ABSTRACT

AN EXPERIMENTAL STUDY OF THE
PAIRED-ASSOCIATE TASK AND LEVELS OF LEARNING

By

Richard Stanley Prawat

Tallying the results of paired-associate studies involving Ss across age ranges leads to the conclusion that an important shift in process, from simple associative to more complex elaborative strategy use occurs between 8 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 4 and 8. This finding is consistent with other results, including studies involving imaginal elaboration (Jensen and Rohwer, 1965; Horvitz, 1971; Taylor and Black, 1969). In addition to age related differences in PAL, a significant age by S.E.S. interaction is consistently reported in the literature. Thus, in a series of studies involving provided mediators, Rohwer reports that high strata youngsters outperform lower strata youngsters prior to 8 years of age, but not in the age range from 8 to 11 years (Rohwer, 1967). It was hypothesized that these results can be explained in terms of Jensen's Level I - Level II theory of mental abilities. Jensen and his colleagues (1969) attribute the onset of S.E.S. differences in tasks like the free recall of randomly arranged, categorized lists to the increasing superiority of high - S.E.S. youngsters in transforming input, a

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skill which becomes apparent by fourth grade. Prior to this time, Jensen argues, high and low - S.E.S. groups tend to rely on converging Level I associative abilities.

The review of literature suggested that PAL falls near the midway point on the associative to conceptual task continuum. To examine this theoretical view, a variable known to affect self-generated mediation in subjects - the imaginal value of words - was manipulated in a repeated measures design involving Level I - Level II type learners and Sex as additional sources of variance. It was hypothesized that stimulus concreteness, defined in terms of the Paivio, Yuille, and Madigan norms (1968), would interact with ability level in such a way that the greatest differences between high and low - S.E.S., Level II and Level I - learners would be found for associates of moderate imaginal value.

To examine associative ability, subjects were tested in groups of 3 to 5; three different digit span tests were used, involving series of from 3 to 9 digits presented aurally. I.Q. test scores and data on parents' occupation were made available through student records. Conversion tables were used to equate I.Q. scores. Following Jensen's definition, Level I, low - S.E.S. subjects were selected on the basis of (1) equal or near equal digit span ability in comparison to the overall mean of the high - S.E.S. group, and (2) an I.Q. score at least one standard deviation below the high - S.E.S. group mean. Equal numbers of males and females were selected.

In the second part of the study, subjects were individually presented with 18 item PA lists containing six high - I, six moderate - I,

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and six low - I associates randomly ordered and reordered for three study and test trials. PAs were aurally presented at a five second rate. Following the PA task, Ss were asked how they tried to learn the pairs. A category system with high inter-rater reliability ($r = .94$) was used to classify responses.

Subjects included 80 eighth graders, ranging in age from 13 years 3 months to 14 years 10 months. Subjects were selected from schools serving predominantly low and high - S.E.S. populations.

Contrary to Jensen's theory, high - S.E.S. subjects significantly outperformed low in digit span and I.Q. test performance. Digit span - I.Q. correlations for the two groups significantly differed, with the low - S.E.S. DS-I.Q. test correlation significantly exceeding the high (.54 vs. .04), again contrary to the Jensen prediction.

No significant S.E.S./Learning Level type differences were obtained for PAL. Imagery Levels constituted a significant source of variance, accounting for 86 percent of the variance in the repeated measures ANOVA. High - I pairs were learned significantly better than Moderate - I pairs which, in turn, exceeded Low - I pairs. The hypothesized Imagery Levels X Learning Level interaction was not obtained.

Five strategy categories were used to subsume subject responses to the experimenter's question. High and low - S.E.S. subjects did not differ significantly in total number of strategies reported, summed across individuals ($X^2 = .508$). Weights assigned to strategy levels (1 = rote, 2 = mnemonic, 3 = verbal association, 4 = verbal elaboration, 5 = imagery) were used in obtaining individual strategy scores. H

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scores. High and low - S.E.S. subjects differed significantly in total strategy scores (Mann-Whitney U test: $z = 2.31$, $p < .02$); this difference favored the high - S.E.S. Ss. However, correlations between Ss total strategy scores and PAL scores were found to be significant only for the low - S.E.S. group (.39 vs. .10; $t = 2.57$, $p < .01$). Data indicates that high - S.E.S. subjects "over elaborate"; that is, they attempt to transform input (abstract stimuli) that does not readily lend itself to transformation.

This study emphasizes the importance of separating strategy production from strategy use. The evidence presented above indicates that I.Q. deficits in children of the age range sampled here may be more related to the production or elicitation of learning strategies than to the effective use of strategies following elicitation.

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AN EXPERIMENTAL STUDY OF THE PAIRED-ASSOCIATE TASK AND LEVELS OF LEARNING

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COLLEGE OF EDUCATION

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INTRODUCTION

Background

Richard Herrnstein, in the September issue of The Atlantic draws a disquieting view of the future. Citing the moderate but significant correlation between measured intelligence and social economic status, the high heritability of intelligence, the likelihood that abstract-conceptual abilities of the type measured by intelligence tests will become more important to occupational achievement in the future, Herrnstein reaches the conclusion that society in the future will assume the form of a "biological caste system." As existing environmental impediments to equal opportunity are eliminated, Herrnstein argues, personal wealth and prestige will be determined more by inherited capabilities than by any other factor. The implications of such a prediction are profound. Thus, if one accepts Jensen's (1969) interpretation of existing data to the effect that blacks score lower on I.Q. tests because of genetic deficiencies and that the black-white population curves for intelligence are moving apart as a result of shorter generation lengths for blacks and an upper class-lower class birth differential twice as great for blacks as for whites, one must conclude that optimism regarding eventual racial equality is unjustified. It seems doubtful if a society stratified along racial lines could survive.

Herrnstein's prognosis is based on a number of assumptions. One of the most important is that the relationship between measured

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intelligence and educational attainment will become greater as occupational requirements become more specific and complex. Herrnstein argues that "as technology advances, the tendency to be unemployed may run in the genes of a family about as certainly as bad teeth do now." There is evidence to show that I.Q. correlates with S.E.S. on the order of .35 to .40 (Jensen,1969b; Tyler, 1965). However, this correlation is the result of an "intervening variable," educational attainment. Jensen, citing Duncan's study (1968) analyzing the relationship between intelligence and occupational status concludes: "if the correlation of intelligence with education and of education with occupation is, in effect, 'partialed out,' the remaining 'direct' correlation between intelligence and occupation is almost negligible." Two recent studies (Griliches, 1968; Conlisk, 1968) examined the effects on individual income of both educational attainment and I.Q. and report that the introduction of the I.Q. measurement into the analysis did not reduce the discernible impact of schooling. This is consistent with Ghiselli's (1955) findings that intelligence tests correlate on the average .20 to .25 with ratings of actual proficiency on the job, as compared with correlations of .50 with speed and ease of training. Thus, educational level and not intelligence per se seems to be involved in social class differences in intelligence.

This is important because, to quote Jensen, "... There is potentially much more we can do to improve school performance through environmental means than we can do to change intelligence per se." Few educators seriously desire to reduce the relationship between training and occupation achievement. As our society increases in complexity.

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complexity, this relationship will become greater. It is desirable, however, to lessen the relationship between I.Q. and educational achievement. Typically, tests such as the Stanford-Binet predict various measures of scholastic achievement with an average correlation of .5 to .6 (Tyler, 1965). Certain environmental influences, such as motivation, or family influences, play just as great a role in determining scholastic achievement as I.Q. (Jensen, 1969b). Attainment of present social goals requires that we develop instructional methods and materials that substantially reduce even this moderate relationship.

An undertaking of the type described above calls for a careful examination of the "prerequisite" abilities and skills measured by intelligence tests. Jensen has ventured a guess as to what some of these abilities might be:

> ...an attention span long enough to encompass the teacher's utterances and demonstrations, the ability to voluntarily focus one's attention where it is called for, the ability to comprehend verbal utterances and to grasp relationships between things and their symbolic representations, the ability to inhibit large-muscle activity and to engage in covert 'mental' activity, to repeat instruction to oneself, to persist in a task until a self-determined standard is attained--in short, the ability to engage in what might be called self-instructional activities without which group instruction alone remains ineffectual. (1969b)

Expression of the need for a careful examination of the "intrinsic" individual differences underlying intelligence test performance as a logical precursor to efforts to adapt instruction to such differences is of relatively recent vintage (see Gagne, 1967). Some of the most active work in this regard is that of Arthur Jensen.

<u>Jensen's Theory</u>

Jensen's research has succeeded in highlighting two broad patterns of ability, which he refers to as Level I and Level II type learning abilities. This distinction parallels the short-term-long-term memory distinction first explored by Peterson and Peterson (1959) and later by Conrad (1962) and Wickelgren (1965). Level I ability is designated as being "associative learning" ability, and is tapped by simple tests such as memory for digits, serial rote learning, selective trial-and-error learning with immediate feedback, free recall of visually or verbally presented materials. "In slightly less pure form" Jensen writes that Level I ability can also be measured by paired-associate learning (Jensen, 1969b). Level I ability involves a minimum of transformation of input. A task such as repeating digits in series presumably involves little more than neural registration of input, motor encoding, in the form of vocal or sub-vocal enervations (Jensen, 1962). Level II abilities, on the other hand, are elicited by tasks involving transformation and elaboration of input - tasks in which the subject must actively manipulate input to arrive at output. A simple example is deriving meaning from a statement like the following: Bill is taller than Frank but shorter than Helen, who is the shortest? Rotely repeating the sentence is necessary but, Jensen argues, not sufficient to solving the problem. Some type of "elaboration," in the form of verbal or imaginal mediation is required in addition to short-term-memory ability. Jensen explains:

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> ...short-term memory is necessary for solving Progressive Matrices, but the covert mental processes of generalization, abstraction, and symbolic mediation needed for the Matrices are not needed for digit memory (1968b).

Jensen's evidence in favor of a Level I - Level II distinction is presented in the next chapter. It is important because it suggests that these patterns of ability interact with race and social class. In fact, Jensen has developed a theory to explain his empirical findings:

> The theory states that the continuum of ability to perform on tests, ranging from simple associative learning to conceptual problem solving, is the phenotypic expression of two functionally dependent but genotypically independent types of mental process, which may be labeled Level I and Level II. Level I processes are essentially associative and are best measured by tests such as digit span and serial rote learning; Level II processes involve transformations or complex operations performed on the stimulus input and are perhaps best presented in tests such as the Progressive Matrices and Cattell's Culture-Fair Tests. The biological or structural basis of Level I and Level II are seen as independent but functionally related in such a way that the growth rate and the asymptote of the child's performance on Level II depend upon his status on Level I.
>
> The theory also states that Level I and Level II abilities are distributed differently in upper and lower socioeconomic classes. Level I is distributed approximately the same in all SES groups, whereas Level II is distributed about a higher mean in the upper classes than in the lower.

This theory has import for education. It suggests that techniques may be developed for teaching low - S.E.S. youngsters rotely or by simple association what now must be learned conceptually or not at all (Jensen, 1969b). However, Jensen's theory regarding Level I - Level II social class differences has been criticized recently by a colleague at Berkeley, William Rohwer, Jr.

<u>Anomalies from PA Research</u>

Rohwer (1971) attacks Jensen's theory on the grounds that a well-

researched laboratory learning task - paired associative learning - does not discriminate between high and low S.E.S., white and black populations, at least at the first and third grade levels, even though paired-associate learning is empirically related to performance on tests of school achievement and is known to elicit complex mental activity in learners. Rohwer argues that the processes known to facilitate paired associate learning, such as imaginal mediation which involves constructing mental images depicting an interaction between stimulus and response words, make it "extraordinarily difficult to maintain that they are not conceptual in nature" (Rohwer, 1971). Thus paired-associate learning should qualify as a Level II - type learning task. The anomaly lies in the fact that black and white and/or high and low S.E.S. populations, do not consistently differ in paired-associate learning proficiency, especially in the middle elementary years. Thus in a 1967 study, Rohwer tested a total sample of 384 children drawn from low and high strata populations at the kindergarten, first, third, and sixth grade levels. Materials consisted of 24 pictorial paired-associates presented individually for two pairing and test trials. The paired-associate learning tasks involves associating two words, pictures, or objects, in such a manner that the second member of the pair can be recalled when the first is present on the test trial. Rohwer found significant differences between grades, with the sixth and third grade groups, which did not differ, both superior to the first grade group, which in turn was superior to the kindergarten sample. Although there was no overall strata difference favoring high S.E.S. youngsters, or ov

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This was sufficient to encourage Rohwer to replicate the study using high and low - S.E.S. preschoolers (1967). In the second study, the sample consisted of 160 children ranging in age from 36 to 65 months. This time, 20 pictorial paired-associates were employed. Learning, as before, was measured in terms of numbers of correct responses made on the two test trials. In contrast to the results obtained previously, a clear difference in learning proficiency was found favoring the higher-strata children. Age was also a significant effect, with older children (53 to 65 months) outperforming younger children. Thus, among younger children, social class differences in paired-associate learning appear to emerge. This same conclusion was reached by Semler and Iscoe (1963). They compared 135 Negro subjects to 141 white subjects across age levels 5 through 9 years. The task, again, involved the ability to pair objects (concrete situation) and photographs of objects ("abstract"). The two groups differed significantly in terms of WISC I.Q. Consistent with Rohwer's later findings, a significant age by race interaction was found such that the learning rate of the younger white subjects, the 5 and 6 year old children, was superior to the younger blacks. No differences were found by 9 years of age.

In yet another study, this time involving a total of 240 children randomly drawn from kindergarten, first and third grade classes in lower and upper strata elementary schools, Rohwer (1967)

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obtained the now familiar grades by strata interaction: upper-class samples were superior in PA learning only in the kindergarten and first grade cases. There was also a developmental trend favoring the third grade sample over the other two, which did not differ.

These results are particularly confusing in light of Jensen's compelling evidence that conceptual abilities are distributed differently in lower and middle S.E.S. groups (see below). The evidence presented by Rohwer, however, shows a converging in PA proficiency just at the time when, according to Jensen (1969b), Level II abilities should be pulling the scores apart. Thus, Glasman (1968) and Jensen and Frederiksen (1970) bracket the onset of S.E.S. differences in at least one Level II task, the free recall of randomly arranged categorized lists, between grades two and four. Furthermore, Jensen has argued elsewhere that the evidence indicates that memory span-serial learning ability asymptotes at around eight years of age for both high and low - S.E.S. youngsters (Jensen, 1968b; Jensen, 1969b). Level II abilities, on the other hand, attain prominence between four and six years of age and show an increasing difference between S.E.S. groups with increasing age. Jensen cites two bits of evidence in support of this hypothesis: his studies of serial learning ability as a function of age, (Jensen, 1965) and the correlations between intelligence test scores at early and later ages (Bloom, 1964). Jensen's hypothetical growth curves for Level I - Level II abilities are shown on the following page. In light of this evidence one solution to the paired-associate problem is simply to regard it as a Level I associative task.

