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ABSTRACT

Two views of paired-associate learning were examined by assessing the paired-associate learning efficiency of eighth grade samples identified by digit span and IQ test performance as Jensen-type Level I and Level II learners. Eighty eighth grade students ranging in age from 13 years 3 months to 14 years 10 months were selected as subjects. Three different digit span tests were used to measure Level I ability, involving series of from three to nine digits presented aurally via tape recorder. Paired associate materials were also presented aurally and consisted of six high-i-age pairs, six low-image pairs, and six moderate-image pairs selected from the 40 highest, 40 lowest, and 40 most moderately rated imagery categories according to the Paivio, Yille, and Madigan norms. IQ scores obtained from school records served as a measure of Level II ability. Imagery conditions constituted a highly significant source of variance. A predicted Learning Levels X Imagery Conditions interaction was not obtained, nor did the Level II group significantly outperform the Level I group. Strategy scores derived from the subjects' reports correlated significantly with paired-associate learning only for Level I subjects. Level II subjects reported greater use of verbal and imaginal elaboration. (WR)

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PAIRED-ASSOCIATE LEARNING AT THREE IMAGERY LEVELS IN LEVEL I AND LEVEL II LEARNERS

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Two views of paired-associate learning were examined by assessing the PA learning efficiency of eighth grade samples identified by digit span and IQ test performance as Jensen-type Level I and Level II learners (N = 80). Three levels of stimulus concreteness, defined by the Paivio norms, were manipulated in a repeated measures design. Imagery conditions constituted a highly significant source of variance. A predicted Learning Levels X Imagery Conditions interaction was not obtained, nor did the Level II group significantly outperform the Level I. Strategy scores derived from subjects' reports correlated significantly with PA learning only for Level I subjects. Level II subjects, however, reported greater use of verbal and imaginal elaboration. Discussion centers on the distinction between strategy availability and strategy effectiveness.

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PAIRED-ASSOCIATE LEARNING AT THREE IMAGERY LEVELS IN LEVEL I AND LEVEL II LEARNERS

Tallying the results of paired-associate studies involving subjects across age ranges leads one to the conclusion that an important shift in process, from simple associative to more complex elaborative strategy use, occurs between 9 and 13 years of age. Thus, in a study involving aurally presented PAs, Bean and Rohwer (1970) bracket the spontaneous production of verbal mediators between grades four and eight. Spontaneous production is said to occur when subjects report mediational (i.e. elaborative) activity in the absence of instructions to mediate and in the absence of provided mediators such as sentences. This finding is consistent with other results, including studies involving imaginal elaboration. Horvitz (1971), for example, compared the PAL performance of third grade, sixth grade, and college students who were given or not given imagery instructions. While performance improved with age, the instructional set difference was significant only at the sixth grade level; third graders apparently are too young to effectively use imagery instructions while college students employ imaginal strategies spontaneously. This hypothesized, age related shift in process has additional research support (Jensen and Rohwer, 1965; Thomas, 1971; Rohwer, 1972).

In addition to age related differences in PAL, a significant age by social class interaction is consistently reported in the literature.

Thus, in a series of studies involving provided mediators, Rohwer found that high strata youngsters outperformed lower strata youngsters prior to nine years of age but not in the age range from 9 to 11 years (Rohwer, 1967; see also Semler and Iscoe, 1963). These data represent an anomaly in that they show a converging in PAL proficiency on the part of high and low SES youngsters just at a time when the rote to elaborative strategy shift should be pulling scores further apart. Thus, PAL reflects an important developmental shift in intellectual functioning which appears to be unrelated to well established social class differences in intellectual functioning.

One solution to this problem, favored by Rohwer (1971), is to view the mental processes involved in PAL in a different light than those involved in SES related differences in measures of IQ and scholastic achievement. Rohwer argues that paired-associates and standardized tests both require transformation of input, but that the former rely more on "imaginative conceptual activity" and the latter on "formal conceptual activity" (i.e. the application of well defined sets of rules). SES differences are more apparent in formal than in imaginative conceptual tasks.

