus the verbal code would be needed for effective sequential storage of visual information. The relevance of these conclusions for the present research will be discussed shortly. However, our concern is not so much with the characteristics of visual versus verbal processes in adults as with developmental trends associated with the two types of codes. We turn next, therefore, to an examination of studies which deal with the short-term retention of visual information in children.

<u>Short-Term Visual Memory in Children</u>

Empirical evidence gathered from studies with children has suggested the predominant use of the visual code in retention of nonverbal material, until the age of five (Conrad, 1972), after which acquired speech takes over to serve as the dominant mode of encoding (Flavell, 1970; Conrad, 1971). Consequently, developmental differences in STM, and differences in recall performance exhibited at any given age level have generally been attributed to variation in the availability and use of verbal mediators (Flavell, Beach, & Chinsky, 1966; Belmont & Butterfield, 1971).

The developmental trend in retention over short time intervals associated with the increasing availability of the verbal code is illustrated in the research reported by Corsini (1969a,b). Corsini (1969a) has found that the retention of instructions for the manipulation of familiar objects is facilitated when kindergarten <u>Ss</u> are presented with both verbal instructions and nonverbal cues (visual availability of objects), as compared to verbal instructions alone. These results suggest that Ss at this stage of development are not able to retain verbal instructions because of the lack of internal symbolic representation. However, the use of nonverbal cues had little effect upon retention with second grade Ss, who did not perform differently with verbal only, nonverbal (visual) only, or verbal and nonverbal mixed instructions (Corsini, 1969b). This age group had presumably been able to produce verbal representations of their own as a mnemonic aid.

Similarly, serial order STM studies dealing with rehearsal strategies of different age groups confirm the developmental trend of the verbal code as an efficient mediation strategy. Even though children as young as five years old are capable of covertly naming objects or pictures presented to them (Locke & Fehr, 1970), naming is generally not efficient as a mediator when retention of serial order information is required (Flavell, et. al., 1966; Hagen & Kingsley, 1968). Instructions to label stimulus items aloud does facilitate performance with first- and third-grade Ss but are again ineffective with Ss in fifth grade (Hagen & Kingsley, 1968). Presumably, first and third grade Ss have the capacity to use verbalization as an aid to retention, and verbalization instructions serve to increase the use of such strategies. With older children, however, spontaneous verbalization is much more prevalent, and is therefore less likely to be influenced by instructions (c.f., Corsini, 1969b).

Kingsley and Hagen (1969) demonstrated that induced rehearsal (i.e. verbalization of picture names with pictures no longer present) can facilitate retention even with nursery school children. In this experiment four groups of nursery school children were presented with stimuli consisting of hard-to-label shapes. The Ss were shown six of these items one by one, with the items being placed face down in a row after presentation. Then a cue card, identical to one of the presentation cards, was presented, the Ss being required to find the stimulus item which matched the cue card by turning up as few of the presentation cards as possible. Three of the groups learned a meaningful one-syllable name for each shape, while the fourth group received no label pretraining. Of the three label conditions, one group overtly labelled and rehearsed the items during learning, one group merely overtly labelled the items, and the last group was instructed to say the labels covertly. The group with induced rehearsal was significantly superior to the other two groups, especially on items occupying early serial positions. However, the overt labelling group performed as well as the induced rehearsal group at the most recent serial positions. The covert labelling and the control groups did not differ in overall performance. The results indicate that covert labelling does not facilitate performance with these Ss, and overt labelling affects only retention of recent items. Induced rehearsal, however, facilitates overall performance by enhancing recall of items at early serial positions. The failure of covert and overt labelling groups to perform better than the control group is interpreted as due to a lack of spontaneous rehearsal at this age, even though the labels are available. This outcome is consistent with the findings reported by Flavell, et al. (1966).

In general, then, all of the above studies, using pictures as stimulus material, suggest that with children beyond nursery school age, utilization of the verbal code is an effective strategy to employ when namable items are to be held in memory for brief periods of time, and that this code develops with age. Conrad (1971) examined directly the relation of covert speech development and the use of the verbal code for retention of visual information in children of five age levels - three to five, six, seven, eight, and eleven years. Two types of pictorial material were used, pictures which had like-sounding names (MAT, BAT, CAT, HAT, TAP, MAN, RAT, BAG) and pictures which had dissimilar-sounding names (GIRL, SPOON, CLOCK, HAND, HORSE, FISH, BUS, TRAIN). Using two identical packs of picture cards the Ss were presented with a selected subset of the original eight cards, the size of the subset being determined separately for each age group. These cards were named by the experimenter (E) and turned fact down one by one. Then the full set was exposed, the S's task being to match the cards that were face down to those in the full set without viewing the face-down test cards. Two types of comparisons were made: (a) performance on the two sets of materials, and (b) differences among the five age groups. To simplify interpretations of the results, the level of task difficulty for the acoustically similar ('homophone") set was held constant at 50% correct recall in all groups. The only measure used in analyzing the data was the percentage of correct matches for the "nonhomophone" set. The results showed no difference between the two sets of stimuli for the Ss below five years of age. However, at 5-6 years superior recall was exhibited on the nonhomophone set, an advantage which increased with increasing age. These results are interpreted as indicating that it is not until five years of age that children begin using the verbal code to retain picture information, since after the age of five pictures with like-sounding names become more difficult to remember (are confused more) as compared to those with distinctive names. The fact that no difference occurred for Ss under five years of age suggests a greater importance of the visual code at these age levels.

From these studies we can conclude that the verbal code is a very important strategy for storing pictorial material. However, none of the studies mentioned above has been directly concerned with the process of visual encoding, even though the materials used would be very likely to arouse visual traces. The almost exclusive interest in the developmental aspects of verbalization by most investigators gives the impression that verbal mediators come to replace visual mediators at around five years of age. Such a conclusion is, of course, inconsistent with the adult studies discussed at the beginning of this introduction, which show quite clearly the existence of both verbal and visual memory codes.

The present experiment was designed to examine the function of both verbal and visual codes in serial processing of pictorial material by children of different grade levels (I, III, and V), the problem of primary interest being to determine what happens to the visual code after the verbal code becomes available as a mediator of retention. To achieve this, the availability of the verbal code was manipulated using three different kinds of pictorial material: familiar pictures with distinctive labels, familiar pictures with acoustically similar labels (c.f., Conrad's (1971) nonhomophone and homophone sets) and unfamiliar "abstract" pictures with no apparent labels. Items in the first set have both verbal and visual codes available, those of the second set have both codes available but with the verbal code being less useful as a mediator, while in the third set use of the verbal code should be minimal.

The task used was serial recognition, similar to that used by Conrad (1971). It follows from the Paivio and Csapo (1969, 1971) findings that if in a sequential task only the visual code is available to the S, performance should be lower than for items which permit use of a verbal code. Furthermore, with a verbal code available, performance should be better for items which have distinctive, as opposed to acoustically similar, labels (Conrad, 1971). In addition, it follows from child studies of verbal mediation (Conrad, 1971; Flavell, et al., 1966; Hagen & Kingsley, 1968; Keeney, et al., 1967) that performance on the acoustically dissimilar list should increase with increasing age, as verbal mediation becomes increasingly effective. If the use of the visual code remains unaffected by the onset of covert verbalization ability, however, we expect minimal differences across age groups on the non-labelable, abstract items.

Chapter 2

Method

Materials

The stimulus items consisted of 24 simple black and white line drawings. The Acoustically Dissimilar (AD) list comprised pictures of objects which had dissimilar-sounding names (GIRL, HOUSE, FISH, CLOCK, SPOON, BOAT, HORSE, KITE). The first five of these stimuli were selected from Conrad's (1971) nonhomophone list, and the remaining three from children's drawing and colouring books. The Acoustically Similar (AS) list was made up of pictures whose labels had similar-sounding names (MAN, HAT, CAT, CAN, CAB, CAP, FAN, PAN). Three of these items (MAN, HAT, CAT) came from Conrad's (1971) "homophone" list, the remainder being chosen from a list supplied by Baddeley (1966). The Abstract (A) set comprised visual reconstructions of eight randomly-selected items from the other two sets. The use of reconstructions for the "abstract" visual items is derived from the work of Fantz (1961). In his work on pattern perception in infants, Fantz (1961) rearranged the features of meaningful pictures (faces) in a scrambled pattern to provide a set of control stimuli equated with the faces in terms of stimulus complexity. Similarly, in the present study reconstructions of familiar pictures, instead of purely abstract forms, were used to match the items of the three lists as closely as possible. The eight pictures chosen for list A were GIRL, MAN, CAN, KITE, CAB, FISH, SPOON, CLOCK. The stimulus items of all three lists are given in Appendix A.

The stimuli were drawn by an artist and printed on 4 x 4 in. plasticized cards. Ten copies of each set were constructed in this manner. The cards of one of these copies were mounted in a random order on a white panel for use as the original recognition set. A second panel was constructed with the cards in a different random order to control for possible spatial position artifacts.

The actual test items used were five of the above pictures randomly drawn from the respective sets, with the single constraint that no one picture be repeated on each trial. The size of the test set was determined on the basis of pilot research conducted with Grade II and VI students.

For pretraining purposes, a practice set of eight cards bearing the first eight letters of the alphabet were prepared in the same way as the above stimuli.

Procedure

Each S sat at a table facing the E. In all of the conditions the experimental task was preceded by two trials on the practice set. The Ss were given the following instructions:

> We are going to play a little game on how well you can remember, with some pictures. But before we do, first I will teach you how we will play this game with some letters (showing the panel). See all of these letters here? I will show you some of these letters. Look at each of them carefully without saying them

aloud, and try to remember all of them because after I finish showing them to you I am going to hide the letters and turn this over (the panel). Again without talking, you are going to point to me the letters I showed you. But you are going to point to the letter I showed you first, first, and then to the second one and then to the third and so on. Did you understand? Now let us try it and see how many letters you can remember.