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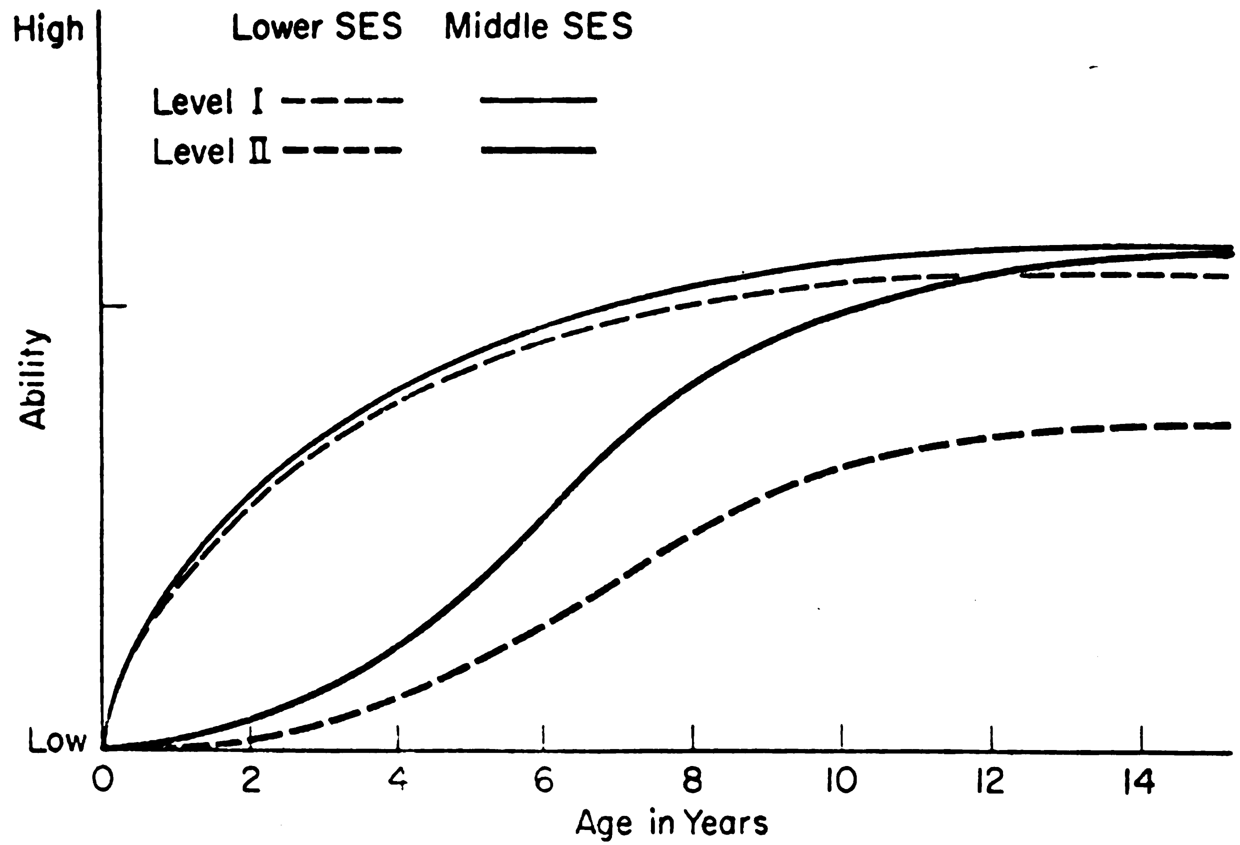

Figure 1. Hypothetical growth curves for Level I and Level II learning abilities (Jensen, 1969c)

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<u>PAL and the Level I Argument</u>

Stevenson et al. (1971) support such a Level I hypothesis in a recent study reporting that paired-associate and serial memory scores are significantly correlated for a sample of 50 4-and 5-year-old disadvantaged youngsters. Stevenson employed line drawings of common objects in both serial and paired-associate learning situations. The significant correlation between PA learning and serial learning supports the hypothesis that paired-associate tasks involve Level I rote learning skills. Jacqueline Rapier (1968) tested 80 white, low- and high - S.E.S. children between the ages of 7½ and 13 years, (mean age, 10.4 years) on both serial learning and PA learning tasks. Black and white pictures of common objects were used and all subjects performed both tasks. In addition to social class, subjects were also grouped by I.Q. score into normal (100-110) and retarded (63-78) categories. Consistent with Jensen's theory, I.Q. scores correlated with serial <u>and</u> paired-associate learning proficiency in the high - S.E.S. group but not in the low - S.E.S. group. The average correlation (Pearson) between I.Q. (Peabody Picture Vocabulary Test) and serial and PA learning was .44 for the high - S.E.S. and .14 for the low - S.E.S. group (corrected for attenuation, these correlations are 0.60 and 0.19 respectively). Furthermore, there was a significant I.Q. by S.E.S. interaction, due to the fact that low - S.E.S. retardates showed significant improvement in the practice on paired-associate tasks, while high - S.E.S. retardates did not. This evidence supports the contention that PAL is a Level I task. Unfortunately, Rapier did not employ age as an independent variable; thus, the interaction of age and strat

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Jensen (1968) makes reference to a study reported by Rohwer, one of a package of 13 conducted under a 1967 Office of Education project grant. The source cited by Jensen is somewhat misleading in that Rohwer only presents data on the PA learning proficiency of preschooler's (see discussion above). However, Jensen reports that, in addition to the four PA tasks, serial learning and memory span tasks, and an intelligence test, (PPVT) were administered. The correlations between mental age (with chronological age partialled out) and the two types of learning tasks were remarkably similar for the high and low - S.E.S. groups (.10 for both serial and PA learning in low - S.E.S. preschoolers; .36 and .51, respectively, for high - S.E.S. children). This evidence, along with the other evidence presented, supports the contention that paired-associate learning is a Level I, rote learning task.

PAL and the Level II Argument

However, as Rohwer points out, there is another side to the argument. Actually, there are four other sides to the argument: first, there is substantial evidence to show that PA learning effectiveness involves considerable conceptual activity in the form of mediation or, as Rohwer calls it, "elaboration;" second, there is reason to believe that PA learning ability increases significantly over the age range from 5 to 18, while serial learning-memory span does not; third, PA learning correlates to a substantial degree with school performance and with performance on intelligence and achievement tests; finally, paired-associate and serial learning ability presumably involve different underlying processes in college-aged populations, evidenced

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both by the lack of transfer from PA to serial lists composed of the same words, and the low correlation between the two types of learning tasks within this age range. We shall briefly examine each of these claims.

Evidence in support of the complexity of PA learning seems indisputable. Studies almost too numerous to mention have established the relationship between mediational activities of various types and effectiveness in paired-associate learning (Bower, 1968; 1969; Adams and Montague, 1967; Bugelski, 1962; Martin, 1967; Martin, Boersma and Cox, 1965; Montague and Wearing, 1967; Paivio, 1967; Paivio, Yuille, and Smythe, 1966; Rohwer, 1967, 1968, 1969; Rohwer and Levin, 1968; Rohwer and Lynch, 1966; Runquist and Farley, 1964; Martin and Dean, 1966). Different mediational processes have been defined by operations which vary stimulus attributes, instructional sets, and presentation times. In the following chapter we shall review the findings of the two most active researchers concerned with mediational activities in paired-associate learning; suffice to say here that PA learning can and usually does elicit covert mental activity of a highly complex sort. If transformation of input is the distinguishing feature of Jensen's Level II ability, then paired-associate learning seems to afford ample opportunity for this type of activity.

Jensen and Rohwer (1965) have indexed the increase in PAL proficiency as a function of age by studying paired-associate and serial learning abilities in a sample of 20 students at each of seven grade levels - kindergarten, grades 2,4,6,8,10,12 - corresponding to mean ages of 5.4, 7.8, 9.4, 11.7, 13.1, 15.4, and 17.6 respectively. All subjects were from middle and upper-middle socioeconomic strata.

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Thirty colored pictures of common objects comprised the 10 pairs of pictures used in the PA task, and the 10 pictures used in the serial task. The tasks were administered under no instructions and under instructions to mediate (i.e. to construct a sentence or sentences containing the names of both PA pairs or of each successive pair of pictures in the serial list). The mediation and non-mediation conditions differed significantly only for paired-associate learning. In the standard or non-mediated condition, serial learning leveled out beyond age 9, while the gradient for PAL was quite steep, suggesting that PA ability increases with increasing age. Furthermore, there was a significant age x instruction x task interaction attributable to the fact that the mediation condition differed significantly from the control condition only at the 2nd, 4th, and 6th grade levels. By high-school age instructions to use mediators had little facilitative effect.

This age advantage in PAL is documented by Rohwer. One study, involving 1st, 3rd, and 6th graders, was mentioned above. Rohwer found that 3rd and 6th graders differed significantly from kindergarten and 1st grade children. However, in two other major studies (total sample: 400), involving various types of provided mediators such as sentences, prepositions, and conjunctions, Rohwer found no significant grade effect between fifth and sixth grade children (Rohwer and Lynch, 1966; Rohwer, Shuell and Levin, 1967). Lack of a main effect for grades was also obtained in a PA study involving 96 3rd, and 96 6th grade children. In this study - unlike the previous two - photographs of objects were used, as well as object names in a standard PA format. In addition, sentence, preposition, and conjunction type verbal

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mediators were provided (Rohwer, Lynch, Levin, and Suzuk, 1967). The lack of an age-grade difference in the mediated condition is not inconsistent with Jensen and Rohwer's earlier finding of an age by mediation interaction. Thus, instructions to use mediators tend to wipe out age differences in speed of learning from 3rd grade on.

In a study involving aurally presented PA's, Bean and Rohwer (1970) bracketed the spontaneous production of verbal mediators between grades 4 and 8 (i.e., ages 9 to 13). Spontaneous production is said to occur when subjects report mediational activity in the absence of instructions to mediate or provided mediators such as sentences.

Thomas (1971) studied PA learning proficiency in 224 children at the 4th and 8th grade levels. Mediators were not provided; performance on the 30 - pair lists significantly increased with age. Cole et al. (1968) tested 144 3rd and 5th grade children on a modified paired-associate task involving both picture and word stimuli, and open, differently painted boxes as the "response." Thus, photographs or names of objects on cards had to be associated with different boxes. Fifth graders performed significantly better than 3rd graders. Two additional studies indicating a developmental trend in spontaneous mediation - and thus PA ability - need to be mentioned. First, Bower (in press) found that college subjects in a control condition performed as efficiently as those in a sentence condition and outperformed those instructed to merely repeat the word pairs aloud. Bean and Rohwer examined 240 sixth and eighth grade children under these same instructional conditions (sentence, rehearsal, and control). They employed aurally presented noun pairs. The effect of grades was significant,

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and so was social class and race (i.e., high-white, low-white, low-black). What is especially interesting, however, is that the high - S.E.S. white sample performed better in the control condition than in the rote rehearsal condition, paralleling Bower's results above and supporting the age-trend hypothesis.

To summarize, there is a body of evidence to suggest that PA learning ability increases as a function of age after eight years of age - especially when conditions call for the use of spontaneous or self-generated mediation. This evidence would seem to support a hypothesis opposite from that advanced earlier: that is paired-associate learning represents a Level II - type conceptual activity.

The third statement made above concerns the relationship between PA learning ability and intelligence and achievement test performance. Stevenson et al. (1965) administered a number of learning tasks to children, including two PA tasks. Both tasks employed nonsense syllables on the stimulus side, and abstract words and abstract forms on the response side. Subjects consisted of bright, average, and dull seventh graders (mean ages 12.8, 13.1, 14.1 for the boys; 12.6, 13.0, 14.4 for the girls, respectively). Bright subjects attended a university laboratory school; the other two groups attended a large metropolitan junior high school.

Bright subjects outperformed normals. Retarded subjects scored significantly below normals on PA learning; however, when compared to normal subjects of equal mental age (fourth graders) retardates did not perform significantly below their M. A. peers. This finding supports the developmental argument presented above.

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Stevenson found that performance on the two paired-associate tasks was highly correlated for both boys and girls (r's = .60, .64) and that PA learning was significantly correlated (.01 level) with memory for story facts, with performance on a task requiring subjects to infer the more probable of two population characteristics on the basis of previous information, with performance on a volume-conservation task, and with solution of anagram problems. In addition, seven out of twelve correlations between PAL and verbal I.Q. were significant at the .05 level.

For average S's, correlations in PAL were significant for both verbal and non-verbal measures of I.Q. All correlations between PA learning tasks and total and composite scores on the Iowa Tests of Basic Skills were significant; PAL correlated significantly with an individual's school grades across subjects.

From this study it is obvious that paired-associate learning involves an important set of skills and abilities. It should be pointed out that these findings do not test Jensen's theory because social class differences were not taken into account. However, in view of these findings it is hard to maintain that PA tasks involve simple Level I associative learning.

Other researchers also report correlations between I.Q. and/or achievement test scores and various forms of paired-associate learning (Duncanson, 1964; Stake, 1961; Stevenson and Adam, 1965). Furthermore, Mordock (1968) conducted an exhaustive review of sixteen PA studies involving normal and subnormal - I.Q. subjects. While meaningfulness of materials, exposure time, subject's age, and the absolute size of I.Q. differences, affected results, normal subjects consistently outperformed subnormal subjects on PA learning. There is also evidence to show that learning defi

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learning deficits increase for retardates from serial to PA learning tasks (Jensen, 1965). The above, of course, represents justification for the contention that paired-associate learning depends more upon abstract-conceptual abilities of the type measured by I.Q. tests than Level I, rote - association ability.

One final bit of evidence in support of the Level II - argument can be found in the fact that serial and paired-associate learning apparently have little in common for college-aged subjects. Thurstone was the first to include both types of tasks in the same factor analysis and he concluded that

> ... the memorizing of temporal sequence, as in digit span, knox cube, and serial learning, involves a retentive ability that is different from the rote memorizing of paired associates (Thurstone and Thurstone, 1941).

Arthur Jensen has examined both of these suppositions. In a complex factor analytic study, serial learning and digit span were found to have approximately equal loadings - .60 to .70 - on a first principal component (1965). Thus, consistent with Jensen's theory, serial learning and memory span have a great deal in common genotypically. However, there is also evidence to show that serial learning ability correlates little if at all with proficiency in paired-associate learning, at least in adult subjects (Jensen, 1962). The fact that performance on these two tasks is not related indicates that different processes are involved (Jensen, 1965). Furthermore, several researchers have demonstrated that the amount of transfer from serial to PA lists is negligible. This is true when the words in the serial task serve a single (A-B, C-D, E-F) or a double function (A-B, B-C, C-D) in the subsequent PA task (Young, 1959, 1961, 1962; Jensen and Rohwer, 1965);

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no transfer has been found from PA to serial lists either (Young, 1959; Underwood, 1961; Jensen, 1962). Jensen has written that "an answer is long overdue to the question of how and why paired-associate and serial learning tasks differ?" The fact that they do, however, can only increase confusion in an already confused area of research.

Conclusions

What sense are we to make of this tangle of seemingly conflicting results? Is the paired-associate task a Level I or a Level II type task? If one grants that PA learning is a more complex task than Jensen seems willing to admit, then the lack of social class and ethnic differences in PAL, constitutes a real dilemma. Thus, how is it that PA learning relates to measured intelligence and school success but not to social class or ethnic differences? If PAL has more in common with tasks requiring transformation and elaboration than with tasks involving simple rote association, one would expect to find consistent ethnic and social class differences of the type reflected by intelligence test and achievement test performance. The contradictory findings in PAL cut to the heart of the Level I - Level II learning distinction. As Rohwer explains, the problem is to provide an account of population differences in learning proficiency that is consistent with the results produced both by direct measures of learning ability (PAL) and by standardized assessments such as the PPVT and the Colored Progressive Matrices. The research contained in this dissertation deals with this problem.

If PA learning is not a Level I task, then it represents a severe blow to Jensen's theory as Rohwer points out (1971). The hypothesis to be explor

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to be explored here, however, is that PA learning is both a Level I, rote association task, and a Level II, conceptual task, depending on certain variables known to affect self-generated mediation. These are factors such as an individual's age, certain stimulus attributes, presentation times, instructional set.

The evidence presented earlier is consistent with Jensen's theory if one assumes that the process involved in paired-associate learning changes dramatically at approximately eight years of age. Eight years of age is a watershed in mental development for two reasons: first, Jensen's evidence indicates that digit-span-serial learning ability asymptotes at approximately eight years of age, with little subsequent improvement in associative ability - which, unlike other skills, remains factorially constant over time and is relatively impervious to practice effects (Jensen, 1964); second, Bloom's (1964) exhaustive review of intelligence test data indicates that eight years of age is particularly important, with correlations between repeated tests of intelligence after 8 falling between .90 and unity. Thus, 80% of the observed variance in adult intelligence is accounted for by the age of 8 years.

A hypothesis consistent with the findings presented above is that Level II, mediational abilities assume prominence in PA learning between 9 and 12 years of age. Prior to this time, both high and low - S.E.S. groups tend to rely on Level I abilities which are equivalent and perhaps more reliable. As Level II abilities stabilize, there is a tendency for the child to rely more and more on the kind of covert mental processes which characterize Level II abilities. This, of course, explai

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explains the diverging PA scores of low and high S.E.S. youngsters after 12 years of age, and the increasing relationship between PAL and scholastic performance - intelligence with age. Differences are seldom found for S.E.S. populations between the ages of 8 and 11. Differences prior to 2nd or 3rd grade level can be explained by the fact that Level I abilities develop at different rates in high and low - S.E.S populations, even though they appear to converge by 8 years of age. Thus, Jensen (1968) found evidence indicating that low - S.E.S. and high - S.E.S. children between the ages of 3 and 5 encode digit series - a Level I test - using somewhat different mental processes. In a factor analytic study (N = 200, mean age, 51 mos.) Jensen found significant S.E.S. differences in correlations between series of 7 to 9 digits scored for position (correct absolute position) and for sequence (number correct in adjacent sequence).

A decrease in correlation between position and sequence scores had been obtained by Jensen in a study involving university students and "supraspan series" of 12 to 15 digits. At the time, Jensen concluded that "much less positional information is encoded for lengthy series and S's tend instead to learn direct associations between adjacent items.(Jensen, 1964)." The fact that low - S.E.S. preschoolers employ this simpler associative strategy is born out by the fact that different loadings on a factor labeled intelligence were obtained in the two S.E.S. groups. The low - S.E.S. group showed significant loadings on the intelligence factor only for series that exceeded their memory span, and only for sequence scoring. The high - S.E.S. group showed comparable loadings for both position and sequence scores

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which were highest in the region of average memory span (four to five digits). In the next chapter additional evidence will be presented to the effect that S.E.S. differences in PAL at the early elementary levels can be attributed to differing rates of growth in Level I ability.

To summarize the, paired-associate learning affords an excellent opportunity to study two processes at work. The hypothesis examined below states that the PA task assumes a Level I, rote-association character (1) when presented to younger children; (2) when presented with appropriate instructions (i.e., the rehearsal condition); (3) when the stimulus materials or the presentation procedures are such as to not readily elicit mediational activity in the learner.

Specifically, this dissertation is concerned with imaginal mediation, and the stimulus conditions which elicit or fail to elicit this type of activity in Level I and Level II learners. The hypothesis, explored here can be stated as follows: stimulus imagery value interacts with ability level in such a way that the greatest differences between high and low - S.E.S., Level I and Level II learners, are found in PA tasks of moderate imaginal value. Words high in image provoking value tend to elicit imaginal mediation in both groups. Words low in imaginal value tend to be learned rotely by both groups.