Jensen's two factor theory of mental ability offers an alternative to this explanation. Jensen's theory states that rote learning ability (Level I) and conceptual ability (Level II) are factorially distinct, and that Level II regresses differently on Level I in lower and middle SES groups. Jensen (1969) makes a case for the fact that middle and low SES groups are equivalent in Level I ability but that middle SES children are superior on measures of Level II conceptual ability. Jensen (1970) argues that paired-associate tasks fall near the middle of the Level I, Level II learning ability continuum. Variables known to affect self generated mediation in subjects, such as an individual's age, certain stimulus attributes, presentation times, determine whether the PA task involves Level I or Level II processes. Prior to nine or ten years of age, Jensen believes, both high and low SES groups tend to rely on converging and near equivalent Level I associative abilities. The onset of SES differences in PAL is attributed to the increasing superiority of high SES youngsters in transforming input, a skill which becomes more apparent with age, overriding individual differences in Level I.

The research reported here is concerned with these conflicting views of paired-associate learning. Thus, if Jensen is correct, PAL is predominantly neither a Level I rote association task nor a Level II conceptual task. PA tasks differ in their relative dependence on Level I and Level II processes as a function of a number of variables. To test this hypothesis, a variable known to affect self generated mediation in subjects--the image provoking value of words, in this case, nouns (Paivio, 1971)--was manipulated in a design involving high and low SES eighth graders equated for Level I ability but differing by a standard deviation in Level II ability (IQ). Jensen predicts that increasing the abstractness of PA items will increase dependence on Level II processes (Jensen, 1970), a prediction receiving some support recently from Feldman et al. (1972).

Specifically, it was hypothesized that stimulus concreteness would interact with ability levels in such a way that the greatest differences between high and low SES, Level II and Level I learners would be found for noun associates of moderate imaginal value. It was hypothesized that nouns highest in image provoking value would tend to elicit imaginal or verbal elaboration in both groups. Nouns low in image provoking value (i.e. abstract nouns) would tend to be learned rotely by both groups. The greatest differences between Level I and Level II learners in this age range should be found for associates of moderate imaginal value. In addition to this Levels X Treatment interaction, a main effect for levels was hypothesized, favoring Level II learners. Imagery conditions was also expected to constitute a significant main effect, with high-I pairs significantly exceeding low and moderate pairs in retention. Moderate-I pairs were expected to exceed low-I or abstract pairs in learnability.

To gather additional data regarding the Jensen and Rohwer views, subjects were asked to describe how they tried to learn word pairs. Subjects' responses to this question were transcribed and a category system with high interrater reliability was used in classifying responses. Jensen's view of PAL predicts that subjects high in Level II ability will employ significantly more of the high level strategies than Level I learners. Rohwer's view is that low SES subjects will be more flexible in strategy use than high; this can be measured by the number of different strategies employed across subjects. According to Rohwer (1971) high and low SES subjects should not differ in terms of high level strategy use (i.e. imaginal and verbal elaboration).

Method

Subjects. Subjects included 80 eighth graders ranging in age from 13 years 3 months to 14 years 10 months. An equal number of subjects were selected from schools serving predominantly low and predominantly high SES populations. SES categorizations were checked by gathering data relating to parents' occupational level. The majority of heads of household in the high SES sample were employed in professional and managerial occupations. Approximately 70% of the low SES sample were minority group members; half of the children were from homes in which the household head was "unskilled" or "unemployed." Equal numbers of males and females were selected.