After each practice trial the E revealed the order of the letters by turning each card over one by one. At the end of two practice trials, the Ss were informed that now they would do the same thing with some pictures.

In conditions AD and AS, the original set was first presented and the Ss were asked to name all the objects. This established that the Ss knew the names of all of the pictures. If any S labelled a picture with a name other than the given one, the E said the correct name and again required identification of all of the pictures. In condition A this phase was omitted and testing started immediately after the practice.

The procedure followed was identical to that used on the practice trials, where the E showed five pictures, drawn randomly from their full sets, one by one, each being presented for approximately 1.5 sec. During the presentation, the panel bearing the recognition set of eight items was kept face down.

After presentation the panel was turned face up and the S pointed to the pictures he saw, in the order they were presented. During testing knowledge of results was not given but periodically the E indicated that the S was "doing fine".

There were eight trials in each condition, with a different random selection of five items presented on each trial. The two panels, representing different random orders of the picture cards, were used alternately across trials. Responses were recorded, in the order in which they were made by the S.

After the testing was over, the Ss tested under condition A were asked how they had remembered the pictures. This was done in an attempt to gain information about how these abstract pictures were coded.

Subjects and Design

The Ss were 180 children from Grades I, III, and V at Holy Spirit Elementary School, Manuels, Nfld. The Grade I Ss ranged in chronological age from 6.0 to 7.2 years ($\overline{X}$ = 6.7), the Grade III Ss were between 8.0 and 9.2 years ($\overline{X}$ = 8.7), and the Grade V Ss between 10.0 and 11.2 ($\overline{X}$ = 10.7). Males and females were equally represented in each age group.

Twenty Ss in each group were tested with one of the three experimental lists: AD, AS, or A. The design was thus a 3 x 3 factorial with three types of lists and three grade levels.

Chapter 3

Results

Serial Order Recognition

The data of primary interest were the number of correct recognitions of items in their correct serial positions. The percentage of correct responses as a function of grade levels and conditions are presented in Fig. 1, where each point is based on 800 observations (5 items x 8 trials x 20 Ss). These data were analyzed by a 3 x 3 factorial analysis of variance with grade levels and conditions as factors.[1] The main effects of grade and conditions were significant ($p<.001$ in each case), but the grade X conditions interaction was not ($F<1$). The analysis of simple effects (Winer, 1962, pp. 236-238) is summarized in Table 1B, which shows that the effects of conditions was significant at each grade as was grades at each level of conditions.

Multiple comparisons among the sets of means for the three list conditions at each grade level were carried out using the Scheffe technique (Ferguson, 1966, pp. 296-297). The results are shown in Table 2 of Appendix B. The only significant difference to emerge for Grade I Ss was between AD and A pictures ($p<.05$). In Grade III, however, Ss in the AD condition performed significantly better than Ss in both AS and A conditions ($p<.01$ in each case), with the latter two not differing from each other. The comparisons for Grade V were similar to Grade I, in that only the AD and A conditions

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[1] The summary tables for this and all subsequent analyses are given in Appendix B.

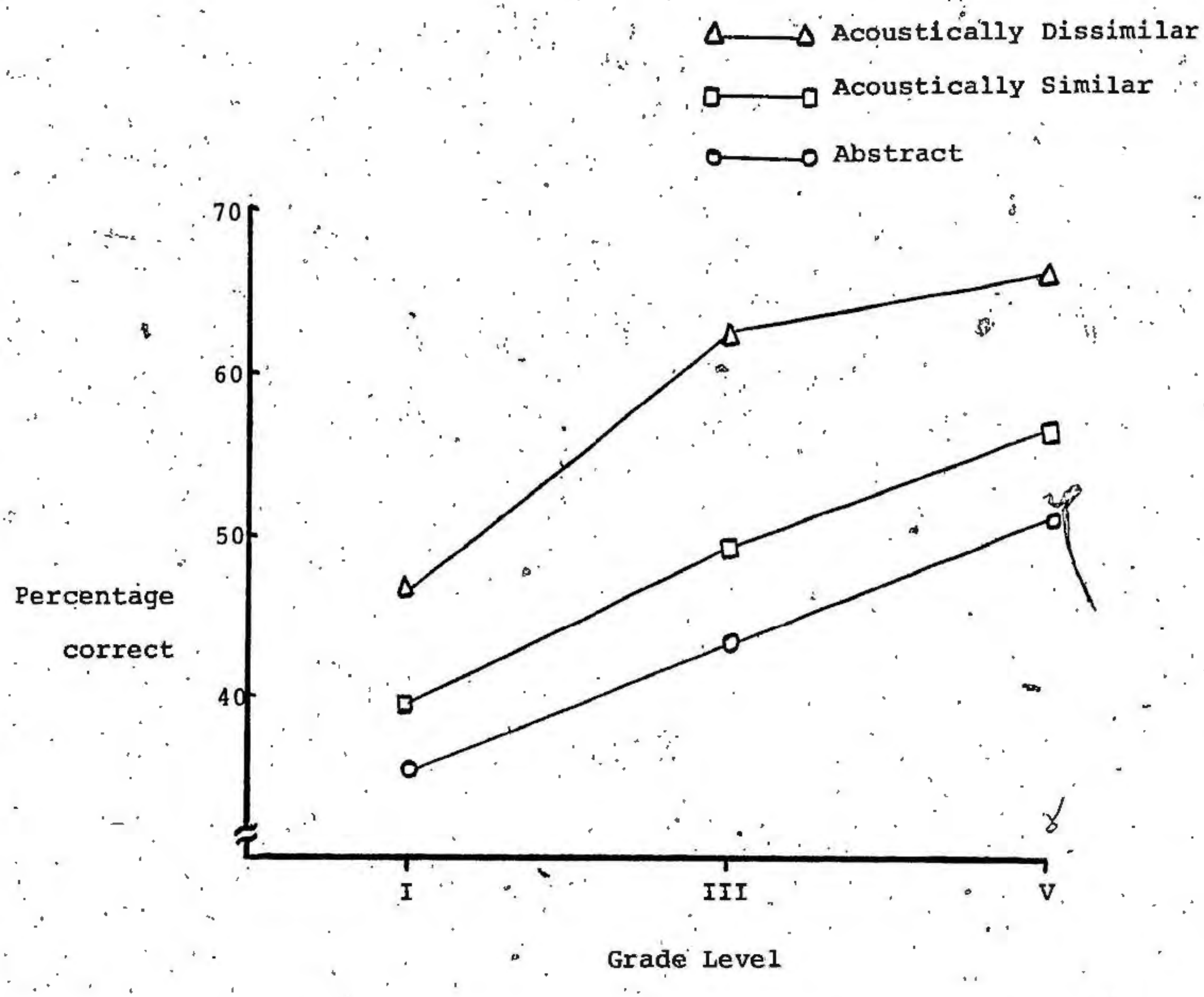

Figure 1. Mean percentage correct in serial order recognition as a function of grade and list conditions.

differed significantly ($p<.01$).

The results of comparisons among the three grade levels for each list condition are shown in Table 3 (Appendix B). In the AD condition, performance of Grade I Ss was significantly below that for Grades III and V ($p<.01$ in each case), with no significant difference between Grades III and V. The same trend is apparent for the AS condition, but here the difference between Grades I and III falls just short of the .05 level of significance. Again, the performance of Grade I is inferior to Grade V ($p<.01$). The only significant difference in the A condition was for Grade I versus V ($p<.01$).

As predicted, performance was highest for list AD, followed by list AS and A respectively. However, the difference between the AD and AS conditions within each grade level was not large and was statistically reliable only for Grade III. These findings are therefore not completely in agreement with those reported by Conrad (1971), who found significant differences from age 5 years on. Discussion of possible reasons for this discrepancy will be presented in a later section. Between-grade comparisons did demonstrate the expected trends of increase in performance with increasing age. Condition A, however, resulted in a signficiant difference between Grades I and V, which was contrary to prediction.

Supplementary data were gathered in an attempt to explain the reason for the latter difference. It was mentioned earlier that at the end of the testing session the Ss under the A condition were informally questioned as to how they remembered the pictures. Those Ss who replied "I don't know" were probed further by specifically asking if they gave the pictures names or any other verbal descriptions. Only in Grade V did any of the Ss state that they had attached verbal labels, such as names, descriptions, and number of parts the picture had, to the pictures. Consequently, the Ss in this grade could be classified as namers (N = 7) and nonnamers (N = 13). Additional Grade V Ss were run in condition A to obtain further data relevant to the possible influence of naming. The data obtained from 20 nonnamers and 11 namers showed a sizeable difference in total mean percentage correct across the eight trials for the two groups, the figures being 41.8% for nonnamers and 59.8% for namers. The difference was significant, $t(29) = 4.90$, $p<.02$. Thus it appears that the significant increase between Grades I and V in condition A shown in Fig. 1 is attributable, at least in part, to the tendency for some Grade V Ss to attach verbal labels to the items.

The data obtained from nonnamers of all grade levels on list A revealed the percentage of correct responses for Grades I, III, and V to be 35.3%, 43.1%, and 41.8%, respectively. A one-way analysis of variance, followed by Scheffe comparisons, showed the difference between Grades I and III to be marginally significant, $F(2, 57) = p<.05$ (due to the decreased within-cell variance) with Grade V not differing significantly from Grades I and III. Thus the results obtained from nonnamers only differ from those reported in Fig. 1 for condition A, in that differences between grades become less pronounced in the present case. Accordingly, the initial prediction that age differences would be minimal with non-labelable A items receives some support.