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Summary

In this chapter we dealt with a confusing issue in the research literature: Paired-associate learning is related to performance on intelligence tests and to tests of school achievement, and also to common sense notions of the kinds of learning required of children in school; yet, unlike any of the above, it is not consistently related to social class differences. Furthermore, there is substantial evidence to indicate that PAL requires considerable conceptual activity, yet Jensen includes it, albeit with some reservations, in the category of tasks exemplified by Level I, rote learning. Evidence for and against inclusion of PAL in Jensen's Level I category was presented. The conclusion was reached that paired-associate learning is predominantly neither one nor the other type task, but can be either, depending on a number of independent variables. Key factors influencing the nature of paired-associate learning are thought to be the same as those influencing spontaneous mediation, a complex mental process. If true, the PA task could become a vehicle for examining mental processes lying at the heart of social class and/or racial differences in school performance. The relevance of such a study extends well beyond the narrow confines of the verbal learning laboratory.

In the following chapter, evidence supporting Jensen's levels of learning distinction will be presented; Rohwer and Paivio's mediational studies activity will be reviewed, as well as evidence supporting a PAL - learning ability interaction.

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CHAPTER II

REVIEW OF LITERATURE

Jensen's Level I - Level II Distinction

Arthur Jensen's hypothesis concerning different patterns of mental abilities within social classes is of central importance to the research reported here. Consequently, we shall devote the first part of this chapter to a discussion of Jensen's findings. Jensen's hypothesis can be stated as follows: it asserts that middle - S.E.S. and low - S.E.S children are equivalent in rote learning abilities but that high - S.E.S. children are superior on measures of Level II conceptual ability. Jensen's hypothetical distribution of Level I and Level II abilities is illustrated on the following page. Children who are above average on Level I but below average on Level II performance usually appear to be bright and capable of normal learning and achievement, although they have great difficulty in school work under traditional educational approaches (Jensen, 1969b). Furthermore, because Level II ability is distributed differently in lower and upper S.E.S. classes, a greater number of high - Level I, low - Level II children can be found in low strata groups. Jensen's hypothesis attempts to explain differences in correlations for high and low S.E.S. populations, between measures of "Level II conceptual ability," (I.Q.) and measures of "basic learning ability" (digit span or serial learning). Thus, while digit series correlates .75 with total I.Q. (minus digit-span) for the normative population, correlations for low - S.E.S. groups fall in the range of .10 to .20 (Jensen, 1967; 1968). This interaction of intelligence, learning ability and social strata has been obtained for such measures

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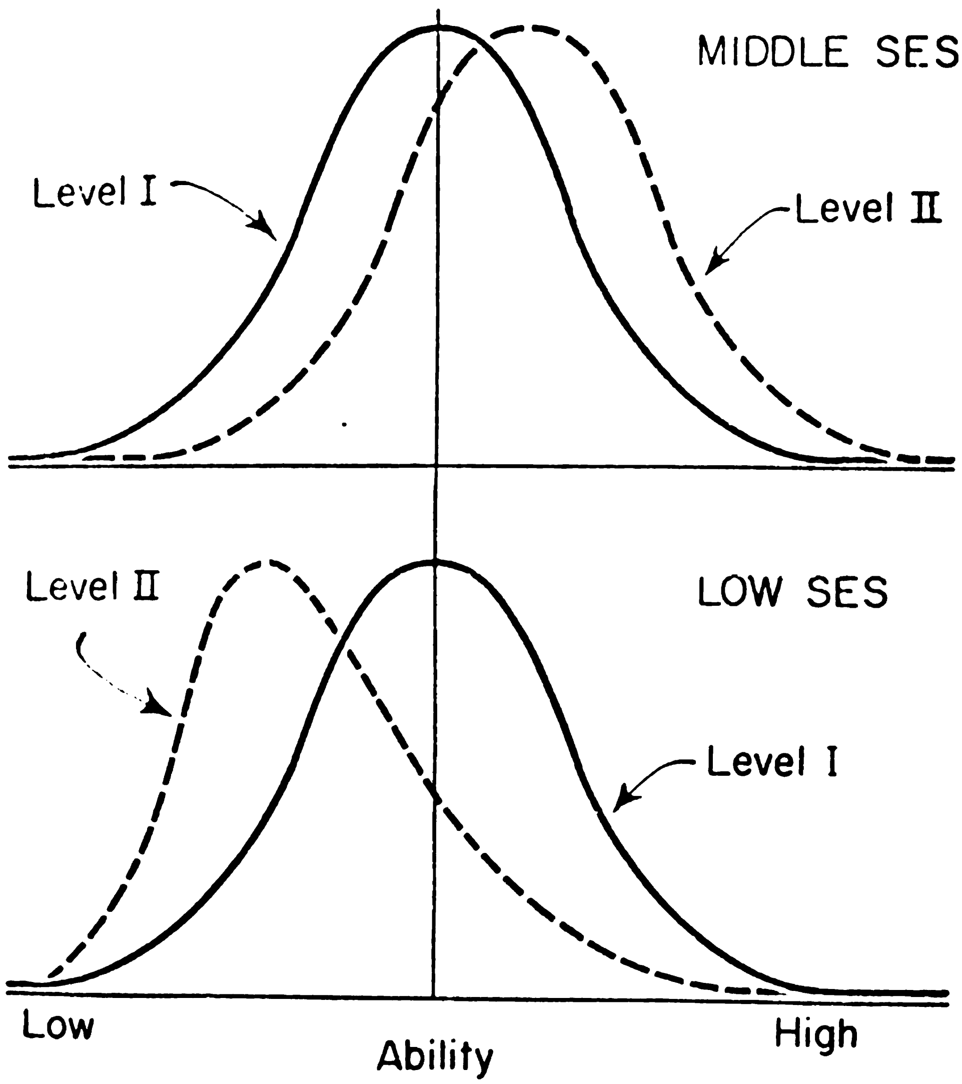

Figure 3. Hypothetical distribution of Level I and Level II learning abilities in middle and low SES groups **(Jensen, 1969c)**

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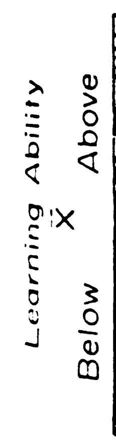

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as learning the serial order of a number of familiar objects or pictures, free recall of categorically unrelated names or objects, trial and error learning, digit span, and paired-associate tasks of the kind described earlier. Such learning tasks correlate very substantially with I.Q. among middle-class children but negligibly among lower-class children. Jensen portrays the difference in correlations schematically as follows:

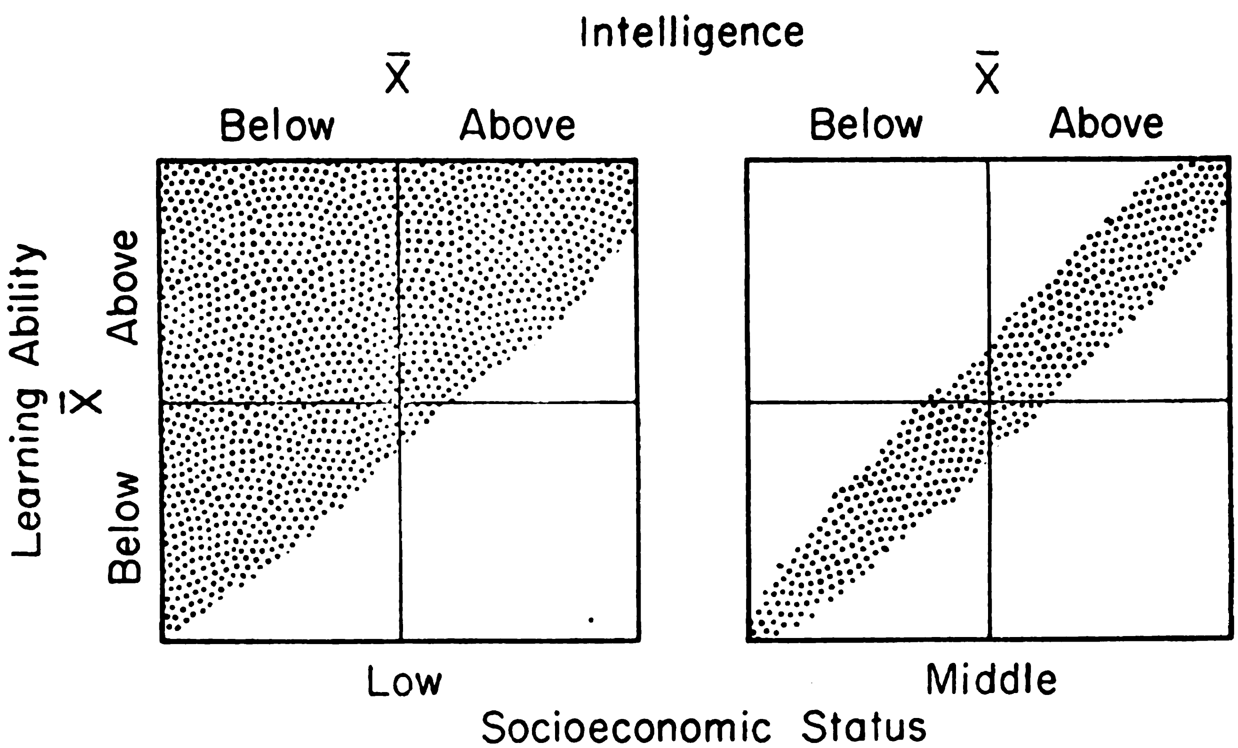

Figure 2. The relationship between ability levels in S.E.S. groups.

A characteristic shared by Jensen's Level I tasks is simply that little transformation of input is required. Thus, what goes in corresponds highly with response output. Jensen argues that little more is necessary for Level I tasks than registration and consolidation of input and the formation of associations through rehearsal (1969b). Tasks like the Raven's Progressive Matrices, on the other hand, require self-initiated mental processes such as generalization, abstraction, and

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An aspect of this theory which Jensen himself regards as most questionable concerns the hierarchial dependence of Level II performance on Level I ability (Jensen, 1969a). In his early formulations, Jensen argued that Level I ability, which he likeded to short-term-memory, was necessary but not sufficient for development of Level II ability: "...High performance on Level II tasks depends upon better than average ability on Level I, but the reverse does not hold (Jensen, 1969b)." A subsequent study by Durning, however, has caused Jensen to question this hypothesis, at least as it relates to adults (Jensen, 1969a).

The conditions sufficient for Level II development have been discussed by Jensen. Essentially there are three possible explanations for the test score differences obtained between lower and upper strata children. First, Level II measures such as I.Q. tests may have a built in cultural bias favoring middle and upper class children. Thus, differences in Level II performance, are not indicative of "real" underlying differences in ability. Second, one can argue that environmental differences between social class groups explain the failure of lower class youngsters to convert basic learning abilities into I.Q. gains. According to this explanation, environmental deprivation causes a lower distribution of intelligence test scores in low S.E.S. populations. The third explanation - favored by Jensen - states that S.E.S. differences in test performance are the phenotypic expression of more basic underlying processes. Furthermore, Jensen believes that an individual's proficiency in terms of such processes largely is determined by genetic factors (Jensen, 1968b). Jensen, in fact, asserts that the genes de-

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termining basic learning ability and I.Q. assort independently. Social class differences in I.Q., then, simply result from the fact that society tends to sort people out more by their Level II ability than by their Level I ability. Jensen cites the failure of efforts to develop so-called "culture-fair" tests of intelligence as evidence against a cultural bias explanation (1967). Environmental explanations also leave much to be desired, Jensen believes, in light of the high heritability (.80) of Level II tasks such as the Progressive Matrices (see Jensen, 1969b), and the fact that low - S.E.S. blacks actually perform better on the presumably more environmental verbal tests than on non-verbal tests of intelligence. Evidence of some upper-strata children exhibiting the same pattern of high Level I, low Level II abilities as children from poor environments also mitigates against an environmental hypothesis (1968b).

Whatever the explanation, evidence in support of Jensen's hypothesis seems substantial indeed. Thus, large scale normative data on the Vocabulary and Digit Span subtests of the Stanford-Binet involving 2,904 white children and 1,800 black children from five Southeastern states, reveals that 62% of the whites and 20% of the blacks at the various ages passed the Vocabulary subtest. This test has the highest correlation with total I.Q. On the other hand, the average percentage passing the Digit-Span subtest was 50% for whites and 46% for the black, low - S.E.S. population. High and low S.E.S. groups differ greatly in Level II performance, but are nearly equivalent in Level I ability (Jensen, 1967 from Kennedy, Van de Riet and White, 1963 and Terman and Merrill, 1960).

Jensen has presented more graphic evidence of this social class -

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learning ability interaction. In a study of children from grades 4, 5 and 6 in an all-white upper-middle class school and in an all-bleck school located in a low - S.E.S. neighborhood, Jensen obtained a non-parametric correlation between digit span and Progressive Matrices I.Q. of .33 for the low - S.E.S. youngsters (N = 60), and .73 for the high - S.E.S. youngsters (N = 60) (Jensen, 1968b). Mean digit span test scores for the 30 lowest scoring children from the suburban school (the lower 6.1%) and the 30 highest scoring children from the black ghetto school (the upper 7.9%) were 38.7 and 65.3, respectively. High - Level I blacks significantly outperformed low - Level I whites. However, the corresponding Progressive Matrices scores, again expressed as a per cent of the maximum possible, were 72.6 and 64.7 per cent respectively. Although black children performed significantly better on the test of rote memory, they performed significantly worse on a measure of complex conceptual activity.

Another large sample study was conducted by Durning (1968, in Jensen, 1969a). Data on 5,539 Navy recruits was analyzed, 95% of whom were between the ages of 18 and 23 years of age, with an average education of 11.9 years. Subjects were given a battery of standard selection tests including the Armed Forces Qualification Test and an auditory digit memory test devised by Jensen with a reliability of .89. Durning found that blacks, whose scores placed them in "category IV" (10th--30th percentile on the AFQT) "as a group scored significantly higher on the Memory for Numbers Test than non-Negro CAT IV's, though the Negroes were lower on most of the standard selection tests."

Durning, also, reported that Category IV recruits, predominantly from low - S.E.S. and disadvantaged segments of the population, differed significant

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Guinagh (1969) reports the following correlations between digit span performance and performance on the Raven's Colored Progressive Matrices for low - S.E.S. black (N = 105), low - S.E.S. white (N = 84), and middle - S.E.S. white third graders (N = 79), respectively: .29, .13, and .43, corrected for attenuation. Project TALENT data on a 10% sample of male twelfth graders (N = 2,946) revealed multiple correlations between a number of S.E.S. indexes and tests of Mechanical Reasoning (.41), Information (.53) and English (.44) tests which were significantly higher than for a test which Jensen labels closest to rote memory tasks, the "ability to memorize foreign words corresponding to common English words" (r = .24) (Jensen, 1969a).

In an interesting recent study, Keogh and Macmillan tested the Jensen hypothesis (1971) with a couple of important variations: first, they varied the type of motivation provided, following Zigler's (1966) comments that social reinforcement alone may not optimize learning in low - S.E.S. populations; second, they employed immediate, delayed, and repetition digit presentation conditions to determine if provided rehearsal yielded a social class effect. The study involved 60 white, middle - S.E.S. and black, low - S.E.S. third graders. Subjects were also grouped by intelligence test data into normal and retarded categories. In terms of intelligence, normals were found to be significantly better than retardates in digit recall. Differences in performance between the retarded subgroups favored the lower S.E.S. retardates, although this was not significant. What is more important is the fact that opportunity for digit rehearsal was not related to S.E.S. - intelli-

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gence distinctions, as the lack of a significant presentation by subgroup interaction demonstrates. This provides further support for the contention that a similar learning process is involved across social class and ethnic categories. The main effect of motivation condition (intrinsic vs. extrinsic) was not significant; however, the low - S.E.S. black retardates did benefit from the concrete reinforcement.

In addition to this compelling evidence, Jensen has reported (1961) that "bright" and "dull" 4th and 6th grade Anglo-American and Mexican-American children, of a low socioeconomic status, equivalent in I.Q. in both the bright and dull categories differ significantly in serial learning at the low - I.Q. level. Mexican-American children with low I.Q.'s significantly outperformed their Anglo-American counterparts, and in fact, performed no worse on the Level I tasks than both high - I.Q groups. The fact that serial learning and I.Q. were negatively correlated but highly reliable supports the hypothesis of independent measures. In another study (1963), involving trial and error learning and retarded, average and gifted children, Jensen found that four of the 36 retarded children outperformed the average gifted child in this simple associative task.

A number of studies, including several described in the previous chapter, seem to converge in agreeing with the Jensen hypothesis that "the continuum of tests going from associative to conceptual is the phenotypic expression of two functionally dependent but genotypically (or structurally) independent types of mental process..." The significance of such a theory becomes manifest as one considers alternative instructional techniques. Before methods less dependent upon Level II abilities can be devised, however, the nature of those abilities m

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Jensen is necessarily vague about the nature of Level II abilities. Word definitions, in fact, do little to shed light on the problem. Jensen, for example, defines general intelligence - which in its "fluid" form constitutes the best measure of Level II ability - as (1) the ability to educe relations and correlates; (2) the ability to see similarities between things which seem different and differences between things which seem similar; (3) the ability to manipulate or transform input (Jensen, 1969b). At another point, Jensen relates "g" to "cross-modal transfer," which is the ability to associate visual input with tactile or auditory input. The most useful definition of Level II ability, however, is still the operational one: General intelligence is a hypothetical construct intended to explain covariation among tests, a construct well established by the research literature. Thus Burt (1958) writes:

> In nearly every factorial study of cognitive ability, the general factor commonly accounts for quite 50% of the variance (rather more in the case of the young child, rather less with older age groups) while each of the minor factors accounts for only 10% or less....For all practical purposes, almost every psychologist--even former opponents of the concept of general intelligence, like Thorndike, Brown, Thomson, and Thurstone--seems in the end to have come round to much the same conclusion, even though, for theoretical purposes, each tends to reword it in a modified terminology of his own.