Materials. Three different digit span tests were used to measure Level I ability, involving series of from three to nine digits presented aurally via tape recorder. Paired-associate materials were also presented aurally and consisted of six high-image pairs, six moderate-image pairs, and six low-image pairs selected from the 40 highest, 40 lowest, and 40 most moderately rated imagery categories according to the Paivio, Yuille, and Madigan norms (1968). Examples of low-I pairs include IDEA-CHANCE, FATE-OCCASION; of moderate-I pairs, GRIEF-MATERIAL, EMERGENCY-PLEASURE; of high-I pairs, APPLE-ORCHESTRA, GARDEN-STAR. Two separate 18 item mixed lists were employed, equated for imagery value and such word characteristics as syllable length and previous exposure. Lists were randomly assigned to subjects. No significant differences were found between list one and two; consequently, data was pooled across lists in analyses presented below. The six PAs at each imagery level for the mixed lists were randomly formed. Obvious associations between words were avoided (i.e. STRAWBERRY-APPLE). In addition, associates were equated across imagery categories for word length, as measured by number of syllables.

Procedures. To examine associative ability all subjects present on several testing days were tested in groups of three to five. Digits were read at a rate of one per second. Each list began with a three-digit series. Immediately following each series, a bell sounded which signaled subjects to begin recording the digit series just heard. Digit span scores consisted of total digits correctly recalled in sequence and position across the three digit span lists. In addition to the measure of Level I ability, IQ test scores were made available through school records. These scores served as a measure of Level II ability. Conversion tables were used to equate Kuhlman-Anderson and Lorge-Thorndike IQ scores. Following Jensen's definition, 40 Level I, low SES subjects were selected from a total of 59 on the basis of (1) equal or near equal digit span ability in comparison to the overall mean of the high SES group, and (2) an IQ score at least one standard deviation below the high SES group mean. Means and standard deviations for digit span and IQ are presented in Table 1 for high and low SES experimental subjects.

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Insert Table 1 about here
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Analysis of variance reveals that high and low SES subjects do not differ significantly in Level I ability ($F = 3.65$, $df = 1/79$, $p > .05$); they differ significantly in Level II ability ($F = 25.35$, $df = 1/71$, $p < .01$).

Level I and Level II learners identified above were then individually presented with 18 item PA lists. PAs were presented aurally with a tape recorder at a five second rate. Subjects were carefully instructed to "Remember the words that go together." During test trials, stimulus items were presented and subjects had five seconds to respond orally with the correct response word. A total of three study and test trials were employed. Items had been randomly rearranged from study trial to study trial to avoid serial effects. In the repeated measures design, scores consisted of the total number of correct responses per item type. All subjects were tested by the same experimenter. Following the third PA test trial each subject was asked the following two questions: "How did you try to learn the words?" and "What made some of the words easier to learn than others?" This was done in an effort to obtain information relating to subjects' use of learning strategies. Subjects' responses to these questions were written down verbatim.

Five strategy categories were used to subsume subject responses to the experimenter's questions. Weights assigned to strategy levels (1 = rote, 2 = mnemonic, 3 = verbal association, 4 = verbal elaboration, 5 = imagery) were used in obtaining individual strategy scores. Interrater reliability was .94 for the category scheme. Category definitions and examples of responses in each of the categories are given below:

1. Rote, which involved the least complex type of strategy for remembering. Examples included " I just kept repeating," or "I said them back and forth."

2. Mnemonic, involving relatively low level strategies which relied on word sound or letter cues. For example, "The first letters were b - c," or "The endings were sometimes the same, like democracy - tendency."

3. Verbal association, used to categorize responses which indicated that an association was made between word pairs but where evidence of complex elaboration was lacking. For example, "Coffee-woman go together," and "I thought of a car and a boat and a boat and the ocean."

4. Verbal elaboration, which differed from the above in that it involved embedding word pairs in sentence strings. Examples included "I made up a sentence: 'The comedy is in season;' 'The policeman came to the fire'," and "For idea - chance I said 'The chance to bring out ideas'."

5. Imaginal elaboration, probably the most complex strategy, involved the use of visual images to combine or unitize word pairs. Examples were "I tried picturing it in my mind--an alligator smoking a cigar; a baby playing the piano," or "I thought of the outside and tried to place it (the associate) in a scene."

Results

A 2 (ability levels) X 2 (sex) X 3 (imagery conditions) repeated measures analysis of variance was used to test treatment effects. The dependent variable was the number of correct associates summed across three test trials. Means and standard deviations for Level I and Level II learners, males and females, and imagery conditions are presented in Table 2.