Order-Free Recognition

The main body of data was also scored for order-free recognition, i.e., correct recognition of items irrespective of their output serial position. This follows from Paivio and Csapo (1969, 1971), who found no difference in retention of material which differed in the availability of verbal and visual codes in a nonsequential task, and thereby suggested that the verbal code is effective primarily as a mediator of sequential recall. Thus, eliminating the sequential scoring constraint in the present data might make the effect of the verbal code less apparent and thus reduce the differences between grade levels and conditions. The percentage of correctly recognized items for all grades in each condition is presented in Fig. 2. Comparing these data with Fig. 1 it can be seen that elimination of the serial order constraint resulted in a marked overall increase in performance in all conditions. A 3 x 3 analysis of variance (Table 4A, Appendix B) revealed significant grade ($p<.01$) and conditions ($p<.01$) effects with no observable Grade X condition interaction, $F(4, 171) = 1.08$. The analysis of simple effects revealed significant effects of both grades for conditions and of conditions for grades in all except Grade V, where the conditions effect was not significant, $F(2, 171) = 2.46$ (Table 4B).

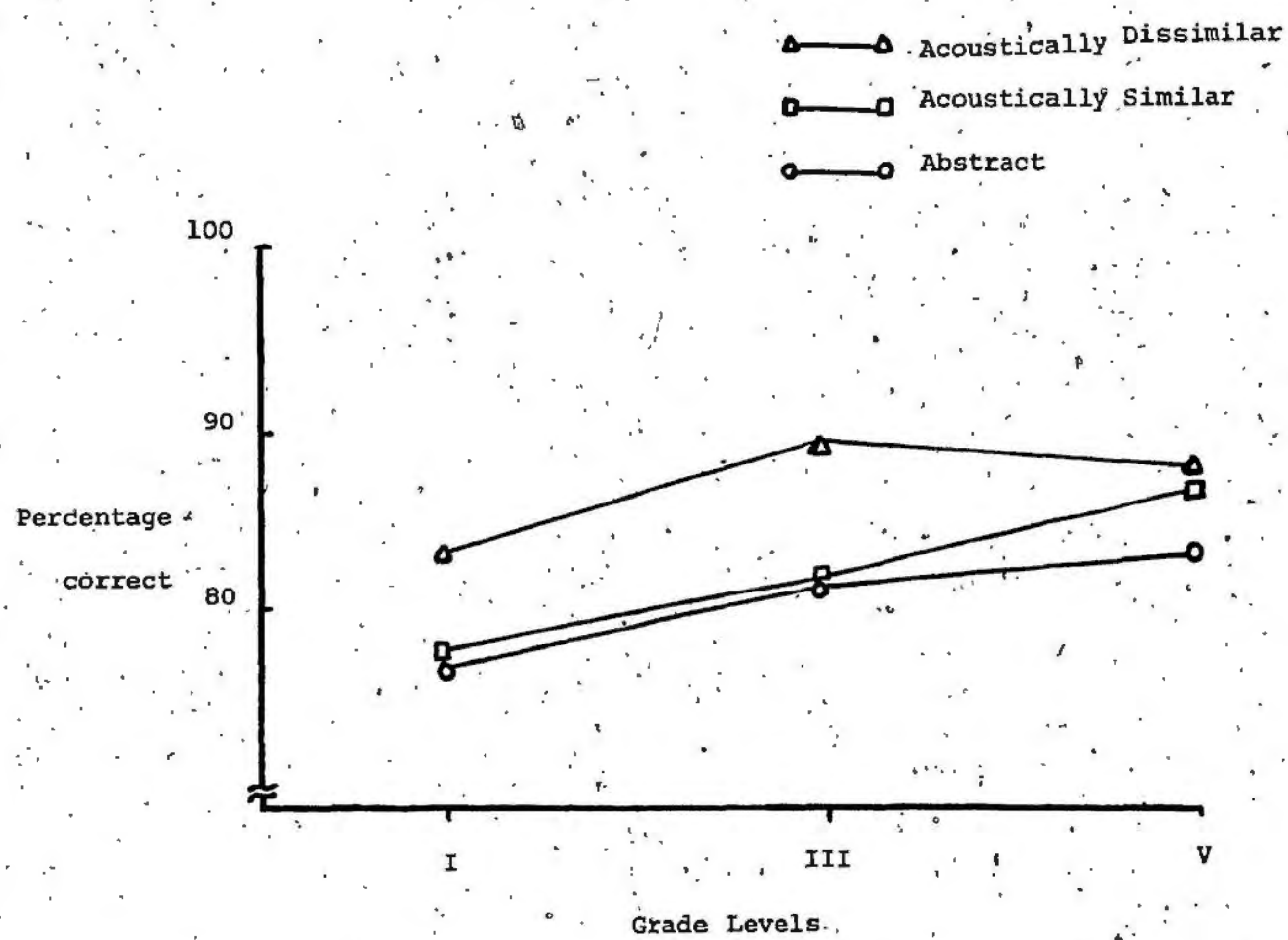

Figure 2. Mean percentage correct in order-free recognition as a function of grade levels and list conditions

The results of comparisons among conditions for each grade level are shown in Table 5 of Appendix B. In Grade I, Ss in the AD condition performed significantly better than Ss in both AS and A conditions (both $p<.05$). Comparisons for Grade III were similar to Grade I, in that AD condition differed significantly from AS and A conditions (both $p<.01$). Comparisons among the three grade levels for each list condition showed several age effects (Table 6). In the AD condition performance of Grade I Ss was significantly below that of Grade III ($p<.05$). Again in both AS and A conditions performance of Grade I was inferior to Grade V ($p<.01$ in each case).

As can be seen, elimination of sequential scoring did not greatly affect the overall pattern of results, in that significant differences among grade levels and conditions were still obtained. However, the reduotion of these differences, in an absolute sense, does lend some support to the rationale for carrying out the analysis. It should be pointed out that the inherent sequential nature of the task is not eliminated by nonsequential scoring, and thus it is perhaps not too surprising that the results are not consistent with the findings reported by Paivio and Csapo (1969).

Serial Position Effects

A number of studies (e.g. Jahnke, 1963) suggest that immediate serial recall of auditorily-presented items (letters and digits) produces a bow-shaped curve with performance being highest for initial (primacy) items, lower for terminal (recency) items, and lowest for middle items in the list. The shape of the curve changes with visual presentation in that the recency effect is reduced and, in some cases, disappears altogether (Craik, 1969; Crowder & Morton, 1969). The reduction in recency for visually-presented items has been attributed to a more rapid loss of just-presented information from the visual than from the auditory sensory store (Crowder & Morton, 1969).

The examination of serial position effects in the present data was carried out in an attempt to provide additional information on verbal labelling influences in ordered recognition with children. First of all, serial position curves for the first trial, free from contamination by practice effects, were plotted (Fig. 3). These curves are based on only one data point per S at each serial position, so no formal analysis was undertaken. Descriptively, all curves exhibit a pronounced primacy effect. The facilitated performance on list AD is restricted to intermediate and recent serial positions for all grades, with a recency effect also occurring for list AS in Grade V alone. List A, on the other hand, shows a minimal recency effect, especially in Grade V. These curves, then, indicate that children follow essentially the same pattern as adults in the serial retention of visually-presented items with a high primacy and lower recency effects. The increased recency effect observed for lists AD and AS, especially in Grade V, is taken to reflect the utilization of the verbal code in addition to the visual