This "general factor" has been found for a wide variety of tests bearing no superficial resemblance to one another. Thus, vocabulary tests correlate .50 to .60 with tests consisting of copying sets of designs with colored blocks; a test of general information correlates on the order of .50 with a test involving working through a printed maze with a pencil (Jensen, 1969). Perhaps psychological "sense" will never

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will never be made of such a complex hypothetical construct. However, it seems to me that an excellent place to begin such an effort is with a laboratory learning task falling near the midway point between Level I and Level II ends of the learning-ability continuum (see next page). Evidence was presented in the previous chapter supporting the view that paired-associate learning is such a task. By manipulating variables which change the nature of PA learning and thus move the task from the associative to the conceptual side of the continuum and back again, one should be able to illuminate differences basic to Level I and Level II mental processes. In fact, the thesis of this dissertation is that one type of mental activity is involved in such a shift, and that that activity is imaginal mediation. In other words, to the extent to which imaginal mediation is elicited, PA learning is a Level II conceptual task.

The next section examines the nature of the mediational process in PA learning. If many different types of mediational activities potentially are involved in paired-associate learning, then a study such as the one undertaken here is futile. If there is reason to believe that one basic process is involved - and there is - then such a study has import.

Mediational Activity in PAL

Mediational activity in paired-associate learning has been a subject of speculation and controvery almost from the beginning of research in this area. It continues to be a matter of some concern in psychology to those engaged in trying to unravel the mystery of this seemingly simple verbal learning task, Rohwer's statement to the contrary not withstanding. Thus, he writes that the paired-

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associate task "can be selected with full assurance that it qualifies under the first criterion, namely that its operating characteristics should be well known" (1971). In fact, much of what was known about PA learning (i.e. see Goss and Nodine, 1965) must be revised in light of important recent work by Paivio, Rohwer and Jensen.

Paivio, in particular, is forcing psychologists to re-examine the effects of such well-established attributes as stimulus meaningfulness, and familiarity. As a result of Paivio's findings, a process thought to lie at the core of verbal learning - implicit verbal mediation - is undergoing evaluation. Paivio, for example, regards the question of the theoretical necessity, or usefulness, of a dual process of meaning and mediation in verbal learning as one of central importance. He writes that verbal mediators (i.e. verbal associates) "are relatively ineffective unless accompanied by imagery (1969)." This, however, is as close as Paivio gets to a uniprocess theory of mediation, despite the fact that "meaningfulness" repeatedly has been shown to have no effect on learning when the imagery - value of words is controlled (1969).

Rohwer, who has done more work in this area than anyone else also favors a two process approach to mediation (1970). However, after an exhaustive series of experiments on verbal mediation failed to confirm a number of alternative hypotheses regarding the "form-class effect" Rohwer proffered an imagery explanation. (The "form-class effect" refers to a consistent finding that associates embedded in verb strings are more easily learned than those embedded in prepositional and conjunctive strings). Rohwer writes

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> A number of explanations of the form-class effect can be given, but the one that comes most readily to most minds (even those of relatively traditional behaviorist persuasion) is that the three kinds of connectives evoke different kinds of visual imagery. The notion is that conjunction connectives evoke a static image of two objects side by side, preposition connectives evoke a static image of two objects in a particular locational arrangement, and verb connectives give rise to an action image of some episode involving the two objects (1970).

The observed effect may result from the fact that action imagery is more memorable than static-locational imagery (prepositions), which in turn is more easily remembered than static coincidental imagery (conjunctions). Rohwer, however, raises some objections to this theory, which we shall presently examine. It is my belief that these objections can be answered in terms of a Level I - Level II explanation of PA learning.

Existing evidence supports the contention that one type of symbolic process is involved in PA learning; this involves evoking sensory images to link or combine stimulus and response members of the pair in some type of static or kinetic image. Paivio defines images as "symbolic processes that are linked developmentally to associative experience involving concrete objects and events," and "in relation to language, ...as conditioned sensations for which appropriate words function as conditioned stimuli" (Paivio, 1969). The fact that the discussion and study of imagery has, according to Reese (1970), "again become not only respectable in psychology, but also relatively popular" can be attributed more to Paivio's efforts than anyone else's.

Paivio's early interest in imagery stemmed from an analysis of a mnemonic technique, called the "one-bun" technique, whereby a series of number related items are memorized by employing a high image rhyme word vis

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word visualized in some bizarre association with the word to-be-remembered: Thus, if the first word is "chair," one might picture a chair inside a huge hamburger bun. "Bun" easily reinstates the number "one." The imagery interpretation was incorporated into an earlier hypothesis of Paivio's - the "conceptual peg hypothesis" - originally used as an explanation for the finding that sequences of nouns and their modifying adjectives are easier to learn in the noun-adjective order than in the adjective-noun order, despite the latter's similarity to English language habits (Lambert and Paivio, 1956). After examining this evidence, Paivio reasoned that high-imagery or concrete stimulus terms function as efficient "pegs" from which associates can be hung and retrieved by means of mediating images. This hypothesis was tested with adjective-noun pairs (Paivio, 1963), and in a series of experiments with noun-noun pairs.

Paivio's belief that imagery value was a stimulus attribute deserving of study has been well substantiated by subsequent research. In a series of studies (Paivio, 1965; Paivio, Smythe, and Yuille, 1968; Yarmey and Paivio, 1965; Frincke, 1965; Yuille, 1968; Paivio and Madigan, 1968) Paivio and his colleagues demonstrated the potency of rated-imagery as a word attribute. Using four types of PA lists: concrete stimulus nouns - concrete response nouns, concrete-abstract, abstract-concrete, and abstract-abstract, Paivio has consistently found learning to be most efficient in that order.

In addition, Paivio has examined a word attribute alternative to imagery, meaningfulness. Meaningfulness is measured by "associative fluency" or the number of verbal associates a word elicits in a given amount of time. Paivio thought it unlikely that m was the effective variable because its effect usually is greater on the response side in PA learning (Paivio, 1969). This reverse effect, of course, runs counter to the conceptual peg hypothesis. The problem has been clarified in a series of experiments. Paivio, Yuille and Smythe (1966) varied image evocation (I) and m independently and obtained the usual stimulus effect for I, while m was effective only when varied within low - I, abstract nouns. Paivio (1967; with Oliver, 1964) also found that partialing out m had little effect on the positive correlation between learning scores and I, but with I controlled, the effect of m was reduced to zero. In another study in which 925 nouns were rated along a 5 point scale according to concreteness, imagery arousal, and meaningfulness (see next chapter) Paivio obtained correlations of .72 between I and m, and .83 between I and C (i.e. the degree to which a word refers to concrete objects, materials, persons). Experiments using these words have demonstrated that I is more effective when the two variables are independently varied over an equivalent range in terms of standard score units (Paivio and Yuille, 1967; Smythe and Paivio, 1968). Finally, Paivio, Smythe and Yuille (1969) first varied both I, and m, independently on two lists with the other attribute held constant; then I and m were covaried on a third list. The conclusion reached was that I accounts for more of the variance than does m, and that it is a more potent variable than is meaningfulness. A subsequent factor - analytic study showed that out of 27 noun attributes, rated I was the best predictor of learning, followed by related attributes such as concreteness (Paivio, 1968).

Not surprisingly, in light of the above, PA learning efficiency has also been found to be related to subjective reports of the use of mediating imagery. In the 1969 study reported above, reported imagery was strongly related to noun _I_, whereas reports of verbal mediation or repetition showed no such pattern. In the case of the list in which only _m_ was varied, moreover, none of the reported strategies were significantly related to _m_. Furthermore, reported imagery correlated significantly with learning even with _I_ partialed out, increasing the plausibility of a uniprocess theory of mediation. The two - process theory of mediation, then, appears to be in jeopardy.

In addition to stimulus attributes like imagery, instructional set also can be expected to influence mediation in PA learning. Paivio and Yuille (1967, 1968) found that imaginal and verbal mediation instructions produced much better learning than a rote repetition set, and that there was no interaction between the two and noun concreteness. Other studies (Bower, 1969; Hulicka and Grossman, 1967; Wallace, Turner, and Perkins, 1957) have evidenced the efficacy of imagery instructions in PA tasks. Anderson and Hidde, (1970) moreover, found in a recent study that imagery instructions facilitated sentence learning. It appears that image construction sets have a powerful effect on learning proficiency. There also is a strong push to employ imagery mediation spontaneously. Thus, Paivio found that the effects of mediation sets for college students tended to disappear after 3 trials, although the effects of noun concreteness persisted throughout.

In a follow-up study (Paivio and Yuille, 1969), a trial-by-trial probe of mediational strategies confirmed the hypothesis that subjects in the rote-repetition condition spontaneously replaced this strategy with a more effective one, verbal mediation being favored on the second trial and imagery increasingly becoming evident by Trial 3. However, stimulus concreteness remained effective throughout learning, suggesting that stimulus imaginal value is a more important determinant than instructional set per se. It would be interesting to examine the instructional set effects developmentally, over time.

To my knowledge, there are only three studies relating imagery instructions to PA learning proficiency in children. Taylor and Black (1969) studied the effects of imagery instructions among sixth grade children. They found that instructional effects were significant. Also, about half of the non-mediation instruction subjects reported using imagery on their own; those who did learned as efficiently as the imagery-instructed children. A second study, involving 48 5th graders and both imagery and verbal elaboration instructions found that imagery instructions facilitated recall more than verbal mediation instructions. In addition, the PA task, which involved recalling 3 concrete nouns to a single stimulus noun, was greatly simplified by instructions to combine or "unitize" the response nouns (Taylor and Whitely, 1970).

A study, supportive of the Level I - Level II, rote-imaginal hypothesis presented here, was recently completed by Horvitz (1971). Horvitz compared the performance of third grade, sixth grade and college students who were given or not given imagery instructions on six different item types (to be discussed below) (N = 180). Contrary to the prediction that the greatest difference between the instruction groups would occur at the third grade level, imagery instructions seemed to make a difference only at the later levels. Furthermore, while performance improved with age, the instructional set difference was significant only at the sixth grade level. This suggests that third graders simply are too young to effectively use imagery instructions while college subjects employ an imaginal strategy spontaneously. The consistency of this finding with the hypothesis advanced earlier of a shift in PA learning from the associative to the conceptual side of the learning ability continuum around 8 years of age is remarkable.

Before becoming too self-congratulatory, however, Rohwer's work on verbal mediation in PA learning, and some puzzling findings of his concerning the relative efficacy of picture over word presentations in younger children needs to be considered. First, however, a word needs to be said about verbal mediation theory. This view of language acquisition and use can best be understood in the context of the probabilistic model favored by behaviorists, which attempts to explain an organism's response - the recall of response words in a PA paradigm, for example - in terms of previously acquired stimulus-response connections or networks. The bulk of PAL research grows out of this theoretical orientation. Thus, earlier studies examined the relationship between word meaningfulness (i.e. associative value) and learning scores through various experimental manipulations. However, Chomsky's recent insights, and the research of Paivio and Rohwer, raises serious doubts regarding the utility of a verbal mediation "alternative" explanation. Certainly it is more parsimonious to posit a single process underlying age-related and S.E.S./IQ related differences in PA learning than to posit two independent processes. Rohwer's work on "verbal mediation" needs to be examined with this question in mind.

Rohwer's Work on "Verbal Mediation"

Rohwer set out in 1966 to study the effects of "elaboration" on PA learning efficiency. Rohwer felt that existing self-report studies relating reported mediational activity to PA proficiency were methodologically inadequate. His suggestion was to experimentally vary the amount of elaboration with which materials were presented for learning. This could be done by manipulating variables such as the grammaticalness or form class of the elaborative strings used to present embedded associates. Rohwer also suggested using elementary school children because it was felt that they had a less of a propensity for engaging in spontaneous verbal elaboration (1967).

In a remarkable series of studies, Rohwer examined the effects of various types of provided verbal and pictorial elaboration. One consistent result that emerged was that the connective form class of the various verbal strings yielded a significant difference: associates embedded in verb strings (i.e. The running COW chases the bouncing BALL) were recalled more readily than those embedded in prepositional strings (The running COW behind the bouncing BALL), which in turn, were associated with higher recall rates than those in conjunction strings (The running COW and the bouncing BALL) (1967). A number of hypotheses were advanced to explain this effect, which was first observed in a developmental study with young children. Here, Rohwer noticed that poorer recall was associated with less mature "mnemonics" (1968).

The first hypothesis to be tested regarding the form class effect was that verb and prepositional strings facilitated learning because they rendered each of the stimulus terms in the PA list maximally dissimilar, thereby reducing the amount of intralist interference. This hypothesis was tested by varying the number of connectives in the PA task; it was rejected (Rohwer and Lynch, 1967).

A second hypothesis stated that verbs impose narrower limits or greater "semantic constraint" on subsequent nouns in a string than do prepositions and conjunctions. Two sets of verb strings with 10 interchangeable response nouns were compared to conjunction strings in a recall and a recognition mode. Only in the latter was the number of alternatives equated for form classes. Again, the hypothesis was rejected. Two replications failed to confirm the constraint hypothesis (Rohwer and Lynch, 1966).

After ascertaining that verb strings as a whole are more easily learned than conjunction strings, Rohwer reasoned that the form-class differences in PA learning become manifest less in the acquisition or storage phase than in the retrieval phase of learning. The "context hypothesis" was examined by presenting verb strings during the study trial, during the test trial (minus response words), and for both. Again, the hypothesis was disconfirmed (Rohwer, Shuell, and Levin, 1967).

Additional hypotheses regarding the form class effect have been examined by Rohwer and his associates and rejected (i.e. 1967 study). Altogether, 1,076 fifth and sixth grade subjects have been involved in testing this remarkable effect. One final and important explanation offered by Rohwer, however, coincides with the hypothesis presented here. Thus, he writes that "verbal material of whatever kinds of units, words, phrases, sentences, evokes covert imagery processes when presented for learning. If so, then it is variations in properties of the evoked images that determine learning efficiency directly..." (1967). To test this hypothesis, and especially the question of the primacy of visual over verbal elaboration, Rohwer independently manipulated verbal and visual mediators and examined effects across ages. In this research, Rohwer visually translated each of the three types of verbal strings into a pictorial analogue. Thus, still pictures, locational pictures, and action sequences of objects were crossed in the experimental design with the three types of verbal elaboration (Rohwer, Lynch, Suzuki, and Levin, 1967). In subsequent studies locational depiction was dropped from the design.

The results which Rohwer has obtained are somewhat puzzling; they need to be examined because they have led him toward a two-process theory of mediation. Thus, in a 1970 review Rohwer concludes that, contrary to Bruner's claim that imaginal representation precedes verbal representation, "a preference for and a capacity to make effective use of visual representation and storage develops later than is the case for verbal modes of representing and storing information." This conclusion is based on research results which indicate that, prior to third grade, PAs presented in pictures with verb strings produce more facilitation than PAs presented in the context of action pictures with noun labels, while the reverse is true at the third and sixth grade levels (Rohwer, Lynch, Levin and Suzuki, 1968). Furthermore, sentence elaboration was significantly better than visual elaboration for preschoolers (1967); again, the reverse was true for third graders (1968). Finally, pictures alone (pictorial) as opposed to words alone (aural) are either not or slightly superior at the kindergarten level, significantly superior at the third grade level, and less superior again at the sixth grade level (Dilley and Paivio, 1968; Rohwer, 1968).

Two hypotheses have been advanced to explain this trend. Paivio argues that imagery is a preferred mode of storage for children; pictures foster imagery but pose a decoding problem when verbal responses are required. Rohwer, on the other hand, believes that maximum learning can occur only when verbal and visual representations are stored simultaneously; language, however, is a more coherent system and thus can be utilized earlier. Rohwer tested these two hypotheses recently (1971). He compared 4, 5 and 7 year olds in verbal recall and in pictorial recognition conditions and in the aural-pictorial types of elaboration conditions described above (N = 504). The only difference was that joined pictures were used instead of action sequences. Paivio's position implies that pictorial superiority will be constant only in the recognition condition, where verbal decoding is unnecessary. Rohwer's hypothesis predicts that pictorial elaboration will become increasingly superior with age regardless of response mode. Neither of the two process hypotheses were confirmed. There was, however, an age trend, and full elaboration (both strings and joined pictures) was superior to no elaboration.

Statement of Theoretical Position

The findings presented above and in the first chapter can be tied together by making the following assumptions: The first is that one process is involved in mediated PA learning. The acquisition phase of this process involves simple stimulus-response learning in the form of vocal or subvocal encoding, first of aural and later of visual input (i.e. by 5-6 years of age; see Kendler and Kendler, 1962). Mental images are evoked to give meaning to the verbally encoded material, a process probably involving cross-modal association. Imaginal elaboration constitutes the heart of mediational activity. The average child, however, does not spontaneously mediate until 8 or 9 years of age.