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Insert Table 2 about here
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Analysis of variance revealed a highly significant main effect for imagery conditions ($\underline{F}$ = 243.63, $\underline{df}$ = 2/152, $\underline{p}$ < .001). Post hoc comparisons of means for imagery conditions (Newman-Keuls procedure) showed that all comparisons exceeded critical values for the .01 level of significance. Thus, the moderate imagery condition differed significantly from the low imagery condition; retention of high imagery associates, in turn, significantly exceeded retention of low and moderate imagery associates. High-I words were learned at a rate nearly three times that of low-I words. Twice as many moderate-I associates were retained compared to abstract associates.

Contrary to other hypotheses stated above, however, the difference in PAL between Level I and Level II learners was not significant, nor was the predicted learning levels by imagery conditions interaction.

Turning to subjects' reported use of strategies, some interesting results were found. Two ways of organizing data were used in answering specific questions. First, the total number of separate responses per strategy category was tallied, providing information regarding the frequency as well as type of strategy response. Second, weights assigned to categories were used in obtaining strategy scores for each experimental subject. Thus, if an individual made one or more verbal responses indicative of a certain strategy category, the weight assigned to that category counted as part of the individual's total strategy score. A chi square test was conducted to s t. ..umber of strategies reported by high and low level subjects differed significantly. It did not ($X^2 = .508$, $p < .50$). Level II subjects seemed just as flexible in employing different strategies as the Level I subjects. However, while the number of different strategies employed by individuals did not differ across learning levels, the type of strategy did. This was evidenced in at least two ways. First, total scores differed. A Mann-Whitney U test was used to determine whether there was a significant difference between the high and low level group's total strategy scores. This difference was found to be significant ($z = 2.31$, $p < .02$, two tailed) in favor of the Level II subjects.

Secondly, the proportion of subjects in Level I and Level II groups reporting use of elaborative strategies (i.e. categories 4 and 5, above) compared to nonelaborative strategies differed significantly ($X^2 = 5.60$, $p < .02$). Males and females did not differ in relative frequency of elaborative and nonelaborative strategy use.

Level II subjects engaged in more complex elaboration than Level I subjects. This did not seem to result in better performance on the learning task, leading one to conclude that there is no relationship between learning performance and an individual's strategy score. In fact, however, this was not the case, at least as far as the Level I youngsters were concerned. A Spearman rank correlation for the high and low level youngsters was computed to determine the relationship between subjects' total strategy score and subjects' corresponding number of correct responses on the learning task, summed across imagery levels. For the two groups, these correlations were .099 and .39, high and low groups respectively. The correlation for the Level I group was significant ($t = 2.57$, $p < .01$, one tailed), indicating a relationship between total strategy score and amount of learning for this group.

On the basis of this data, then, the question to be resolved is Why did strategy scores not relate to learning performance in the Level II group? A possible explanation for these findings is discussed below.

Discussion

Jensen's Level I--Level II theory of mental ability was used to reconcile results of PA studies involving older and younger subjects with similar studies involving subjects high and low in SES. Jensen's view of the PA task, however, receives only minimal support in the present study. Following Jensen, it was hypothesized that (1) increasing the imaginal value of word pairs would succeed in shifting the paired-associate task from the associative to the conceptual side of the Level I--Level II continuum for all subjects, and (2) that moderately concrete (or abstract) word pairs would produce the greatest differences between high and low Level II youngsters just beginning to spontaneously mediate. The fact that no differences in PAL were found, despite significant differences in IQ between the groups, might indicate that performance on the task was more a function of nonconceptual rote learning ability than of Level II kinds of ability. Similarly, the failure of the predicted Levels X Treatment interaction to materialize can also be construed as evidence that similar low level processes were involved across item types.

The trouble with concluding that Level II processes were not involved, however, is that imagery levels did constitute a highly significant source of variance. Clearly some process must have been at work to produce this enormous treatment effect.