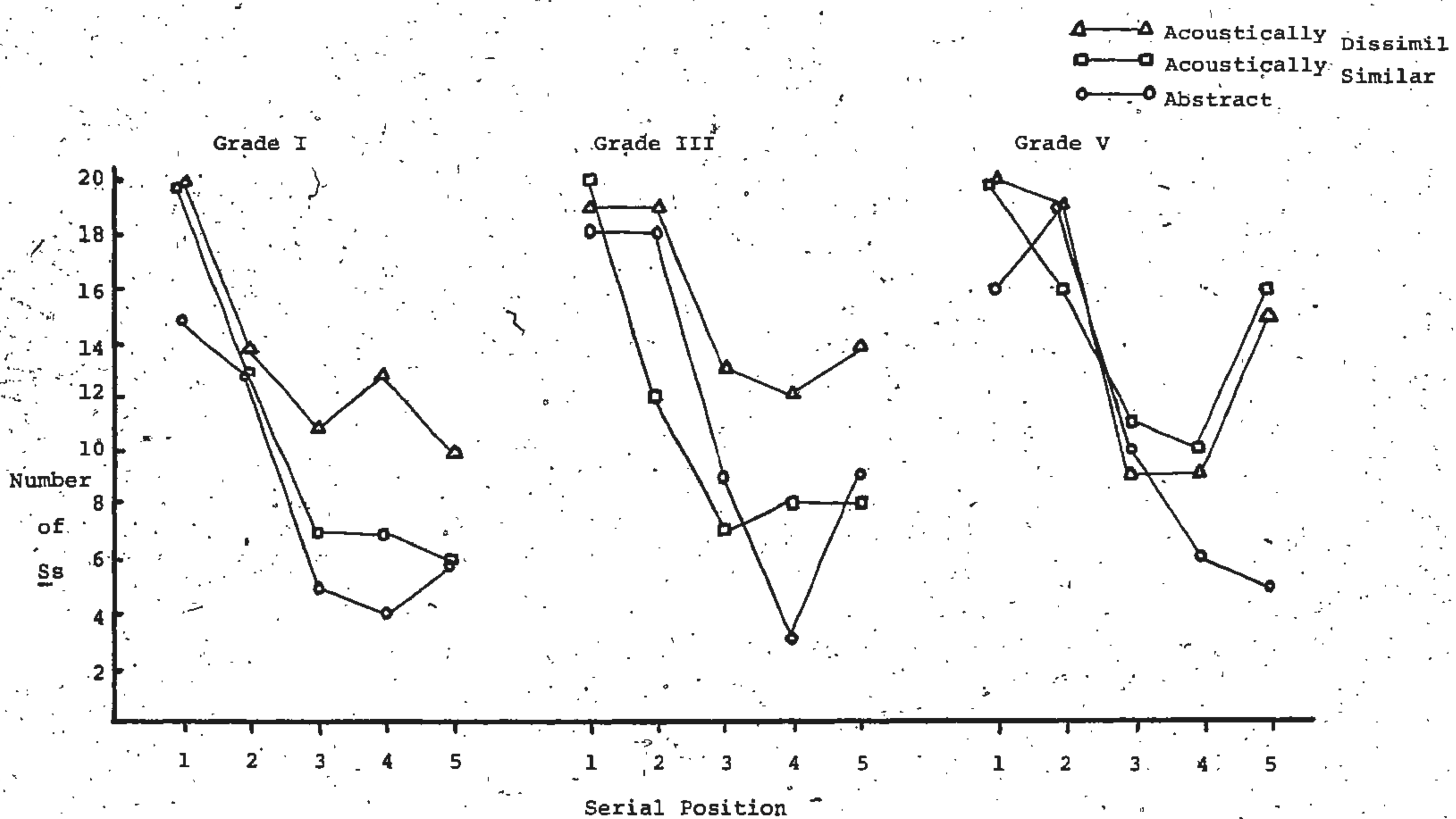

Figure 3. Number of Ss responding correctly at each serial position on Trial 1 as a function of grade levels and list conditions

code. The high primacy effect on list A for all grade levels on the first trial, where verbal labelling possibilities are at a minimum, supports the notion that the visual code alone can be utilized for retention of pictorial material in initial serial positions.

Serial position curves with the data averaged over the eight trials were also determined (Fig. 4). These data were analyzed by a 3 x 3 x 5 analysis of variance with grades, conditions and serial position as factors (Table 7, Appendix B). The main effects of grades ($p<.001$), conditions ($p<.001$), and serial position ($p<.001$) were all significant. The interactions of grades x serial position ($p<.05$) and conditions x serial position ($p<.05$) were also significant. The grade x serial position interaction is plotted in Fig. 5, which shows that the differences among the three grades were more pronounced at later serial positions. These data are again consistent with the notion that the grade differences reflect different degrees of verbal labelling. However, there is some hint of a ceiling effect in the recognition of items presented in the first serial position and this might have contributed artifactually to the significant interaction. The conditions x serial position interaction (Fig. 6) reflects primarily the increasingly higher performance of Ss in the AD condition over the other two at later serial positions. Here an interpretation based on increased utilization of the verbal code is also applicable to the recency data. However, the possibility of a ceiling effect at serial position 1

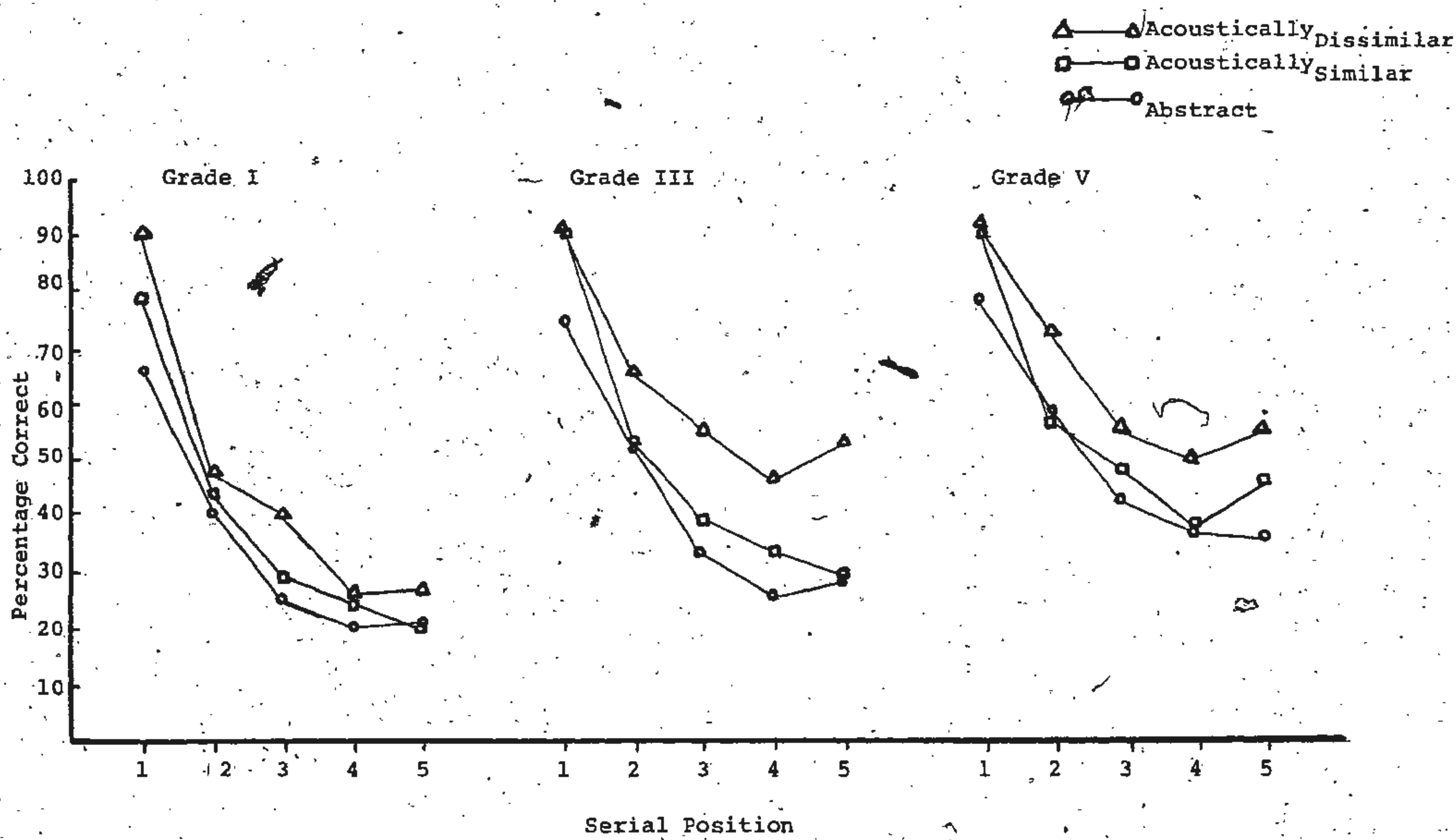

Figure 4. Mean percentage correct at each serial position on all trials as a function of grades and list conditions