The retrieval phase of elaborated learning involves re-evoking the stored image and making an appropriate verbal association to obtain the desired response output. The ability to call-up and "manipulate" images lies at the heart of Jensen's Level II learning ability. (Interestingly enough, Jensen has written that "The conceptually most pure and simple instance of this key aspect of intelligence is displayed in the phenomenon known as cross-modal transfer," a simple measure of which consists of asking a child to identify letters written in large strokes between his shoulder blades (1969).

If the stimulus materials do not readily lend themselves to imagery elaboration, as in the case of random digits, abstract words, or nonsense syllables, or if task demands are such as to require an immediate verbatim response, as in digit span or serial learning tasks, imaginal mediation does not occur. Furthermore, because short term memory ability has an earlier ontogenesis than elaborative ability, with over half of the variance in digit span performance accounted for by the age of 2½ (Jensen, 1968), age related differences in this ability are much less marked than is the case for elaborative or transformational ability. Rote memory ability is less related to educational attainment than Level II ability, thus social class differences will be less pronounced for tasks involving the former than for the latter.

The assumptions presented above explain a number of consistent but seemingly contradictory research findings in the area of paired-associate learning. Thus, before 8 years of age, children tend to learn "unelaborated" paired-associates as a series of stimulus-response associations. The high correlation between PA performance and serial learning-digit span in young children as well as the steady decline in social class differences in PA proficiency up to 8 years of age (third grade), support this view. This hypothesis is further supported by Rohwer's findings that noun or sentence "elaboration", which may be rotely acquired, facilitates PA learning more in younger children than providing pictorial or action imagery. The fact that this effect reverses in children after 8 years of age, and that imagery sets become effective right at this time, indicates an important developmental shift in PA learning.

It is my belief that this shift represents a qualitative change from associative to conceptual modes of processing information. Not surprisingly, paired-associate performance increasingly relates to tests of abstract-conceptual ability from grades three on. Differences in PA proficiency between upper and lower-strata children also begin to increase beyond third grade. Another puzzling finding which can be explained by these assumptions is the lack of correlation between serial and paired-associate learning in adults, in seeming contradiction to Jensen's Level I PA hypothesis.

Evidence presented indicates that PA attributes, such as imagery may interact with "ability," with differences between fast and slow subjects greatest for associates of moderate imaginal value. If true, this represents important support for a Level I - Level II explanation. This specific hypothesis was tested in this dissertation.

CHAPTER III

DESIGN

Hypotheses

The specific hypotheses examined in this study have not yet been explicitly stated. The following six statements were the predicted outcomes of this study:

1. The correlation between I.Q. as measured by the Lorge-Thorndike or Kuhlman-Anderson group administered intelligence tests and digit span falls within the range of 0 and .20 for the low - S.E.S. mixed-race group and between .50 and .70 for the high - S.E.S. white group. (Note: Conversion tables have been used to equate Lorge-Thorndike and Kuhlman-Anderson I.Q. scores.)

2. No significant differences in digit span ability exist between high and low S.E.S. eighth graders despite significant differences in performance on the I.Q. tests. No significant sex differences obtain for either measure.

3. Significant differences in performance on the mixed list PA's (i.e. lists containing high, moderate, and low - _I_ pairs) result between Level I, low - S.E.S. subjects and Level II, high - S.E.S. subjects favoring the Level II learners.

4. Rated levels of imagery yield a significant main effect, with high-imagery word pairs recalled at a significantly higher rate than moderate-imagery pairs; these, in turn, significantly exceed low-imagery words in recall.

5. A significant interaction exists for the imagery-values by levels

of learning source of variation, with the greatest differences between Level I and Level II learners occurring for associates of moderate imaginal value.

<u>Sample</u>

All eighth grade subjects, present on several testing days, in three parochial (Catholic) schools serving different S.E.S. levels in the community were administered digit span tests in groups of 3-5 via tape recorders (low S.E.S. N = 59) (high S.E.S. N = 50). The total N, numbering 109, will be referred to below as "pre-experimental subjects."

Schools were selected on the basis of obvious social class differences. The lower class school was a project school funded by charitable organizations and located in the inner city of St. Paul, Minnesota. It served a predominantly (70%) minority population of seventh and eighth graders. Two high - S.E.S. schools were employed in the study; one an all-girl parochial school, the other a boys' school. The two schools were situated on adjoining plots of land in a suburban community near Minneapolis. Both schools served white upper class populations. Social class data for the project school group (low - S.E.S. subjects) and for the suburban group (high - S.E.S. subjects) are presented below.

I.Q. test scores were made available for each subject through school records. On the basis of performance on the digit span or Level I ability measure, and I.Q., the Level II ability measure, approximately 46 subjects were selected from each strata, with equal numbers of boys and girls in low and high S.E.S. samples. From this number of 46, which allowed for absenteeism, 40 were individually tested on the PA task described below. Subjects from the project-school were selected on the basis of (1) equal or near equal digit span scores in comparison to the overall mean of the high - S.E.S. eighth grade group, and (2) an I.Q. score which is at least one standard deviation below the high - S.E.S. group. Subjects selected from the high - S.E.S. schools performed at a level equal to their group mean in digits correctly recalled, and also scored one standard deviation above the low - S.E.S. group on the test of intelligence.

Occupational Levels and Age

As indicated above S.E.S. categorizations were further checked by gathering data relevant to parents' occupational level. This is presented below. It is obvious from the occupations listed here that the two groups readily do fall into low and high - S.E.S. categories.

	Occupational Level of High - S.E.S. Father/Mother	Frequency
I.	President/vice-president of firm	6
II.	Physician/dentist/attorney/banker (professional)	15
III.	Supervisor-engineer/investment manager/ Vista supervisor/data processing manager/ distributor/sales manager/stock broker/ designer/funeral director/elementary principal (managerial)	11
IV.	Buyer/salesman/teacher/manufacturing agent/ engineer/IRS specialist/labor representative/ insurance broker/ Supreme Court administrator (semi-professional)	18
		50

	Occupational Level of Low - S.E.S. Father/Mother	Frequency
I.	Detective/accountant/statistical engineer/	4
II.	Foreman/supervisor/correctional officer	3

III.	Pipefitter/apprentice/electrician/butcher/ driver-salesman/welder/secretary (skilled)	12
IV.	Cook/baker/security officer/truck driver/ cab driver/maintenance leader/railroad pilot/ floor layer/special student attendant (semi-skilled)	9
V.	Laborer/shipping clerk/dockworker/stockman/ mail-handler/groundsman/elevator starter/janitor (un-skilled)	17
VI.	Unemployed	11
		56

The mean ages and ranges for low and high - S.E.S. subjects are also relevant. These data are presented below:

Subject Class	Mean Age (yrs. - mos.)	Age Range
High - S.E.S. Males	13 - 9	(13 - 3 to 14 - 8)
High - S.E.S. Females	13 - 8	(13 to 14 - 7)
Low - S.E.S. Males	13 - 9	(13 to 15 - 1)
Low - S.E.S. Females	13 - 8	(12 - 6 to 14 - 10)

Materials and Instruments

All subjects were presented with an 18 item PA list. PA's of three levels of rated imagery according to the 1968 Paivio, Yuille, Madigan norms were randomly ordered and reordered for aural presentation at a 5 second rate. A standard study-trial; test-trial format was followed (see below). Two separate 18 item lists were employed, equated for imagery value and such characteristics as syllable length and previous exposure. The two lists were randomly assigned to subjects. A separate analysis of variance examined possible list effects.

The six PA's (12 words) selected at each level, for each of the two lists, fall within the 40 highest, 40 lowest, and 40 most moderately rated imagery categories according to Paivio's norms. The mean imagery value for the 925 nouns rated by Paivio's subjects is 4.97 on a 7 point scale; 1 represents the low imagery end of the scale and 7 represents the high imagery end. The standard deviation for this list is 1.93. The 40 words lowest in imagery value do not exceed 2.77 in rated I, and thus fall more than one SD below the mean. The 40 high-imagery words have a rating greater than 6.70, or .89 SD's above the mean. The range for the 40 words of moderate imagery value is 4.80 to 5.13. These are words clustering closest to the mean I value.

Six paired-associates for the mixed-list were randomly formed. The total of 24 words were preselected on the basis of "familiarity" or recognition-ratings by eighth grade subjects (pilot study). Obvious associations between words have been avoided (i.e. STRAWBERRY - APPLE); associates have also been equated across imagery categories and PA lists for word length, as measured by number of syllables. Because of the compelling evidence presented above (see page 36) which mitigates the importance of meaningfulness as the effective word attribute in PAL, and because of the high correlation obtained between I and m (.72 in this instance), no effort has been made to control for this variable within or between lists.

Nine hundred and twenty-five words judged by the experimenters to be "relatively unambiguously classifiable as nouns" constitute the word sample used by Paivio. Of these, 325 nouns had been scaled for I and 60 second m in previous research. An additional 600 words were "semirandomly" selected from Thorndike and Lorge (1944). An attempt was made to sample several frequency ranges and to reduce the skewness previously obtained by adding words judged by the experimenter to be relatively abstract. Subjects were given detailed instructions to rate each word along a 7 point scale according to the ease or difficulty with which the word aroused a mental image or picture. Words were also rated in terms of "concreteness," or the extent to which the word referred to "objects, materials or persons." The correlation between the scaled attributes of I and C was .83.

The practice of obtaining ratings or other measures of stimulus words is by now, of course, a familiar practice in psychology (Gorman, 1962; Noble, 1952; Spreen and Schulz, 1966; Thorndike and Lorge, 1944). The fact that previous studies had rated many of the same words for I and C enabled Paivio to assess intergroup reliability or stability. Thus, I values for 253 nouns correlated .87 with scale values obtained in previous research (Paivio, et. al., 1966) where a 5 point scale had been employed. A correlation of .97 was obtained for 90 of the nouns previously scaled for concreteness by Spreen and Schulz (1966). Also, a point-biserial correlation between present C scores and Gorman's dichotomous, abstract-concrete scale was .87 for the 245 words common to both lists.

Intergroup reliability measures were obtained for the 1968 norms by randomly assigning raters to two equal groups, with an N of 15 for the two resulting I subgroups and 14 for the two C subgroups. Five hundred words were presented to each subgroup for rating at each of two sessions, two days apart. A counter balancing procedure was used. The correlations between subgroup means for the item attributes were .94 in the case of both I and C. Within group stability was estimated by correlating means based on I and C ratings for 54 words repeated in the test booklets. The correlations, again, were .98 and .96 for I and C respectively. The reliability of the imagery rating, then, is assumed to be well established.

The Reliability of PAL and Digit Span

Reliability data are rarely available for learning tasks, and PAL is no exception. The Stevenson study discussed above (see page 16) supports the view that PA performance is relatively consistent across tasks. Stevenson found correlations of .60 and .64 between abstract-word and abstract-form PA's for girls and boys. Rohwer carefully examined PA reliability for 288 elementary children in grades K, 1, and 3 (Rohwer, Ammon, Suzuki, and Levin, 1970). Employing the method of alternate forms, Rohwer obtained six reliability coefficients (by item type) for each of the six samples in the study. In all cases, scores consisted of the number of correct responses given on the test trials summed across two of the four lists presented. Total score reliabilities ranged between .54 for the high - S.E.S., white kindergarten sample, to .87 for their low - S.E.S. black counterparts. Rohwer concluded that the PA test yielded scores approximately equivalent in reliability to those yielded by the Colored Progressive Matrices and the PPVT.

Digit span reliability has been well established by normative data on intelligence tests, several of which employ digit span subtests. Thus, the reliability of the digit span test of the Wechsler Adult Intelligence Scale is reported to be between .66 and .71 for the various age groups tested (Wechsler, 1958). The manual for the Wechsler Intelligence Scale for Children reports digit span reliabilities between .50 and .60 for different age groups (Wechsler, 1949).

Jensen also provides some impressive reliability coefficients for digit span ability. In a 1967 study involving over 500 adult subjects, Jensen obtained a total recall reliability, based first on correlations between testing days 1 and 2, of .76; intercorrelations among replications yielded a total recall reliability of .92. More recently, Jensen reported a reliability of .89 for a special auditory digit memory test (1968).

<u>I.Q. Measures</u>

The overwhelming majority of I.Q. test scores were obtained within the past three years, all but four being Kuhlman-Anderson and Lorge-Thorndike tests, Booklet EF and Level 3, respectively. Test types and numbers per test are reported below:

Kuhlman-Anderson	58
Lorge-Thorndike	38
Otis-Lennon	1
Otis Quick Scoring	1
Kuhlman-Finch	1
WISC	1

Conversion tables were used to equate test scores. The most recent data available comparing Lorge-Thorndike and Kuhlman-Anderson deviation I.Q. scores at appropriate levels is found in Hieronymous and Stroud (1969). Each subsample took the Lorge-Thorndike Intelligence Tests (N = 1,655) and one other battery in a counter-balanced design. Other tests include the Kuhlman-Anderson, the CTMM, the Henmon-Nelson Tests of Mental Ability and the Otis Quick Scoring Test. Subsample N's range from 365 to 459. Correlations between L-T verbal and Kuhlman-Anderson scores for each grade level are .75, .79, and .77 respectively.

Means, SD's, and ranges for the grade 4 sample on the Lorge-Thorndike and Kuhlman-Anderson tests are given below:

TABLE 1

Means, Standard Deviations and Ranges for the Lorge-Thorndike and Kuhlman-Anderson Tests - Grade 4 Sample

	Mean	SD	Range
L-T Verbal	111.3	14.0	67-151
L-T Nonverbal	111.9	13.6	67-149
Kuhlman-Anderson	115.1	14.3	67-154

These findings are consistent with previous comparison studies. Thus, Flanagan and Schwarz (1958), comparing Kuhlman-Anderson, Booklet H, and Lorge-Thorndike, Level 5 (high-school), used stanine conversion tables, and found the K.A. I.Q. scores to be higher by one point in the 82 to 126 range; below I.Q. 82 the tests were equal. Lund (1955) compared L-T Level 4 and K.A. Booklet EF. From I.Q. 106 to 121, the tests were equivalent; from 99 to 105, the K.A. yielded scores one point higher.

The conversion "formula" presented in Table 2 comes from tables in Hieronymous and Stroud. Comparisons between the Otis, Kuhlman-Finch and Kuhlman-Anderson were obtained from similar tables (Lund, 1955; Flanagan and Schwarz, 1958). All I.Q. results were converted to Kuhlman-Anderson scores.

Reliability and validity data is plentiful for both the Lorge-Thorndike and Kuhlman-Anderson I.Q. tests (Buros, 5th and 6th Editions, 1959; 1965). On the Lorge-Thorndike, 1957 version, item to subtest

TABLE 2

Conversion from Lorge-Thorndike to Kuhlman-Anderson I.Q. Tests

If the score on the Lorge-Thorndike is	
60 to 69	subtract 5
70 to 74	subtract 4
75 to 79	subtract 3
80 to 84	subtract 2
85 to 89	subtract 1
90 to 109	they are equivalent
110 to 114	add 1
115 to 119	add 2
120 to 129	add 3
130 to 139	add 4
140 to 149	add 5

correlations range between .43 and .70. Alternate forms reliability coefficients for this test range between .76 to .90 at all levels. Odd - even reliabilities are even higher (.88 to .94). Validity data is also impressive. A correlation of .67, based on 214 cases, was obtained between performance on this test given at the beginning of the ninth grade and average achievement at the end of the grade. Correlations between L-T scores and Stanford-Binet and WISC scores range between .54 and .77. Intercorrelations among L-T subtests are satisfactory (.30 to .70).

Reliability data on the Seventh Edition of the Kuhlman-Anderson is presented in Buros (1965). Test-retest coefficients, with as much as two grades between testing, range from .83 to .92; testing with adjacent forms yields correlations from .77 to .89. Split-half coefficients for Booklets K to CD range from .93 to .95 and factor analyses of subtests in Booklets D to H lead to estimates of total score reliability of between .85 to .95. Concurrent and predictive validity coefficients range between the high 40's to the high 80's, with more than 150 correlations reported between the Kuhlman-Anderson and other tests of intelligence and achievement.

Both I.Q. tests, then, appear to be more than adequate measures of general, Level II ability.

Design

A 2 x 2 x 3 repeated measures analysis of variance design was used to examine hypotheses 3 through 5 listed above with appropriate post-hoc procedures to determine the nature of any significant main effects or interactions. The dependent variable is the number of correct responses summed across three test trials. The single within-subjects factor in the repeated measures design will be imagery value. Between-subjects factors consist of levels of learning, and sex. Sequence effects were controlled by randomizing PA presentation order from trial to trial. In addition, two 18 item mixed-lists were employed. Separate analyses of variance were used to examine possible list effects and also to test for significant differences between high and low - S.E.S. youngsters in digit span and I.Q. test differences.

Procedures

All eighth grade subjects present on several testing days in three parochial schools were given a digit span test similar in format to the Digit Span subtest of the Wechsler Intelligence Scale for Children. Subjects were tested in groups of 3-5 in an isolated room within each school building. Three different digit span tests were presented, each with series of from 3 to 9 digits in length. A Sony tape recorder was used for presentation of test instructions and items (see appendix for a transcript of the instructions). Digits were read at a rate of one per second, and each list will begin with a 3-digit series. Immediately following each series, a bell sounded signaling each subject to begin recording the digit series just heard. Pencils and sheets with seven columns were provided for this purpose. Subjects were prevented from writing down any series prior to hearing the bell. Variable amounts of time were allowed between series for this purpose. Digit span scores consist of the total digits correctly recalled in sequence and position across the three digit span lists.