An alternative to the Jensen view (Rohwer, 1971) states that low SES populations are deficient only in tasks involving formal conceptual activity. This view holds that successful performance on PA tasks depends more on imaginative than formal conceptual processes; thus differences are less marked in PAL than in standardized test performance. Results of this study, however, indicate that Level II learners employ more of the complex strategies in learning word pairs than Level I learners. Level II youngsters reported using elaborative strategies nearly half the time, while Level I youngsters reported using elaboration a little over a third of the time. A question raised in connection with this data, then, is Why is the "extra" elaboration reported by Level II subjects not reflected in superior performance in PAL?

Several explanations could be entertained. For example: Level II youngsters, being more verbally fluent, were better able to describe what they did during the experiment. This explanation was rejected on the grounds that the groups did not differ in terms of total number of responses falling in the most ambiguous response category--the verbal association category--and the fact that equivalence across learning levels meant no relationship between PAL and strategy use in either group, which seemed unlikely. An explanation which has some support, however, can be stated as follows: Most of the additional, unsuccessful elaboration engaged in by Level II subjects was ineffective because it involved words low in image provoking value. Subjects included specific word examples in their verbal reports and this made possible an examination of item type percentages (i.e. high-I, etc.) for each strategy category; these data reveal that nearly a third of the examples involving elaboration reported by Level II subjects employed words low in imaginal value, versus a fifth of the examples given by Level I subjects. The Level II group apparently attempted to elaborate or transform "inappropriate" stimuli more frequently than the Level I group. This is at least suggestive of why Level II eighth graders have difficulty converting some elaboration into learning gains.

To summarize, this study indicates that by 13 years of age both high and low SES youngsters spontaneously engage in complex elaboration in PA learning; the high SES, high IQ group, being perhaps more "elaboration prone" than the low, overgeneralizes what can be a powerful strategy. The most significant finding in this study, however, is that the material to be learned plays a crucial role not only in strategy production but also in strategy effectiveness following production. Level II ability seems to be related more to the production or availability of elaborative strategies than to their effective use during this transitional age period. Strategy effectiveness is chiefly a function of the concreteness of the materials to be acted upon. This discussion brings to the fore an important issue in PA learning, the distinction between strategy availability and strategy effectiveness (i.e. production versus use). Flavell and his colleagues (1966) were the first to make this distinction in an attempt to account for developmental differences in learning among normal children. More recently, Paivio's data (1971) support the contention, made above, that availability of elaborative strategies does not guarantee that learning will occur. Thus, Paivio concludes: "Item imagery in fact accounts for more of the variance in recall scores than does the instructional set to use imagery when both variables are included in the same design (p. 342)." In the experiment reported here, the imagery conditions factor accounts for a stunning 86% of the total variance. The fact that this stimulus effect apparently overrides social class differences in elaborative strategy production has obvious educational implications.

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TABLE 1

Means and Standard Deviations

for Digit Span and IQ Scores in High and

Low SES Experimental Subjects

Group	Digit Span: Male	Digit Span: Female	IQ: Male	IQ: Female	
High SES					
n	20	20	16	20	
M	87.5	81.5	108.3	109.3	108.8
SD	13.0	12.9	8.2	10.3	
Low SES					
n	20	20	18	18	
M	81.7	76.4	96.8	96.6	96.7
SD	11.9	13.1	9.8	6.9	

Note.--IQ data were not available for all Ss. Achievement scores were used in lieu of IQ data.

108.3
109.3
2) 217.6
108.8

TABLE 2

Means and Standard Deviations

for PAL by Levels and Sex

Group	Imagery Conditions					
	Low I		Mod I		High I	
	Sex					
	Males	Females	Males	Females	Males	Females
Level II						
M	2.55	3.45	5.30	7.65	11.40	11.55
SD	2.26	2.80	2.43	3.10	2.76	3.72
Level I						
M	2.90	3.00	6.05	5.20	11.45	11.35
SD	2.98	2.93	3.00	2.91	2.39	4.08

Note.--N = 80