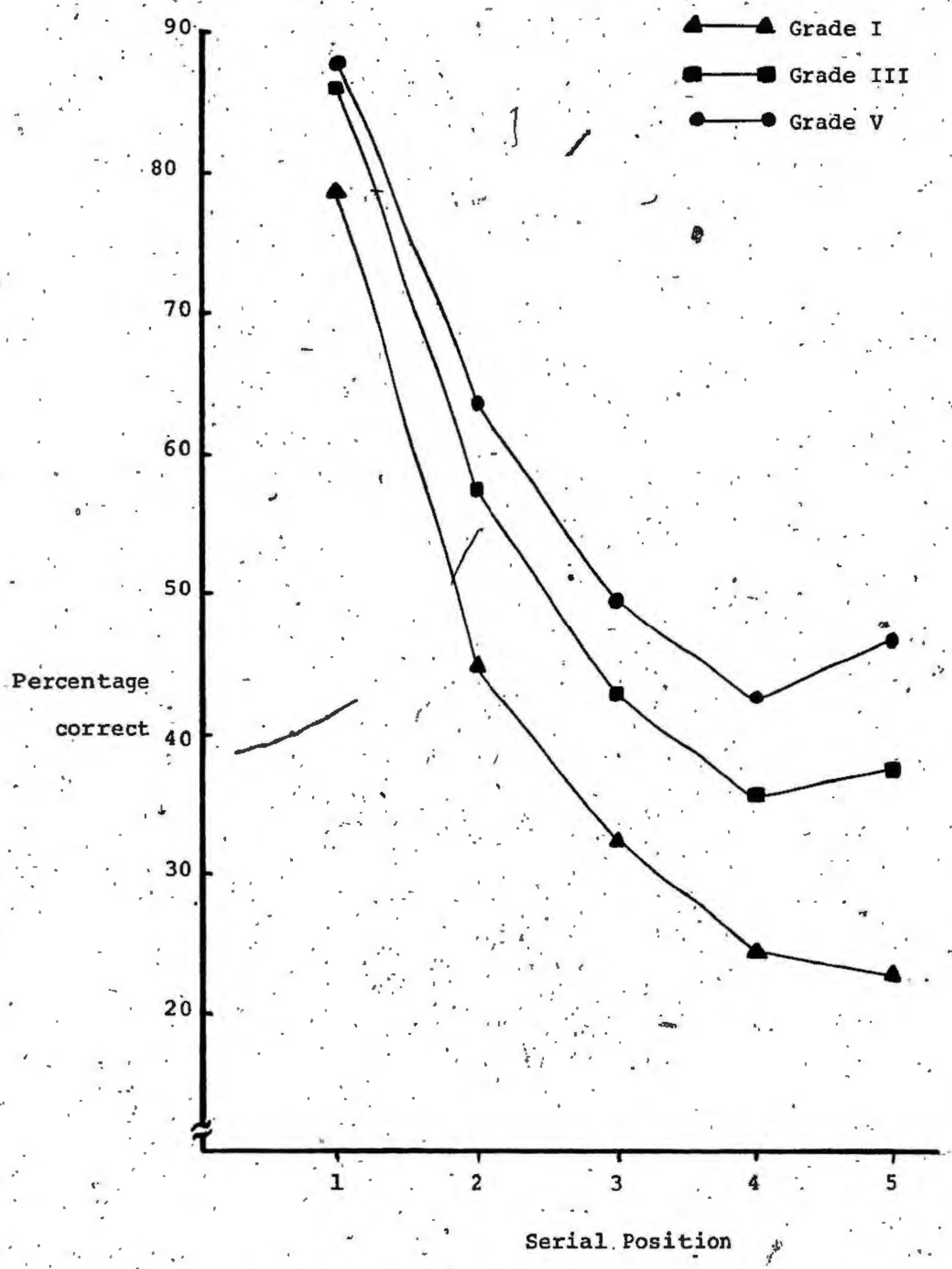

Figure 5. Mean percentage of correct serial position as a function of age

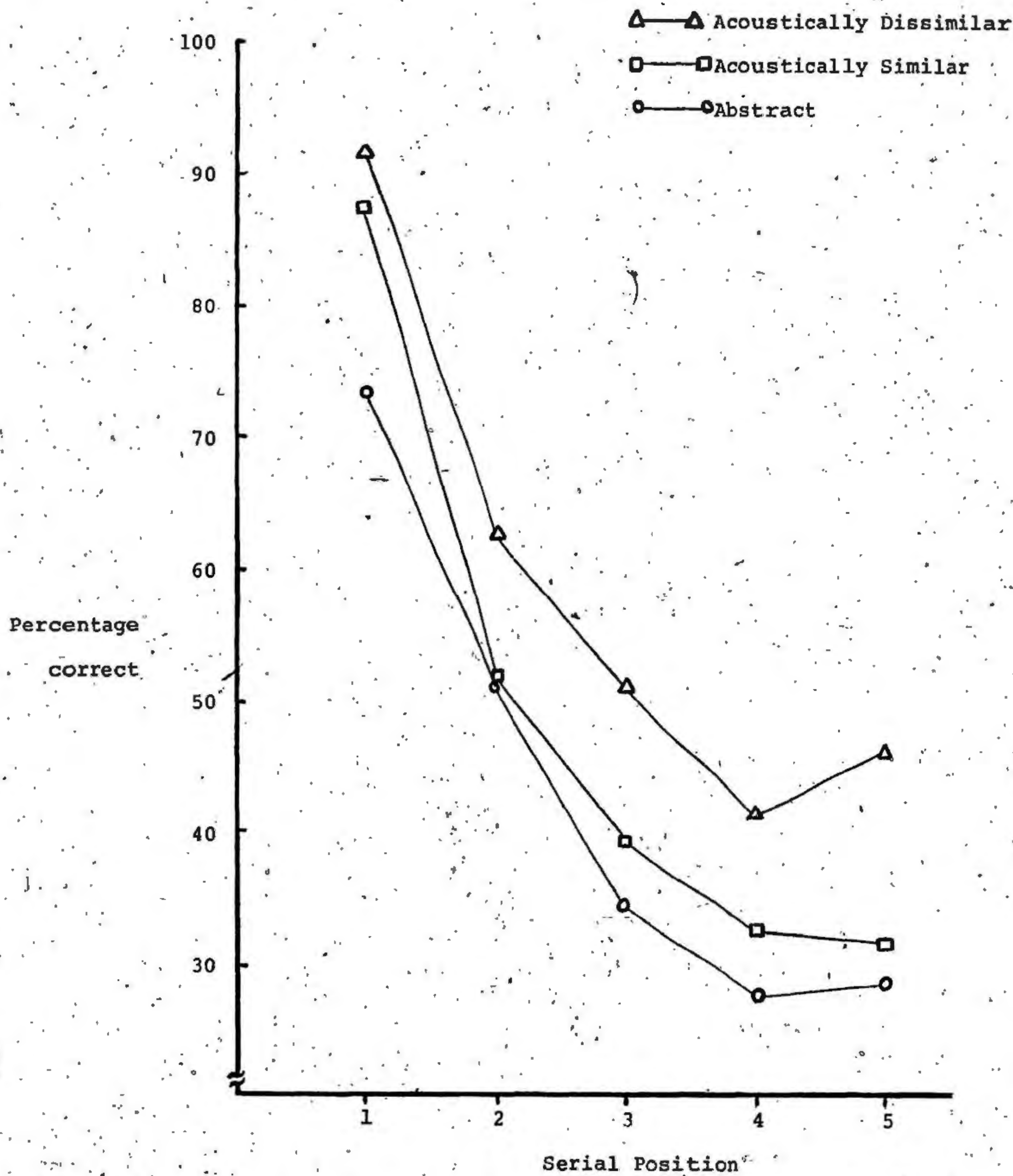

Figure 6. Mean percentage of correct serial position as a function of list conditions

again does not permit an unambiguous interpretation of the interaction.

Chapter 4

Discussion

The main purpose of the present experiment was to investigate the developmental function of both verbal and visual processes in short-term sequential memory for pictorial material. The results will be discussed in terms of the predictions made at the outset. First of all, the overall level of performance on the three sets of material was ordered in the expected manner, with recognition scores being highest for the AD list, next highest for list AS, and lowest for list A. This ordering was furthermore independent of grade level, as shown by the absence of an interaction effect in the initial analysis of variance (Table 1A), but the pairwise comparisons among the three lists at each grade revealed slightly different patterns of significance (Table 2).

The difference between lists AD and AS did increase somewhat with increasing age, lending some support to the prediction of an increased use of verbalization by older children, but the differences were not as great as reported by Conrad (1971). The primary discrepancy in the two sets of findings lies in the tendency for performance to asymptote between Grades III and V in the present study. The reason for this is not completely clear. One possibility is that the lists used here were the same for each grade, whereas Conrad controlled for differences in list difficulty at different ages. However, the existence of a ceiling effect in the present data seems unlikely, since the Ss in the AD condition in Grade V were performing at less than 70 percent correct. An alternative interpretation is that verbalization strategies were used to the same extent in Grade III and V. This finding is not implausable when we consider that ours was a serial order recognition task, while Conrad's task did not require retention of order information. Thus, the developmental function for use of the verbal code reported by Conrad (1971) may in fact hold only for nonsequential memory tasks. The function may asymptote at an earlier age when implicit verbalization is encouraged by the inherent nature of the experimental paradigm.

It was predicted that, if the use of the visual code remains unaffected by increasing use of the verbal code, performance on list A should be relatively invariant across grade levels. This prediction was not upheld by the initial analysis of the data; rather, performance on list A paralleled that on list AS, increasing systematically between Grade I and Grade V. Retention was higher on list AS, probably because verbalization could be used with these items to some extent. However, the effectiveness of verbalization must here be considered minimal, since the difference between list AS and A was not significant at any grade (Table 1).

The prediction of minimal retention differences across grade levels on list A did receive some support from a supplementary analysis of performance on this list alone, when the data from those Ss who reported attaching verbal labels to some of the items were excluded. In this case, the

Grade V Ss were not different from Grades I and III, although the difference between the latter two was marginally significant. The tendency for Grade V Ss to use verbalization, even with list A items, was illustrated also by the serial position data (Fig. 4), the analysis of which showed increased recency effects with increasing grade (Fig. 5). These increases occurred regardless of list type, as evidenced by the lack of a significant three-way interaction in the analysis of variance. Again, it should be noted that these results may be specific to the serial task, and that the same results may not obtain when retention of order information is not required.

The results leave little doubt of the existence of a visual code for Ss at all grade levels used in the present study. Overall retention of the items in list A was about 40 percent, as compared to about 60 percent for list AD items, which were easily labelable. The use of a visual code is most apparent, however, from the serial position data, especially those from the first trial (Fig. 3), where any attempts to attach labels to the items of list A should be at an absolute minimum. It can be seen from Fig. 3 that performance on list A was in general just as good for the two labelable lists when the data for the first two or three serial positions are considered. It is difficult to see how these results can be accounted for without the postulation of a memory system which can encode material on the basis of its visual properties.

Thus it appears that a visual STM code exists as a mediator of retention for Ss at the three stages of development studied here. The acquisition and increased utilization of implicit verbalization does not replace the use of this code, as other investigators seem to imply (Conrad, 1971; Flavell, et al., 1966; Keeney, et al., 1967). On the contrary, the visual code appears to persist and to be relatively unaffected by developmental changes in verbalization, as the analysis of the data obtained from nonnamers only on list A revealed. These conclusions are in accord with data arising from adult studies which suggest that the two codes are functionally independent (Bahrick & Boucher, 1968; Paivio & Csapo, 1969; 1971; Shaffer & Shiffrin, 1972; Tversky, 1969). The finding that performance is enhanced when a distinctive verbal code is also available is consistent with previous findings on the effect of verbalization (e.g. Flavell, et al., 1966; Keeney, et al., 1967; Hagen & Kingsley, 1968). In a more general way, the results are also relevant to research findings on the effects of visual imagery in children's learning (Rohwer, 1970). These studies, using primarily the paired-associate learning paradigm, have shown that children find it easier to remember pictures than words, but only when the appropriate verbal labels are stored along with the pictures. Thus in general it seems that two codes are better than one, both when the use of the two codes is compared with use of the verbal code (Rohwer, 1970), or the visual code alone, as in the present study. This observation has been used as the basis of a "dual coding" theory of memory by Paivio (1971).