Digit span scores were then employed, along with test results[1] to select subjects from the low - S.E.S. population equal to or nearly equal to high - S.E.S. subjects in digit span ability but falling at least one standard deviation below the high - S.E.S. group in terms of measured intelligence. The high - S.E.S. group was equated with the low - S.E.S. group in Level I ability but was selected to exceed the low - S.E.S. group in intelligence by a standard deviation. Forty-six subjects were selected from each school. Equal number of boys and girls were selected from each population and randomly assigned to conditions.

Following random assignment of subjects, 18 item, mixed-list PA's were presented aurally to each subject at a 5 second study-test trial rate. Subjects were individually tested. An isolated room in

1 (see note, page 46)

the building was used to ensure a minimum of distraction. Subjects were carefully instructed to "Remember the words that go together" (see appendix for complete transcript of instructions). Following the aurally presented instructions, a study test trial example consisting of three pairs was administered. The pairs are: woods-hammer, material-circuit, moment-belief. All study and test cue words have been recorded by a white female.

During test trials, stimulus items were presented and subjects had 5 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 consist 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 and a category described in the following chapter was used to classify responses.

CHAPTER IV

ANALYSIS OF RESULTS

<u>Part One</u>: <u>Analysis of Pre-Experimental Subject Data</u>

The five hypotheses presented in the last chapter are examined in order, beginning with the first two which concern pre-experimental subjects. You will recall that all eighth graders in the schools tested present the week of the experiment were administered digit span tests. This includes 50 high - S.E.S. and 59 low - S.E.S. subjects. In addition, school records yielded 99 I.Q. scores which were made equivalent through the method described in the previous chapter. It should be kept in mind then that sample sizes in the following discussion will differ somewhat from test to test, depending on whether digit span or I.Q. score data are being examined.

<u>Hypothesis 1</u>. The correlation between I.Q. as measured by the Lorge-Thorndike or Kuhlman-Anderson group administered intelligence tests and digit span falls within the range of 0 and .20 for the low - S.E.S. mixed-race group and between .50 and .70 for the high - S.E.S. white group.

<u>Hypothesis 2</u>. No significant differences in digit span ability exist between high and low - S.E.S. eighth graders despite significant differences in performance on the I.Q. tests. No significant sex differences obtained for either measure.

These two hypotheses will be discussed together. The analyses of variance for digit span scores yielded unpredicted results. As Table 4

TABLE 3

Means and Standard Deviations for Digit Span Scores in the Pre-Experimental Group by S.E.S. and Sex

	Males			Females		
	M	S.D.	N	M	S.D.	N
High S.E.S.	87.10	(12.80)	N = 21	89.59	(16.59)	N = 29
Low S.E.S.	77.83	(15.87)	N = 30	77.07	(15.50)	N = 29

TABLE 4

Summary Table of Analysis of Variance for Digit Span Scores in the Pre-Experimental Group

Source	df	MS	F
S.E.S. Level	1	3391.54	14.22*
Sex	1	21.43	.09
S.E.S. X Sex	1	75.14	.31
Within cell	105	238.56	

*$p < .01$

reveals, S.E.S. Level did constitute a significant source of variance ($p < .01$). Neither sex, nor the Sex X S.E.S. interaction was significant, which was as predicted. However, strata differences in digit span performance were not expected. Table 3 shows that the direction of the significant S.E.S. Level differences favors the high - S.E.S. group. High - S.E.S. subjects exceed the low - S.E.S. group by nearly one standard deviation. This finding, of course, is directly counter to Jensen's hypothesis that middle and low - S.E.S. children are equivalent in rote learning abilities.

Before examining the relationship in the upper and lower S.E.S. groups between the Level I or digit span measure and the measure of Level II ability, data on I.Q. test performance should first be examined. It was hypothesized that high and low - S.E.S. subjects would differ significantly in terms of I.Q. test performance. The one-way analysis of variance supports this hypothesis. As Tables 5 and 6 indicate, the high - S.E.S. subjects perform significantly higher on tests of Level II ability than do the low - S.E.S. subjects ($p < .01$). The average difference in I.Q. score between the two groups is 10.7 points. No significant differences exist between males and females.

Thus, Hypothesis 2 predicted no significant differences in digit span ability between high and low - S.E.S. eighth graders; this hypothesis was disconfirmed. Significant differences favoring upper strata subjects were found. Significant strata differences in I.Q. test performance were expected and obtained, as well as the lack of significant male-female differences on both measures.

The first hypothesis, that the relationship between I.Q. and

TABLE 5

Means and Standard Deviations for I.Q. Test Scores in the Pre-Experimental Group by S.E.S. and Sex

	Males			Females		
	M	S.D.	N	M	S.D.	N
High S.E.S.	107.06	(9.36)	N = 17	110.21	(10.26)	N = 29
Low S.E.S.	97.04	(12.97)	N = 27	98.85	(10.53)	N = 26

TABLE 6

Summary Table of Analysis of Variance for I.Q. Test Scores in the Pre-Experimental Group

Source	df	MS	F
S.E.S. Level	1	3044.57	25.35*
Within groups	97	120.08	

*$p < .01$

digit span scores will differ significantly as a function of social class, is important to the Jensen theory. Jensen argues that different patterns of ability are characteristic of high and low social class groups. Thus, rote ability is thought to be evenly distributed across S.E.S. groups; Level II ability is said to be distributed about a higher mean in the upper classes than in the lower. If true, this explains the different correlations between the two measures obtained in high and low - S.E.S. groups. Data from this study, regarding this relationship, needs to be carefully examined.

It was predicted that correlations between digit span - I.Q. for the low S.E.S. group would fall within the range of 0 to .20; for the high S.E.S. group, correlations between .50 and .70 were predicted. These absolute values were obtained, as Table 7 shows, but the S.E.S. groups were reversed. Thus, the correlation between Level I - Level II measures is .04 for the high - S.E.S. subjects, and .54 for the low - S.E.S. subjects. Not only is Hypothesis 1 disconfirmed, but results are exactly counter to what was expected.

These are the findings: (1) No significant differences were found between sexes within S.E.S.; (2) S.E.S. correlations were significantly different at the .01 level, two tailed, with low S.E.S. digit span - I.Q. correlations significantly exceeding high S.E.S. correlations; (3) confidence intervals (95 percent confidence range) for the samples were: high - S.E.S., $r = .04$, range between -.252 and .328; low - S.E.S., $r = .54$, range between .316 and .708. These results represent a blow to the Jensen hypothesis. Looking at data relating to social class and at I.Q. test performance for these groups, it is hard to deny that the subjects are truly representative of upper

TABLE 7

Correlations Between Digit Span and I.Q. for High and Low S.E.S., Male and Female Pre-Experimental Subjects

High S.E.S.	.04	.05*	N = 46
Males	.09	.11*	17
Females	.00	--	29
Low S.E.S.	.54	.68*	N = 53
Males	.50	.62*	27
Females	.61	.76*	26

*Correlations corrected for attenuation assuming both measures to have a reliability of .80.

TABLE 8

Summary Table of One-Way Analysis of Variance for Paired-Associate List I and II

Source	df	MS	F
Lists	1	.06	.001
Within groups	78	57.99	

and lower strata populations. Yet ability patterns, for these samples, run counter to those predicted by the Jensen hypothesis.

In examining I.Q. data for the two groups, a possibility that restriction in range might account for lower correlations in the high - I.Q. group was entertained. An examination of the standard deviations presented in Table 5, however, makes it evident that the range is similar in both groups; nor do the sample S.D.s differ appreciably from the population S.D. of 12.3 points.

To briefly summarize results to this point: Hypothesis 1 was disconfirmed. It predicted different patterns of ability in high and low - S.E.S. groups; rote learning and I.Q. were thought to be significantly related only for upper strata subjects. In fact, the two measures correlated only in the lower strata group. This finding runs counter to the Jensen hypothesis. Results relating to Hypothesis 2 also contradict Jensen' theory. Thus, high - S.E.S. subjects outperformed low - S.E.S. subjects on measures of Level I, rote learning ability and Level II ability. No significant sex differences were obtained for either test.

Part Two: Analysis of Experimental Subject Data

The remaining three hypotheses should be examined together. Before proceeding, however, results for the one-way analysis of variance for lists needs to be presented. As Table 8 indicates, no significant differences were found between list one and two. Separate PA lists were included in the design in an effort to increase the generalizability of the findings, not because of any interest in lists as a source of variance. This goal can best be served by pooling data across list categories in subsequent analyses.

The remaining three hypotheses should be examined together.

Hypothesis 3. Significant differences in performance on the mixed list PA's result between Level I, low - S.E.S. subjects and Level II, high - S.E.S. subjects favoring the Level II learners.

Hypothesis 4. Rated levels of imagery yield a significant main effect, with high-imagery word pairs recalled at a significantly higher rate than moderate-imagery pairs; these, in turn, significantly exceed low-imagery words in recall.

Hypothesis 5. A significant interaction exists for the imagery-values by levels of learning source of variation, with the greatest differences between Level I and Level II learners occurring for associates of moderate imaginal value.

Results pertinent to all three hypotheses can be found on the following page (Table 9). Means and standard deviations by levels, sex, and treatment are presented for the paired-associate task. Only Hypothesis 4 was supported by results of the study. Before further elaboration of these results, however, we should discuss selection of experimental subjects. The two criteria for selection of low strata experimental subjects, you will recall, was (1) equal or near equal digit span test performance compared to the overall digit span performance of the high strata group; (2) an I.Q. score which was at least one standard deviation below the high - S.E.S. group. Another overall criteria, of course, was equal numbers of boys and girls in high and low strata groups. Generally, these criteria have been met. Some difficulties arose from the fact that the high - S.E.S. sample significantly outperformed the low - S.E.S. group in the digit span test. This, plus the high correlation between rote learning and

TABLE 9

Means and Standard Deviations for the Three Repeated Measures of Paired-Associate Learning by Levels and Sex

		Low I		Mod I		High I	
		M	S.D.	M	S.D.	M	S.D.
Level II	Male N = 20	2.55	(2.26)	5.30	(2.43)	11.40	(2.76)
	Female N = 20	3.45	(2.80)	7.65	(3.10)	11.55	(3.72)
Level I	Male N = 20	2.90	(2.98)	6.05	(3.00)	11.45	(2.39)
	Female N = 20	3.00	(2.93)	5.20	(2.91)	11.35	(4.08)

TABLE 10

Means and Standard Deviations for Digit Span Scores in the Experimental Group by Levels and Sex

	Males		Females	
	M	S.D.	M	S.D.
Level II	87.50	(13.04)*	81.50	(12.91)
Level I	81.65	(11.90)	76.40	(13.12)

*N = 20 per cell

TABLE 11

Summary Table of Analysis of Variance
for Digit Span Scores in the Experimental Group

Source	df	MS	F
Learning Level	1	599.51	3.65
Within groups	79	164.49	

TABLE 12

Means and Standard Deviations for I.Q. Test
Scores in the Experimental Group by Levels and Sex

	Males			Females		
	M	S.D.	N	M	S.D.	N
Level II	108.25	(8.23)	N = 16*	109.30	(10.33)	N = 20
Level I	96.83	(9.82)	N = 18	96.56	(6.91)	N = 18

*I.Q. data were not available for all subjects

I.Q. in the low - S.E.S. sample, meant that some overlap in I.Q. between the groups was inevitable if they were to be equated for Level I ability. Tables 10, 11, and 12 present data on digit span and I.Q. test performance for the treatment groups.

Analysis of variance for treatment group digit span scores yields a nonsignificant difference across S.E.S. levels. This is evidence of equality in rote learning ability. I.Q. differences between groups are significant, as can be seen in Table 12. The mean I.Q. difference between high and low - S.E.S. groups of 12.1 points is equivalent to the population standard deviation reported for the Kuhlman-Anderson intelligence test of 12.3 points (i.e. for eight samples, in grades 1 through 10, involving sample sizes from 116 to 459; Kuhlman-Anderson Handbook, 1952; Lund, 1955; Hieronymous and Stroud, 1969).

Whenever atypical samples are selected from populations which differ on certain measures, the possibility of a regression effect needs to be considered. In this case, subjects have been selected in the low - S.E.S. group who fall above their group mean for the digit span test. The high - S.E.S. sample falls somewhat below their DS group mean. Depending on the correlation between Level I performance and PAL, differences between samples on the latter could be a function of regression to the mean. The fact that no significant differences were found in PAL between high and low strata groups (see Table 13), however, rules out such an effect, and makes the lack of differences even more impressive.

While the hypothesized strata differences, and the predicted Treatment X Levels interaction did not materialize, an examination of Table 13 reveals an enormous Treatment effect. It has been

TABLE 13

Summary Table of Repeated Measures Analysis of Variance for Paired Associate Learning

Source	df	MS	F
Between Subjects			
Learning Levels	1	6.34	.43
Sex	1	10.84	.73
Levels X Sex	1	30.10	2.04
Error (between)	76	14.76	
Within Subjects			
Treatment - Imagery	2	1467.93	243.63*
Treatment X Levels	2	4.14	.69
Treatment X Sex	2	2.71	.45
Treatment X Levels X Sex	2	12.30	2.04
Error (within)	152	6.03	

*$p < .001$

reported that treatment effects seldom account for more than 10 percent of the total variance in experimental studies. In the present experiment, however, 86 percent of the variance is accounted for by the Treatment factor. This marks the imagery-levels source of variance as an unusually powerful main effect. As a matter of fact, evidence will be presented later in the chapter to show that the imaginal value of words relates not only to the level of elaborative strategy elicited, but also to the effectiveness of the strategy once it is employed.

Before further discussion of the treatment effect, however, the fate of Hypotheses 3 and 5 must be dealt with. Hypothesis 3 predicted significant differences in performance on the mixed list PA's between Level I, low - S.E.S. subjects and Level II, high - S.E.S. subjects, favoring the high strata sample. The fact that no differences in PAL were found, despite significant differences in I.Q. between the groups, might indicate that performance on the task was more a function of non-conceptual rote learning ability than of Level II kinds of ability. Similarly, the failure of the predicted Treatment X Levels interaction to materialize (Hypothesis 5) can also be construed as evidence that similar low level processes were involved across item types. Remember, it was theorized earlier 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, 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. Thus, it was hypothesized that abstract words would elicit low level, rote strategies in both groups; highly concrete words would provoke spontaneous elaboration in both Level II and Level I groups. If the ability to call to mind and manipulate mental imagery is at the heart of Jensen's Level II construct, then this experiment, which carefully controls for rote learning ability, should have produced the predicted results.

The trouble with concluding that Level II processes were not involved, however, is that imagery-levels did constitute a highly significant ($p < .001$) source of variance. High image words were learned at a rate nearly three times that of low image words (Table 9). Twice as many moderately concrete associates were retained compared to abstract associates. Clearly some process must have been at work to produce this enormous treatment effect. Evidence will be presented later which indicates that stimulus concreteness does in fact directly relate to the type of elaborative strategy elicited. This finding raises more questions than it answers. For example, why do the Level I subjects perform as well across item types as the Level II subjects? This question is embarrassingly similar to one raised by Rohwer in a paired-associate study cited earlier: "Why do lower-strata children, whose performance on school-related learning tasks is inferior, learn as effectively as upper-strata children on PA tasks?" (Rohwer, 1967).

Before dealing with this, and related issues, Table 14 should be examined. Table 14 reports results of the post-hoc comparisons of means for the imagery conditions (Newman-Keuls procedure). As can be seen, all comparisons exceed critical values for the .01 level of significance. Thus, the moderate-imagery condition differs significantly from the low-imagery condition; the high-imagery word category significantly exceeds both of the others.

This, then, brings us to the final bit of data, that relating to

TABLE 14

Post-Hoc Multiple Comparisons of Mean PA Scores for Imagery Conditions

Means	Low I 2.98	Mod I 6.05	High I 11.44	Shortest Significant Ranges (p .01)
Low I	-	3.08*	8.46*	$R_2 = 2.03$
Mod I	-	-	5.39*	$R_3 = 2.31$

*$p < .01$

the subject's reported use of elaborative strategies. Several puzzling questions have been raised. Summarizing results thus far, the following has been found: (1) Digit span - I.Q. correlations differed significantly across social class, with the low S.E.S. Level I - Level II correlation (.54) significantly exceeding the high S.E.S. correlation (.04) ($p < .01$). (2) Upper strata subjects significantly outperformed lower strata subjects on tests both of rote learning ability and general intelligence ($p < .01$). (3) Learning level differences did not emerge on a mixed-list PA task for upper and lower class samples equated for rote learning ability but differing one standard deviation in I.Q. (i.e. Level I and Level II learners). (4) Rated levels of imagery yield a significant main effect ($p < .001$), with high-imagery word pairs being recalled at a significantly higher rate than moderate-imagery pairs; the latter significantly exceeded low-imagery words in recall. (5) No significant interaction between imagery-values and learning levels was obtained.

Reported Use of Strategies

Turning now to subject's reported use of strategies, perhaps some of the questions raised above can be answered. As you may recall, strategy information was obtained for each subject at the end of the PA testing session. The following two questions, "How did you try to learn the words?" and "What made some of the words easier to learn than others?", were asked of the subjects for this purpose. Subjects' responses to these questions were written down verbatim. Data obtained in this fashion can be examined in several ways. In this study, three different ways of organizing data were used. First responses were categorized in terms of increasing complexity. For example, the lowest level category, the "rote learning category," consists of the following responses by subjects:

"I just kept repeating."

"I tried to memorize the last words."

"I would hear them over and over."

"I remembered them in order, the last words."

"I said them back and forth."

"I repeat them in my mind."

The next highest category, the "mnemonic category," involves relatively low level strategies relying on word-sound or letter cues. Some examples (see appendix for complete transcript of all responses by S.E.S. and sex):

"The first letters were b - c."

"Some sounded alike."

"The endings were sometimes the same - like democracy - tendency."

"For core-link I remembered Lancelot Linc and his girlfriend Cora." (cartoon characters)

"Alligator didn't sound like the rest." (alligator-cigar)

Next comes the "verbal association category." This is probably the most ambiguous of the five strategy categories; it includes responses indicating that an association was made between word pairs, but where evidence of complex elaboration is lacking. Thus, if the subject responds that "policeman and fire go together" or that "'soul-belief' is a phrase," it is possible that complex sentence or imaginal elaboration has occurred, but objective evidence for such elaboration is not contained in the response. Examples of verbal association include:

"I tried to remember - strawberries are red, (strawberry-blood) situations and facts are related."

"Coffee-woman go together."

"Soul and belief are both religious things."

"Charm and disease are just the opposite."

"I thought of green for grief and 'green material'; cigars come from Florida and so do alligators."

"I thought of a car and a boat and a boat and the ocean."

This category includes the mediational strategies, once thought to underlie all stimulus-response learning, of the type long studied in verbal learning laboratories. The fourth type of response, designated "verbal elaboration", involves embedding word pairs in sentence strings; this strategy entails "elaboration," defined as complex transformation of input. Originally it was thought that one category, "verbal mediation," would prove sufficient for all responses of the non-mnemonic or non-imaginal type. However, so many subjects were so explicit regarding the use of sentence elaboration that this category was added. Some examples, from subject protocols, are given below:

"For hammer and auto I said 'if fixing a car, you need a hammer'."

"I made up a sentence: 'The comedy is in season'; 'The policeman came to the fire'."

"I think of something to go along with it: 'Fate would be a bad occasion'."

"For idea - chance, I said 'The chance to bring out ideas'."

"I remembered some because they were stupid - like there's a joke about an 'elephant up a tree'."

"I tried to make a phrase: 'You're a victim of an accident with a stubbed toe'."

The fifth category marks the highest level strategy - that of "imaginal elaboration." Again, the explicitness of many of the subjects concerning the use of this relatively complex strategy came as a surprise to the experimenter. The second or third subject tested, for example, replied that for apple - orchestra she "thought of men playing violins inside a huge apple." Several mentioned that the pairs easiest to learn were "wierd" or "queer" and "just stuck" in their mind. Many were more explicit that this. Examples below are not atypical:

"I took a picture - like an alligator with a cigar in its mouth."

"Mother and coffee came to mind because my mother drinks coffee in the morning." (coffee-woman)

"I tried picturing it in my mind - an alligator smoking a cigar; a baby playing the piano; gardeners looking at a star."

"I thought of the outside and tried to place it (the associate) in a scene."

"I thought of a car going into the ocean."

"I couldn't bring democracy to mind."

To summarize, then, the five strategy categories are as follows: (1) rote, (2) mnemonic, (3) verbal association, (4) verbal elaboration, (5) imaginal elaboration. These categories were weighted, 1 to 5 respectively; the weights 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. Scores ranged from 1 to 13, with 5 representing the most frequently occurring strategy score. Various non-parametric tests were used to examine the data (see below).

The reliability of the classification scheme was checked by having two judges independently rate all verbal reports. A Pearson correlation coefficient was computed between the separate total strategy level scores for each individual. The correlation coefficient obtained ($r = .94$) clearly indicates a high level of agreement between the two sets of independent ratings.

In addition, two other ways of organizing the 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, because so many subjects included specific examples in their report, the percentages of item-types (i.e. high - I, etc.) for each strategy category were also available. This information will be used shortly in examining certain hypotheses.

The mean number of different strategies reported, per individual, is presented below:

H - S.E.S. Males = 1.7
H - S.E.S. Females = 1.65
L - S.E.S. Males = 1.45
L - S.E.S. Females = 1.58

The overall mean is 1.60 strategies. This indicates that few of the eighth graders adopt a single strategy and stick with it. Most employ more than one type; several (12) report using three and four different strategies in learning word pairs.

A chi-square test was conducted to see if the number of strategies reported by high and low level subjects differed significantly. It did not ($\underline{X}^2 = .508$, $p < .50$). Level I subjects seem just as versatile in employing different strategies as the Level II subjects. However, while the number of different strategies employed by individuals does not differ across learning levels, the level of strategy does. This is evidenced in at least two ways. First, total scores differ. A Mann-Whitney $\underline{U}$ test was used to determine whether there was a significant difference between the high and low level groups' total strategy scores. This difference was found to be significant ($\underline{z} = 2.31$, $p < .02$, two tailed) in favor of the Level II subjects.

Secondly, the proportion of subjects in upper and lower strata groups reporting use of elaborative strategies (i.e. 4 and 5, above), versus non-elaborative strategies, differs significantly. Males and females do not differ in relative frequency of elaborative and non-elaborative strategy use ($\underline{X}^2 = 1.01$, $p < .50$). Tables 15 and 16 show the distribution of subjects by levels and sex in elaboration and non-elaboration categories. The fact is that the high - S.E.S., Level II group reports significantly more elaboration than their low - S.E.S. counterparts: that is, the proportion of S's in each group reporting use of elaboration versus non-elaboration differs significantly ($\underline{X}^2 = 5.60$, $p < .02$). This result might be expected

TABLE 15

Distribution of Subjects
in Level I and Level II Groups Using
Elaborative and Non-Elaborative Strategies

	Non-Elaborative	Elaborative	Total
Level II	12	28	40
Level I	23	16	39
Total	35	44	79

TABLE 16

Distribution of Males and Females
Using Elaborative and Non-Elaborative Strategies

	Non-Elaborative	Elaborative	Total
Males	15	25	40
Females	20	19	39
Total	35	44	79

were it not for the fact that no significant difference exists in PAL proficiency between the groups.

Thus, Level II subjects engage in more complex elaboration than Level I subjects. This does 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 is not the case, at least as far as the Level I youngsters are 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 are .099 and .39, high and low groups respectively. The correlation for the low level group is significant ($t = 2.57$, $p < .01$, one tailed), indicating a clear relationship between total strategy score and amount of learning for this group.

A median test was used to study the relationship between elaboration and learning performance for the Level I group. It was hypothesized that the median of the elaborative group would be higher than that of the other. This was confirmed ($\underline{X}^2 = 5.82$, $p < .01$, one tailed). Table 17 presents the distribution of low level subjects, falling above and below the median on PAL, who reported using elaborative and non-elaborative strategies.

Use of elaborative strategies is significantly related to learning performance only in the low - S.E.S., low I.Q. sample. Although the upper strata group reports using more of the complex learning strategies, they perform at a level equal to the lower strata group.

TABLE 17

Distribution of Subjects Above and Below Median on PAL Using Elaborative and Non-elaborative Strategies

	Non-elaborative	Elaborative	Total
Subjects above median in PA learning	7 (3)*	12 (17)	19
Subjects below median in PA learning	16 (9)	4 (11)	20
Total	23	16	39

*Frequencies in each category for Level II subjects.

The question to be resolved, then, is, why do strategy scores not relate to learning performance in the Level II group? This question is similar to one raised earlier, which may be phrased as follows: In light of a significant treatment effect, indicating that complex strategies are involved, why do Level II subjects perform no better across item types than Level I subjects?

There are at least four hypotheses which can explain this finding. The first two hypotheses can be called "verbal fluency" hypotheses: (1) Level II subjects, having greater verbal skill than Level I subjects, are simply better able to describe what they actually did do during the experiment. This explanation implies that both groups were equivalent in strategy use, but that the more verbal, higher strata youngsters were better equipped to explain what they did to learn the words after the fact. (2) The second explanation is as follows: The Level II subjects, being more verbally fluent - and perhaps more eager to please the experimenter - simply "made up" strategies in response to the experimenter's questions. Thus, what individuals in the high - S.E.S. sample say they did, and what they really did during the experiment, may not necessarily correspond. The "verbal fluency" hypotheses point up the limitations of self-report data. The next two hypotheses assume that subjects' reports are valid, but that the elaboration strategies, once elicited, are not effective. Hypothesis (3) states: Level II subjects were more efficient in elaborating word pairs than Level I subjects, just as their reports indicate. Once the task was mastered, however, the upper strata group was less motivated to do well on subsequent trials. This hypothesis assumes that the Level II sample had complex strategies at their disposal, but that they became bored with the task.

The fourth possiblity also assumes that subjects in the high and low level groups did what they said they did: (4) Level II subjects employed a greater number of elaborative strategies across learning trials than Level I subjects; for some reason, however, this "extra" elaboration was simply not effective in learning word pairs. This implies that elaboration is not uniformly effective across item types; there may be a diminishing return on elaboration as one moves from concrete to abstract associates. According to this hypothesis, the Level II subjects may be guilty of "over-elaboration," or inappropriate elaboration; they may be attempting to "transform" input which does not readily lend itself to transformation.

We shall examine each of the four hypotheses in turn: (1) If the Level II youngsters were better able to describe what they did during the experiment, thus deriving higher strategy scores, there should be marked differences in the frequency with which certain kinds of responses appear. Most notably, the most ambiguous category - the verbal association category - should include a far greater number of separate responses for low - S.E.S. youngsters than for high. Thus, responses like "Coffee and woman go together; they have something to do with each other," might actually be indicative of mental elaboration for low - S.E.S. youngsters; because this group lacks verbal fluency, they might have a difficult time making explicit the elaborative strategies employed. Table 18 presents the frequencies of response for each strategy category. In fact, the number of responses in the verbal association category is identical for

TABLE 18

Frequencies of Response by Strategy
Category for Low and High Levels

Level I:	Imagery	14	Level II	19
	Verbal Elaboration	7		14
	Verbal Association	15		15
	Mnemonic	--		8
	Rote	20		13
		56		69

both low and high - S.E.S. samples. The percentages of total response do not differ appreciably across strata (.27 for high - S.E.S.; .22 for low - S.E.S.). Also working against the above hypothesis is the fact that S.E.S. equivalence in strategy use means no relationship between PAL and strategy scores in either group, which is unlikely.

The second hypothesis does not seem to be supported by protocol data either. In addition to an analysis of type and frequency of response, protocol material lends itself to a breakdown by item - type and strategy level (Table 19): (Note: Responses per strategy category may differ from those presented in Table 18 because more than one paired-associate example may be contained in a separate statement.)

If, as hypothesized, the more verbally fluent youngsters were reporting strategies in response to the experimenter's questions that they did not actually use, less of a relationship should exist between item-types and strategy levels for this group. Thus, if the upper strata youngster is more prone to "discover" an appropriate, high - level strategy after the fact, and to report having used it when in fact he did not, this should be reflected in one of two ways: (1) the subject should be unable to cite specific word pair examples in his report; or (2) the associates he uses in reporting elaborative strategies should be randomly distributed across item-types. Any pair, then, could be adapted to ex post facto descriptions of strategies. The data in Table 19, however, indicates that this did not occur. 22 out of 54 word pair examples cited by the

TABLE 19

Frequencies of Item-Type Examples by Strategy for High and Low Levels

		Concrete	Moderate-I	Abstract
Level II	Imagery	23	2	1
	Verbal-Elab.	9	5	4
	Verbal-Assoc.	22	4	6
	Mnemonic	2	1	1
	Rote	-	-	1
Level I	Imagery	19	-	-
	Verbal-Elab.	3	2	3
	Verbal-Assoc.	18	1	3
	Mnemonic	-	-	-
	Rote	3	2	-

Level I sample, and 32 out of 81 examples cited by the Level II sample, fall in the concrete-elaborative strategy cell. The percentages, respectively, are 41 and 40. High-image words are equally related to high - level strategies across social classes. On the basis of this data, the second hypothesis does not appear to have support.

The third hypothesis to be examined posits an interaction between Level I - II and trials. Thus, if the Level II group employed more complex strategies at the beginning of the paired-associate task yet wound up no better in overall performance at the end, it might be attributed to a loss of interest in a task which for them was easily mastered. If this in fact was the case, the Levels X Trials source of variance in a repeated - measures ANOVA should be significant. Table 20 presents results which show that this interaction does not represent a significant source of variance. Hypothesis 3 is further disconfirmed by the experimenter's observation that both high and low level youngsters seemed equally motivated to do well in the experimental task.

If one views the four hypotheses proffered above as being exhaustive of all possibilities, then, the fourth and last hypothesis is correct by default. However, there is evidence to support this hypothesis. The fourth hypothesis states that most of the "additional" elaboration engaged in by Level II subjects was ineffective because it involved words low in image-provoking value. Table 17 shows that the main difference in distribution between elaborating and non-elaborating high and low level youngsters, who fall above and below the median in PA learning, is in the elaboration-below

TABLE 20

Summary Table of Analysis of Variance for
Paired Associates for Levels and Trials 1 and 3

Source	df	MS	F
Between subjects			
Levels - S.E.S.	1	3.9	.42
Subjects within groups	78	9.3	
Within subjects			
Trials	1	151.8	10.82*
Levels X Trials	1	.16	.01
Trials X Subjects within groups	78	14.0	

*$p < .01$

median category. Nearly three times as many Level II as Level I subjects report unsuccessful elaboration. This unsuccessful elaboration, it is hypothesized, involves words low in imaginal value. Evidence in direct support of this hypothesis, however, is somewhat limited: In Table 19 the number of abstract and moderate-image associates cited by subjects, which fall in the elaborative strategy category, is 27 percent for the Level II group and 18 percent for the low. Thus, nearly a third of the examples involving elaboration reported by upper strata subjects employed words low in imaginal value. A fifth of the low - S.E.S. elaborative examples, however, are non-concrete. This data is, at least, suggestive of why higher level eighth graders have difficulty converting some "transformation" into complex learning gains.

Evidence will be presented in the final chapter which indicates that stimulus concreteness is a more potent factor in PA learning than instructional set (i.e. imagery instructions). Results from this study support the contention that stimulus concreteness is even more of a factor in tasks requiring spontaneous mediation, especially when subjects are moving from rote to conceptual modes of learning. This discussion of subject protocols may be summarized as follows:

(1) Five strategy categories were used to subsume subject responses to two experimenter questions: "How did you try to learn the words?" and "What made some of the words easier to learn than others?" The inter-rater reliability for this scheme was found to be .94.

(2) High-and low - level subjects did not differ significantly

in terms of the total number of strategies they reported summed across individuals.

(3) Weights assigned to strategy levels, i.e. 1 = rote; 2 = mnemonic; 3 = v-association; 4 = v-elaboration; 5 = imagery, were used to obtain individual strategy scores. High and low level subjects differed significantly in total strategy scores (Mann-Whitney $\underline{U}$ test: $z = 2.31$, $p < .02$); this difference favored the high level subjects.

(4) Correlations between subjects' total strategy scores and PA learning scores were found to be significant only for the low level group (.39 vs. .099; $t = 2.57$, $p < .01$). That is, the probability of obtaining a value as extreme as .39 by chance is less than .01.

(5) Level II subjects report using significantly more elaboration than Level I subjects ($\underline{X}^2 = 5.60$, $p < .02$). Males and females did not differ in amount of elaboration.

(6) Lack of a relationship between strategy scores and PAL in the high level group appears to stem from the fact that high level subjects "over-elaborate." That is, high level subjects attempt to extend elaborative strategies, more often than low level subjects, to low - image associates.

In the next chapter, the writer will discuss the significance of the results presented above. The view of the high and low level youngsters which emerge from this data clearly differs in significant ways from the one drawn by Jensen's Level I - Level II theory. This "divergence" of views will be a main topic of discussion in the final chapter.

CHAPTER V

CONCLUSION

In a recent paper, William Rohwer, Jr. (1972) suggested a five pronged approach to educational research: First, he said, researchers should start with existing research studies to find out where similar processes are involved in different tasks. Secondly, they should tally results of the task performance over a wide range of human development, seeing if different stages of development have different effects on performance. Third, researchers should study the effects of various experimental conditions on performance; and fourth, they need to know which types of individuals respond to which types of situations. Finally, said Rohwer, the researchers should be able to ensure that the process needed for the task is a process within the grasp of most people.

With slight variation the research reported in this dissertation has adhered to this set of strategies. Thus, instead of searching for similar processes across different tasks, our examination of research studies focused on different processes across the same task - this was the paired-associate task. Employing Arthur Jensen's distinction between Level I associative type learning, which requires little if any transformation of input, and higher order Level II types of learning, a case was made for the presence of both simple and complex learning processes in PAL. Furthermore, tallying results of paired-associate task performance across age ranges led to the conclusion that a shift in process, from associative to elaborative, occurs from eight to thirteen years of age. In addition to age-related differences, social class - I.Q. factors, which are inevitably confounded, also were found to correlate with Level I - Level II type strategy use. A significant age by S.E.S. interaction in PAL consistently reported in the literature, can be explained in terms of differing rates of Level I - Level II ability growth across S.E.S.: Thus, higher strata youngsters outperform lower in PAL prior to eight years of age because of superior rote learning abilities; from 8 to 11 years of age, S.E.S. groups are equivalent in PAL, both relying on converging rote-learning strategies. After thirteen, it was hypothesized, high - S.E.S. youngsters learn paired-associates significantly better than low - S.E.S. youngsters because of superior Level II abilities.