In summary, then, this study provided evidence for the presence of a visual code for retention of visual sequential information independent of a verbal code, which is acquired with the development of speech. The presence of the verbal code was more apparent for Grade III than for Grade I Ss, but did not increase between Grade III and Grade V, whereas changes in the visual code were less pronounced across all three grade levels. The results suggest that both forms of encoding must be taken into account in developmental studies using pictorial material.

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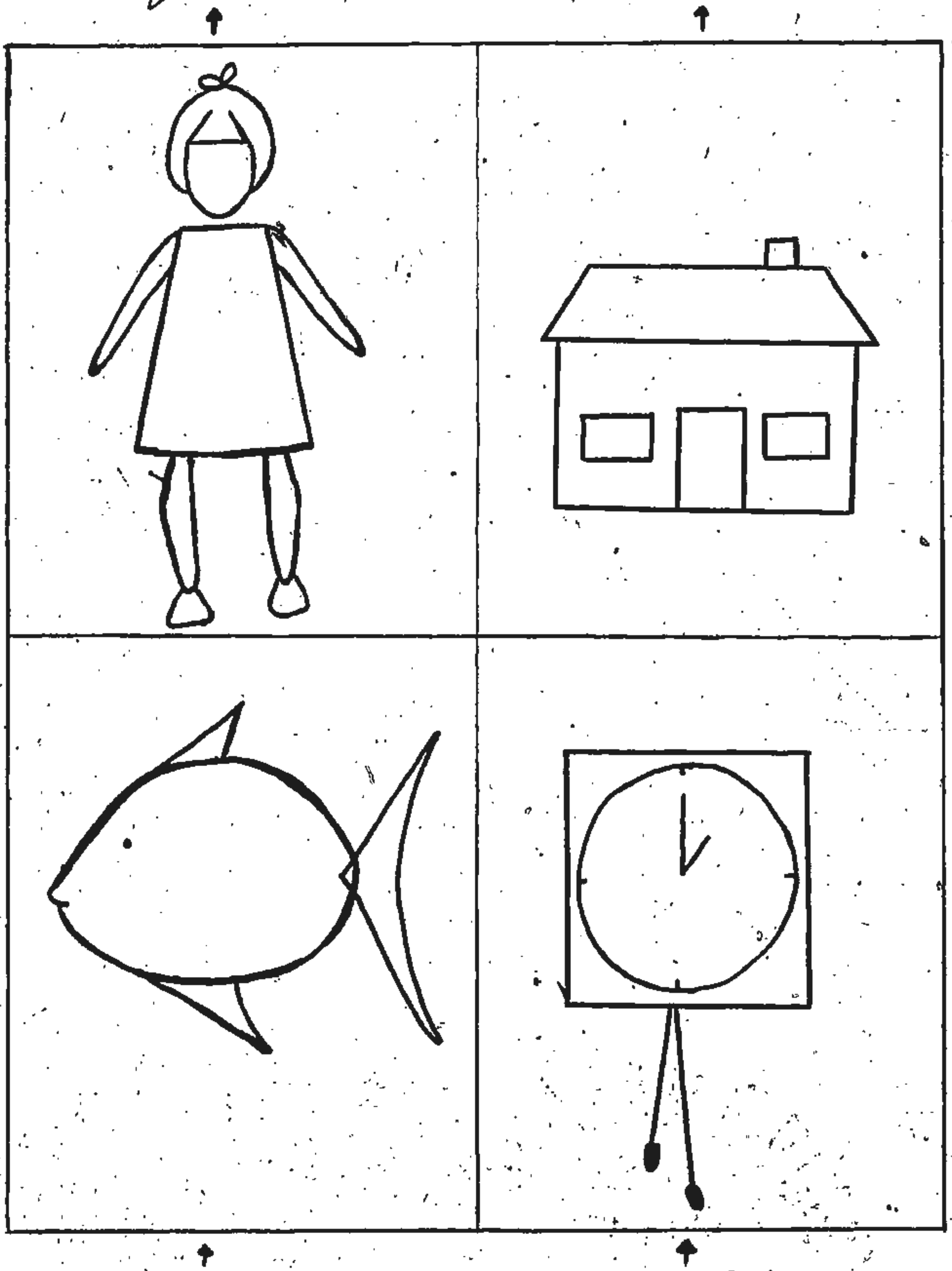
APPENDIX A

ITEMS USED IN THE THREE LIST CONDITIONS

Appendix A

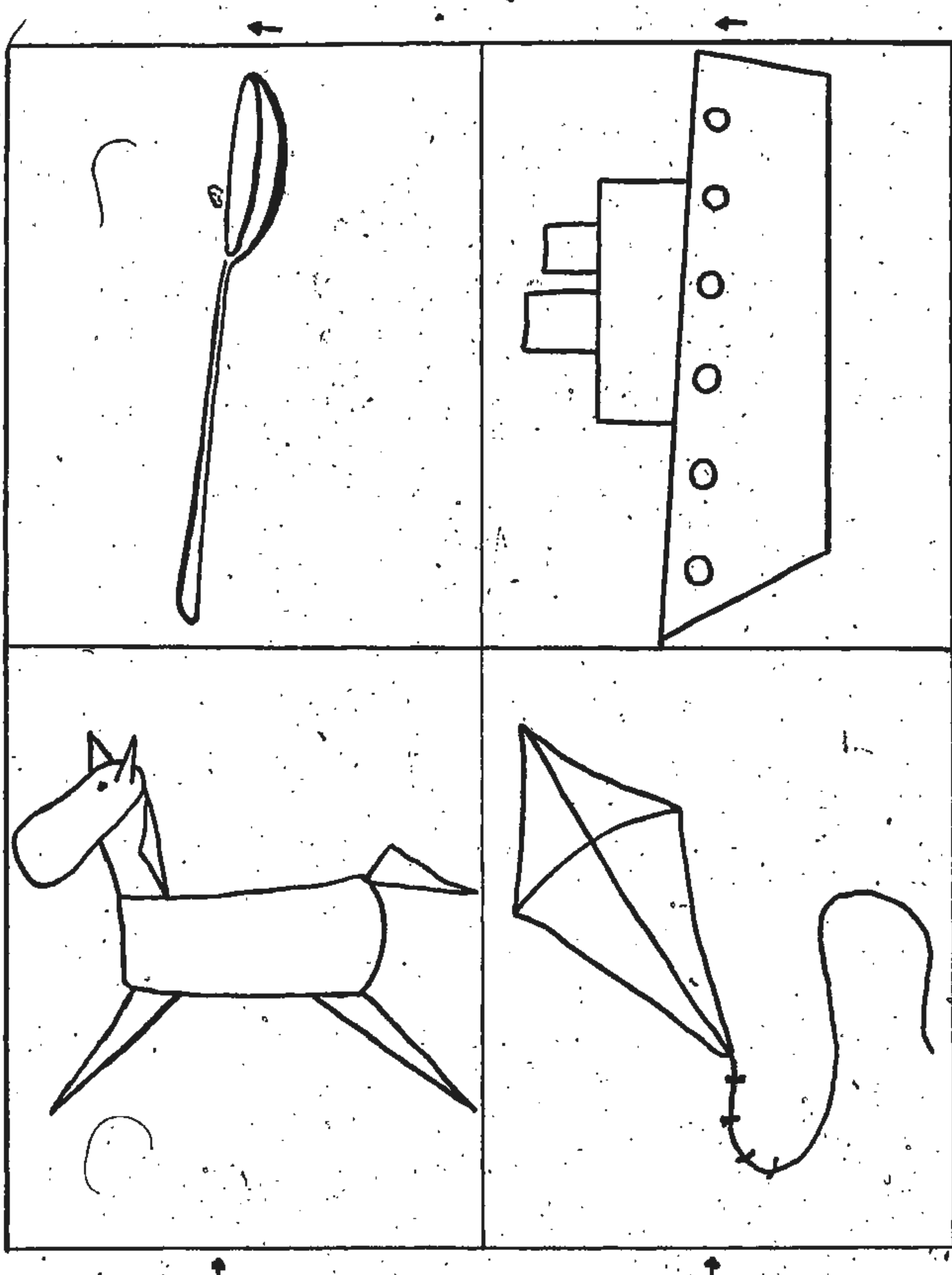
Acoustically Dissimilar List items



Note: Arrow heads indicate the upright position of pictures

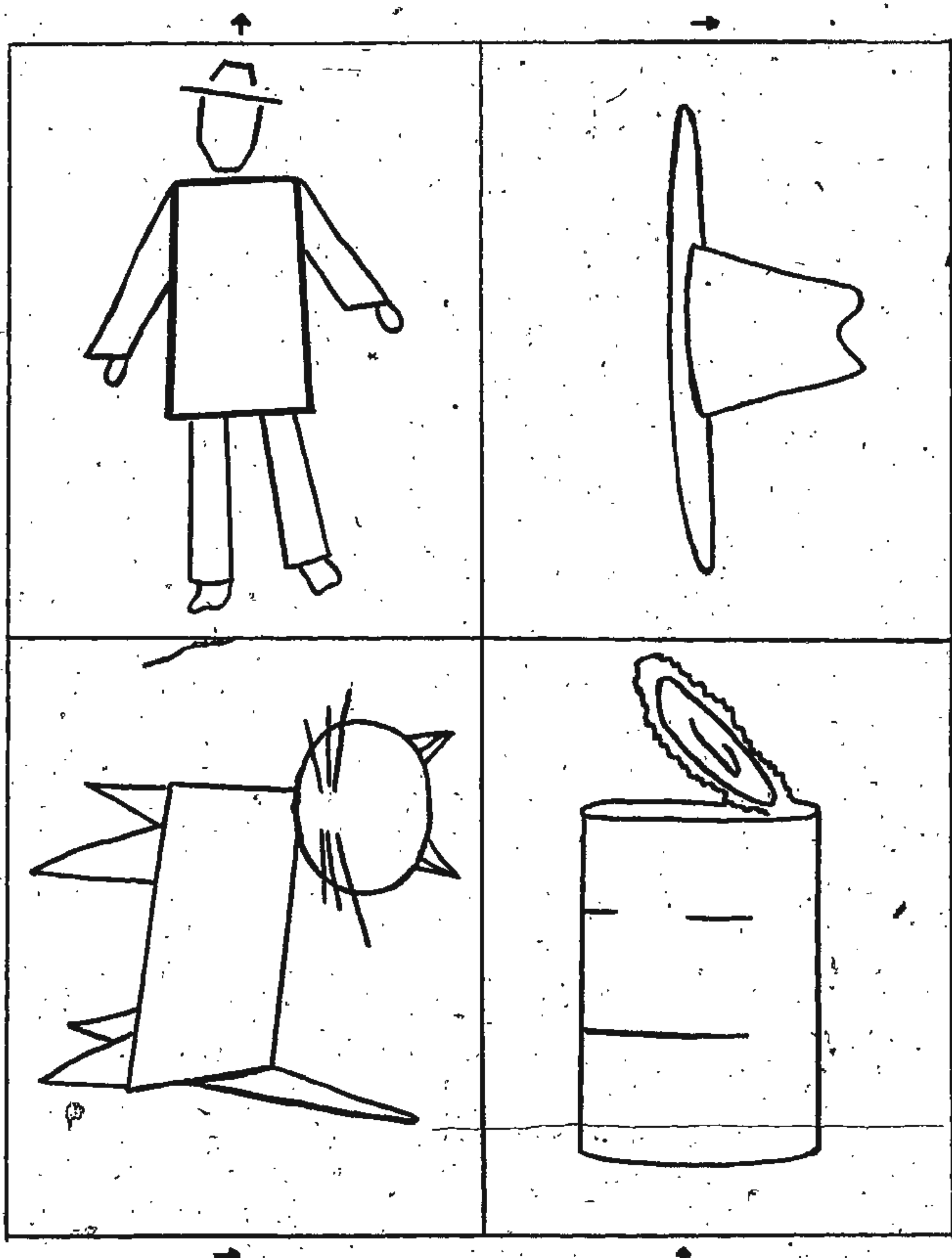
Appendix A

Acoustically Dissimilar list items



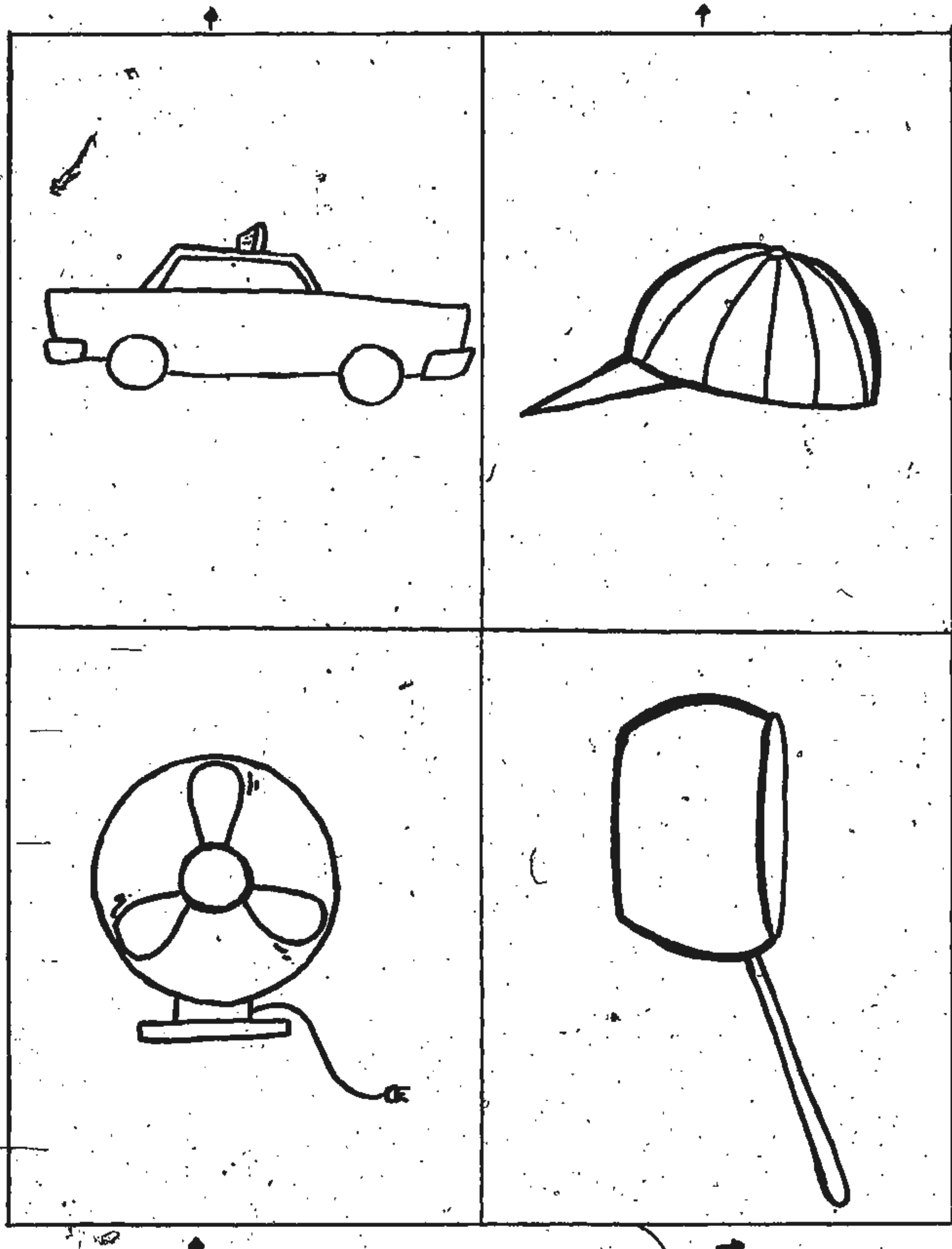
Appendix A

Acoustically Similar List items



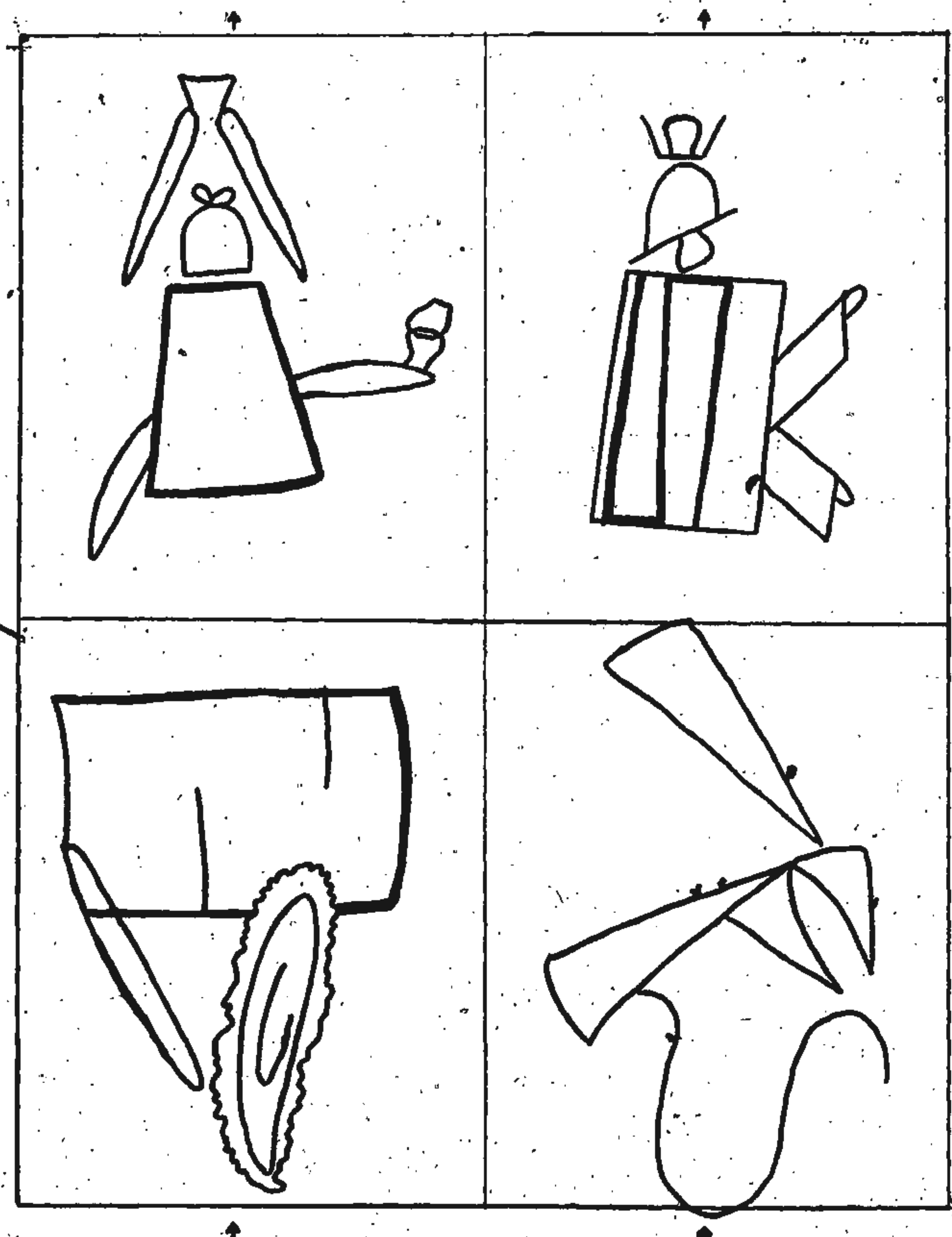
Appendix A

Acoustically Similar List items



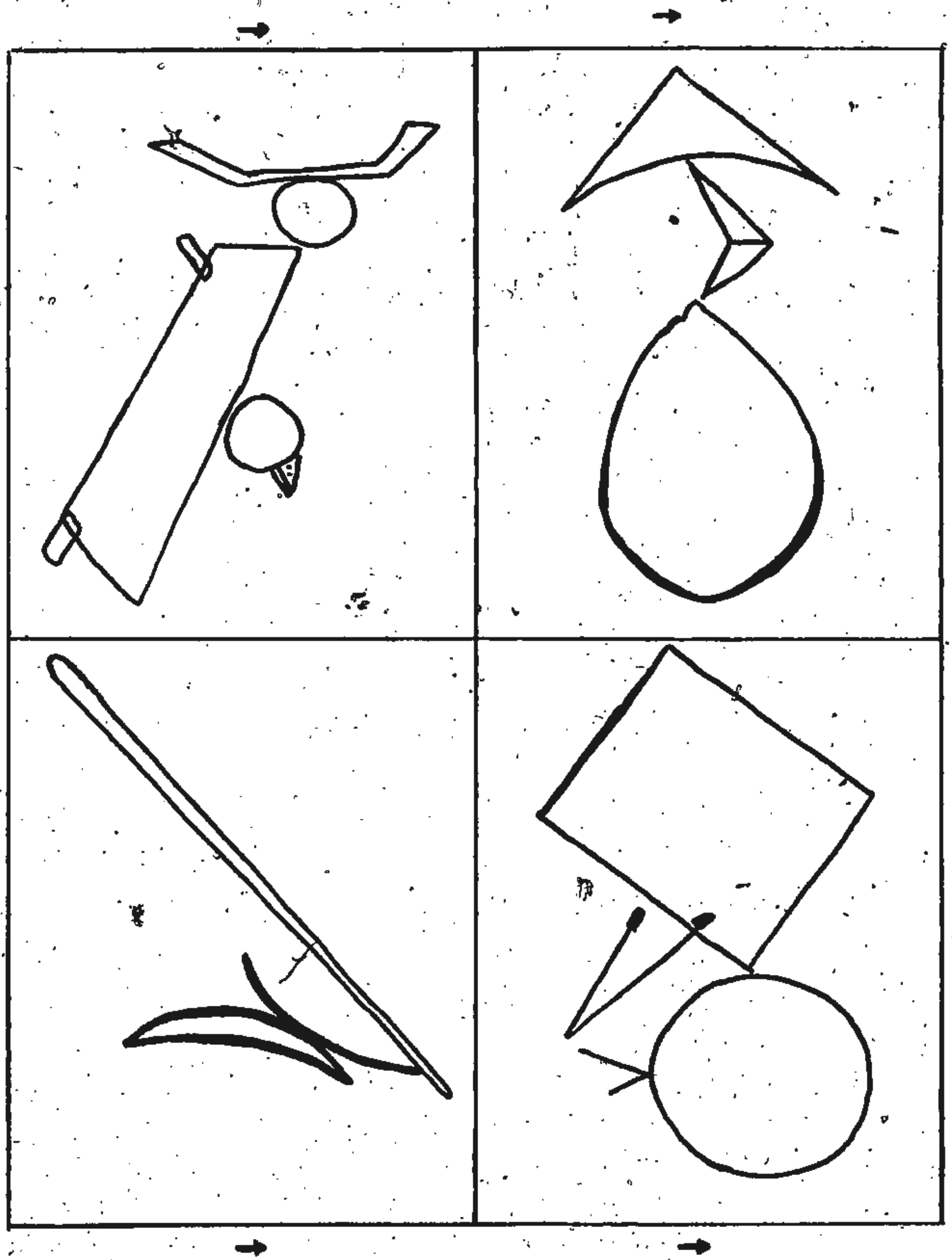
Appendix A

Abstract List items



Appendix A

Abstract List items



APPENDIX B

ANALYSIS OF VARIANCE SUMMARY TABLES

Appendix B

Table 1

A. Analysis of variance summary table for serial order recognition

Source	Sum of Squares	d.f.	Mean Square	F
A (Grade)	1487.1	2	743.55	29.15 **
B (Condition)	1173.23	2	586.62	23.00 **
A X B	59.97	4	14.99	<1
Within Cell	4361.5	171	25.51	
Total	7081.8	179		

**p < .01

B. Analysis of variance for simple main effects

Source	Sum of Squares	d.f.	Mean Square	F
<u>Simple effects of B</u>				
Conditions for Grade I	214.93	2	107.47	4.21*
Conditions for Grade III	645.23	2	322.62	12.65**
Conditions for Grade V	373.03	2	186.52	7.31**
<u>Simple effects of A</u>				
Grades for list AD	685.63	2	342.82	13.44**
Grades for list AS	464.53	2	232.27	9.11**
Grades for list A	396.9	2	184.95	7.25**
Within Cell	4361.5	171	25.51	

*p < .05

**p < .01

Appendix B

Table 2

Scheffe comparisons among the means for each list condition at each grade level (Serial order recognition)

Grade	Comparison	F (2, 171)
I	AD, AS	3.08
	AS, A	1.27
	AD, A	8.30 *
III	AD, AS	11.44 **
	AS, A	2.35
	AD, A	24.16 **
V	AD, AS	5.51
	AS, A	2.08
	AD, A	14.35 **

* $p < .05$

** $p < .01$

Appendix B

Table 3

Scheffe comparisons among the means for each grade level in each list condition (Serial order recognition)

Condition	Comparison	F (2, 171)
AD	Grade I, III	16.06 **
	Grade III, V	0.71
	Grade V, I	23.55 **
AS	Grade I, III	5.66
	Grade III, V	3.53
	Grade V, I	18.13 **
A	Grade I, III	3.89
	Grade III, V	3.89
	Grade V, I	15.57 **

** $p < .01$

Table 4

A. Analysis of variance summary table for order-free recognition

Source	Sum of Squares	d.f.	Mean Square	F
A (Grade)	227.14	2	113.57	16.46**
B (Condition)	193.67	2	96.84	14.04**
A x B	29.83	4	7.46	1.08
Within Cell	1180.35	171	6.90	
Total	1630.99	179		

**p<.01

B. Analysis of variance for simple main effects

Source	Sum of Squares	d.f.	Mean Square	F
Simple effects of B				
Conditions for Grade I	67.23	2	33.62	4.87**
Conditions for Grade III	122.23	2	61.12	8.85**
Conditions for Grade V	34.02	2	17.01	2.464
Simple effects of A				
Grades for List AD	69.03	2	34.52	5.00**
Grades for List AS	119.23	2	59.62	8.64**
Grades for List A	68.7	2	34.35	4.98**
Within Cell	1180.35	171	6.90	

**p<.01

Appendix B

Table 5

Scheffe comparisons among the means for each list condition at each grade level (order-free recognition)

Grade	Comparison	F
I	AD, AS	6.10*
	AS, A	0.18
	AD, A	8.38*
III	AD, AS	12.61**
	AS, A	0.03
	AD, A	13.93**
V	AD, AS	0.44
	AS, A	2.27
	AD, A	4.70

*p<.05
**p<.01

Appendix B

Table 6

Scheffe comparisons among the means for each grade level in each list condition (order-free recognition)

Condition	Comparison	F
AD	Grade I, III	9.06*
	Grade III, V	0.36
	Grade V, I	5.51
AS	Grade I, III	3.71
	Grade III, V	4.96
	Grade V, I	17.25**
A	Grade I, III	4.70
	Grade III, V	0.81
	Grade V, I	9.43**

*p<.05
**p<.01

Appendix B

Table 6

Scheffe comparisons among the means for each grade level in each list condition (order-free recognition)

Condition	Comparison	F
AD	Grade I, III	9.06*
	Grade III, V	0.36
	Grade V, I	5.51
AS	Grade I, III	3.71
	Grade III, V	4.96
	Grade V, I	17.25**
A	Grade I, III	4.70
	Grade III, V	0.81
	Grade V, I	9.43**

*$p<.05$
**$p<.01$

Appendix B

Table 7

Analysis of variance summary table for serial position effects

Source	Sum of Squares	d.f.	Mean Square	F
A (Grade)	297.68	2	148.84	29.00**
B (Condition)	236.00	2	118.00	23.00**
A X B	12.41	4	3.10	<1
Within Cell	877.64	171	5.13	
C (Serial position)	2002.17	4	500.54	337.03**
A X C	23.33	8	2.92	1.96*
B X C	24.41	8	3.05	2.05*
A X B X C	31.18	16	1.95	1.31
C X S	1015.85	684	1.49	

$* \ p < .05$

$** \ p < .01$