Because paired-associates lend themselves to rote as well as to complex mediational types of strategies, they afford an excellent opportunity to study the two processes at work. The overriding objective in undertaking research reported here was to examine "intrinsic" individual differences underlying intelligence test performance; this is a necessity if instruction is to be adapted to fit such differences. Our review of literature indicated that the PA task was an excellent one for this purpose because it falls near the midway point on the associative to conceptual task continuum. By manipulating variables which change the nature of PA learning, thus moving the task from the associative to the conceptual side of the continuum, it was hoped that differences basic to Level I and Level II mental processes could be illuminated. The thesis of this dissertation was that one type of mental activity, imaginal mediation, was involved in such a shift. In fact, it was theorized that the ability to call-up and manipulate mental images lies at the heart of Level II (i.e. I.Q.) ability. On the basis of this theoretical view of Level II ability, several hypotheses were advanced. These may be separated into two categories.

The first two hypotheses dealt with Jensen's theory regarding different patterns of ability in high and low - S.E.S. populations. Jensen argues that the continuum of tests going from simple associative (i.e. digit span tests) to conceptual (I.Q. tests) is the phenotypic expression of two genotypically independent types of mental processes which he terms Level I and Level II ability. In addition to research on long-term-short-term memory, Jensen's contention is buttressed by data demonstrating a significant interaction between S.E.S. levels and learning tasks; low - S.E.S. youngsters typically perform at a level equal to high - S.E.S. youngsters on digit span, serial learning, and trial and error tasks, but perform significantly below the latter on tasks requiring complex "transformation of input." Jensen's theory thus predicts different correlations, for high and low - S.E.S. populations, between Level II measures and Level I measures like digit span. This hypothesis was tested in this dissertation.

The remaining three hypotheses examined the theory of Level II ability discussed above. In examining Level II differences in a task like PAL, it is necessary to control for rote learning ability because of data indicating that the two measures are relatively independent in one S.E.S. group but not in the other (see above).

This was done. It was hypothesized that a stimulus variable - the imaginal value of words - known to effect self-generated mediation in subjects, would interact with S.E.S. differences in elaborative ability (i.e. Level II ability). It was posited that stimulus concreteness would interact with ability level in such a way that the greatest differences between high and low - S.E.S., Level I and Level II learners, would be found for associates of moderate imaginal value. Words high in image-provoking value, it was thought, would tend to elicit imaginal mediation in both groups; abstract stimuli would tend to be rotely learned by both groups. Following Rohwer's research strategy we examined the effects of this experimental condition on performance, and tried to discover which types of individuals responded to which types of situations. Before discussing these hypotheses, however, we should examine the two hypotheses relating to Jensen's theory.

Patterns of Ability Across S.E.S.

Jensen argues that rote learning ability and conceptual ability are facterially distinct, that they regress differently on S.E.S., and that Level II regresses differently on Level I in lower and middle - S.E.S. groups. In one sense, Jensen's theory is supported by data presented in this study. Level II ability does regress differently on Level I ability across S.E.S., at least in the upper and lower strata thirteen year old populations sampled. Thus, correlations between digit span and I.Q. obtained in this study differ significantly as a function of social class. These correlations, however, run directly counter to those predicted by the

Jensen theory. Instead of the 0 to .20 Level I - Level II correlations (corrected for attenuation) predicted by Jensen for low - S.E.S. samples, a correlation of .68 was obtained. This differed significantly ($p < .01$) from the high - S.E.S. DS - I.Q. correlation of .05. Moreover, Jensen's hypothesis that rote learning ability is evenly distributed across social class is contradicted by analyses of variance which reveal that high and low - S.E.S. groups differ significantly ($p < .01$) in rote learning ability as well as in I.Q. test performance. The data in this study, then, indicate that the Jensen theory is either wrong or in serious need of revision.

A recent statement by Rohwer (1970) regarding Level I development forces reexamination of the data presented in the second chapter above. He writes, "In pre-school children, that is, in three, four, and five year olds, the performance of high - S.E.S. White and low - S.E.S. Black children is virtually equivalent (Jensen, 1968), whereas in fourth-, fifth-, and sixth-grade children, digit memory among high - S.E.S. Whites is markedly better than among low - S.E.S. Blacks. Furthermore, digit-span performance is considerably better among high - than among low - S.E.S. Black children at the third grade level (Green, 1969)." Rohwer presents no evidence to support his contention that 9, 10, and 11 year olds from upper and lower strata groups differ in DS ability, but his statement does highlight the fact that Jensen's research has seldom focused on children older than 10 years. Thus, the massive study cited by Jensen, involving 1,800 low - S.E.S. black youngsters, encompasses an age range from 6 to 10 (Kennedy, et.al., 1963). Two of the early studies cited by Jensen did sample sixth grade youngsters; however, two out of three experiments in the first study involved fourth graders (9½ years) (1961); the Rapier study as we have noted, involved subjects with a mean age of 10.4 years.

Guinagh's study, cited above, produced inconsistent results for third graders (1969). DS - I.Q. correlations for his most priviledged upper strata group averaged only .22; when combined with data from the other middle - S.E.S. school, however, the over-all relationship was increased to .34. Guinagh comments "It is surprising that the group of children with the highest S.E.S. level, the University of Florida laboratory children, had a correlation...almost identical to the correlation of the low - S.E.S. black children." Further confounding the picture is the fact that the only study cited by Jensen involving adult subjects (Durning, 1968; N = 5,539), concluded that "Basic learning ability as measured by digit span was not found to bear the 'necessary-but-not-sufficient' relationship to general intelligence (AFQT)...the hierarchical relationship between Level I and Level II which (Jensen) observed may be evident only in children (Durning, 1968, p. 61)."

Jensen's theory of an S.E.S. by type of ability interaction may have been too simplistic. Thus, in adult populations, rote learning ability and I.Q. seem not to be highly related; Jensen reports, in fact, that a factor analysis of the WAIS reveals that the loading of DS on "g" gradually declines with age (1964). In early elementary samples (i.e. subjects 8 years of age or younger), Level I and Level II abilities are significantly correlated in upper but not in lower strata populations.

However, as rote ability asymptotes for the low - S.E.S. group (i.e. 12 to 14 years of age) the hierarchical relationship between Level I and Level II abilities becomes manifest. It might be argued, then, that the elaborative strategies underlying Level II ability are dependent at first on a mature rote-learning base. This argument, of course, is pure conjecture. The range of correlations observed between digit span scores and I.Q., however, coupled with the fact that reliabilities are consistently high for both measures, supports the contention that the two abilities are factorally distinct. It, thus, becomes necessary to control for Level I ability in studying I.Q. related differences in learning.

PAL and Elaborative Strategies

The remaining hypotheses relate to the Level II - elaborative strategy relationship posited above. Thus, it was hypothesized that in PA learning (1) subjects high in Level II ability would significantly outperform subjects low in Level II ability due to a greater propensity for mental elaboration; (2) concrete word pairs would be learned at a significantly faster rate than moderately-concrete word pairs; abstract associates, it was predicted, would differ significantly from both moderate and high - image words in ease of learning. Again, this effect was thought to relate directly to the type of strategy elicited by high, low, and moderately concrete stimuli. The third hypothesis predicted an interaction between I.Q./S.E.S. levels and the treatment variable (see above).

While neither the first nor the third hypothesis was confirmed, subject self-report data did support the contention that Level II subjects engage in more elaboration (i.e. verbal and/or imaginal) than Level I subjects. Using frequency of response as a rough measure of the tendency to employ each of the defined strategies in learning associates, Level II youngsters engaged in elaboration nearly half the time (48%), while Level I youngsters reported using elaborative strategies a little over a third (37%) of the time. The question that was raised in connection with this data was, Why is the "extra" elaboration reported by high level subjects not reflected in superior performance in PAL?

Four hypotheses were advanced to explain this finding. The only hypothesis supported by the data, however, posits a greater production or availability of high level strategies in the Level II group, yet a diminished effectiveness as subjects in this group attempted to generalize elaborative strategies to abstract or moderately abstract stimuli. Thus it was hypothesized that only a third of the word pairs - the concrete associates - readily lend themselves to imaginal mediation. The fact that Level II subjects reported elaborating almost 50% of the time supports the contention that this group attempted to elaborate "inappropriate" stimuli more frequently than the low level subjects; the lack of relationship between strategy scores and PAL for this group can be explained in this manner.

This discussion brings to the fore an important issue in PA learning. This issue is concerned with 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. They stated it in terms of two hypotheses. One hypothesis was referred to as the "production - deficiency hypothesis," and stated that younger children simply fail to produce appropriate mediators in learning situations. The second hypothesis, termed the "mediation - deficiency hypothesis," is similar to the one advanced by us above: Thus, younger children do produce mediators in task situations, but these mediators fail to have the expected effect on overt behavior.

Generally, studies evaluating strategy production/availability have employed the method of instructed or self-generated elaboration; those concerned with strategy effectiveness have presented elaboration to subjects. This distinction between availability and effectiveness has been supported in subsequent research. Martin (1967), for example, compared normal and educably retarded youngsters, using an 8 - item PA list. For half of the retarded sample (CA = 11-8), PA's were presented in an elaborated verbal context. Retarded children provided with elaboration were significantly superior to retarded controls and indistinguishable from normal controls. Martin hypothesized that greater availability of mediation accounts at least in part, for the usual superiority of normal subjects. In another study, however, retarded adults, matched in mental age with third graders, performed significantly below the latter in the provided elaboration condition (Rohwer and Lynch, 1968). When elaborator availability is controlled, elaborator effectiveness must be involved in age and I.Q. differences.

In this regard, Rohwer's studies are interesting because they demonstrate that S.E.S. - related differences, when they do emerge in PAL (i.e. for samples between 5 and 11), appear to be stronger in elaborated than in non-elaborated conditions (Rohwer and Levin, 1971). This suggests that high I.Q./S.E.S. youngsters are more effective in using provided elaboration in the age range from 8 to 11. When older children are involved, however, our data indicates that elaborator effectiveness - or ineffectiveness - works against the high - S.E.S. youngsters. Thus, by 13 years of age both groups spontaneously engage in Level II - type mediation; the Level II group, however, being more "imagery prone," overgeneralizes what can be a useful strategy.

If this explanation is correct, research evidence should show that (1) stimulus concreteness relates directly to the production of elaborative strategies, but (2) the availability of high - level strategies, while necessary, does not guarantee strategy effectiveness. Data should indicate that item concreteness strongly effects PA learning even after complex strategies are elicited.

Paivio (1971) presents evidence in connection with the first assertion: Reported use of imagery correlated substantially with learning when the stimulus words or response words were concrete (r = .56, .39, respectively)(Paivio, Smythe, Yuille, 1968); subjects took significantly longer to discover imaginal mediators for pairs with abstract stimuli than for ones with concrete stimuli; mean latencies of image generation correlated significantly (-.47) with mean recall scores for the pairs (Yuille and Paivio, 1967; Paivio and Foth, 1970). Elaboration clearly relates to stimulus concreteness.

The second statement also has strong research support. Paivio reports that "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" (1971). In an effort to remediate deficiencies in the elaborative learning of low S.E.S. black children relative to white children, Rohwer and Ammon (1970) attempted to train subjects to mentally elaborate mixed-list PA's. They were forced to conclude that the method of presenting learning material (i.e. words versus pictures, etc.) "can have a more pronounced effect on learning efficiency in young children than the kind of training experience which they are given."

It is doubtful if another stimulus attribute will be found which has such a consistent strong effect on learning; the imaginal value of words not only influences the production of complex, elaborative strategies, but also the effectiveness with which those strategies eventually are used.

Implications

At the beginning of this chapter, we cited a recent paper by Rohwer which advocated a five pronged approach to basic research. Rohwer argues that after an important process or skill has been identified across tasks, and significant human and experimental variables have been carefully examined for their effect on skill performance, researchers must be prepared to generalize their findings to educational settings. However, Rohwer cautions that "the goal of the proposed strategy is not to establish a direct link from basic research to educational change. Instead, it is to use basic research to demonstrate the promise of particular changes so that relevant research can be done to directly evaluate their effects." Rohwer goes on to say that the ultimate aim has to be to assist students in mastering useful skills. Researchers can pinpoint when transition periods for certain skills occur so that formal instruction in the skill can be made most efficacious.

The research reported here helps to pinpoint the transition period for an important process - mental elaboration - which research shows underlies some I.Q./social class sources of variance in PA learning. Our research supports the contention that the years from 10 to 14 represent a "critical period" for the spontaneous production of elaboration in children. The fact that 70% of the Level II eighth graders report using elaborative strategies compared to 41% of the low level youngsters (see Table 15) is also a significant finding. This suggests that social class differences in school learning, which become increasingly apparent with age, may well be a function of this greater propensity by Level II youngsters to elaborate or transform input. However, the most significant finding which emerges from the results presented above is that the material to be learned plays a far more crucial role in strategy production and effectiveness than previously thought. Thus, Level II ability is related more to the production or availability of elaborative strategies than to their effective use during this transitional period. Strategy effectiveness is much more a function of the concreteness of the material which is to be acted upon.

This conclusion needs to be examined in light of some data recently presented by Rohwer (1972). Rohwer and his associates tried four different approaches aimed at getting high and low - S.E.S. children to memorize PAs. At one extreme, the teacher acted out a charade to establish connections between word sets, and at the other, the teacher merely asked the children to learn the word pairs. Rohwer found that elaboration could be triggered for the older, high - S.E.S. children by simple directions. Younger children, and low - S.E.S. children, however, needed more specific direction from the teacher before facilitative elaboration was elicited. Rohwer reports that there were certain age clusters when more prompting was necessary.

Generalizing this finding to our older samples, it appears that little elaborative prompting is necessary for the high I.Q. group. This group is more than ready to elaborate input; they simply need to work on making more effective the strategies they already possess. Perhaps some of the formal operational tasks described by Piaget would provide these subjects with the necessary practice in manipulating abstract input. A majority of the low - S.E.S. subjects, however, fail to produce high level strategies, even in this clearly defined learning - situation. This group might more readily profit from elaborative training per se.

If the aim of educators is to raise the mean achievement of all students and at the same time to lower the socially explosive correlation between achievement and ability (i.e. I.Q.) (see Anderson, 1967), then the data presented above suggests that we develop highly concrete and clearly defined curricula. Research here also supports the argument made by Rohwer and others that we withhold "formal" education until the child is cognitively able to handle it. Formal education is used in this sense to connote teaching and learning which relies mainly on abstract verbal descriptions of reality as opposed to actual physical encounters with reality. There is strong reason to believe that children who do not spontaneously elaborate verbal input will have considerable difficulty learning in abstract verbal educational environments. Given the developmental trend in mental elaboration, this may mean that lower-class-lower-I.Q. youngsters will begin such "formal" instruction a year or two behind their higher I.Q. age-mates.

Deriving meaning from the written and spoken word requires covert mental activity of the type examined in this dissertation. Our data indicates that there is much we as educators can do to facilitate this type of "self-instructional" activity in children, both through improved methods and less abstract, more image provoking materials.

In the article discussed in the first chapter, Richard Herrnstein, a Harvard psychologist, concluded that inherited intelligence will become the passport to success and achievement in the future. This conclusion is inconsistent with the facts presented here. The mental abilities, which our traditional passive-listening approach to education emphasize, are slowly becoming known. Once the mystique surrounding the I.Q. quotient is removed, the abilities underlying test performance turn out to be surprisingly few in number. Several laboratory studies, such as the one reported here, point the way toward improved instructional methods and materials, which will substantially reduce even the moderate correlation now existing between I.Q. and school achievement. This goal is important; if we as educators succeed in achieving this goal, the factors which determine an individual's station in life will be even less the prerogatives of inherited wealth or genetic substance, than his or her own inner drive and aspiration.

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APPENDICES

APPENDIX A

INSTRUCTIONS FOR

LEARNING TASKS

APPENDIX A

INSTRUCTIONS FOR LEARNING TASKS

APPENDIX A-1

DIGIT SPAN TASK

This is a test of your ability to remember numbers. You will hear a list of numbers. Listen carefully. When the numbers you are to remember are through you will hear a bell like this.......... Write the numbers down as quickly as possible. The numbers should be listed in the same order as I have read them.

Be sure not to start writing until you hear the bell. Here is the first list:

3-8-6

3-4-1-7

8-4-2-3-9

3-8-9-1-7-4

5-1-7-4-2-3-8

1-6-4-5-9-7-6-3

5-3-8-7-1-2-4-6-9

6-1-2

6-1-5-8

5-2-1-8-6

7-9-6-4-8-3

9-8-5-2-1-6-3

2-9-7-6-3-1-5-4

4-2-6-9-1-7-8-3-5

5-7-4

7-2-9-6

4-1-3-5-7

1-6-5-2-9-8

8-5-9-2-3-4-2

6-9-1-6-3-2-5-8

3-1-7-9-5-5-8-2-3

APPENDIX A-2

PAIRED ASSOCIATE TASK

The following is a very popular exercise in psychology called a paired-associate task. A paired-associate task is a task in which pairs of words are learned. You will hear some words like this WOODS---HAMMER

MATERIAL---CIRCUIT

You are asked to remember the words that go together. After hearing all of the word pairs, you will hear the list again - only this time you will hear the first word and you are asked to respond with the second word. Here is an example:

woods---hammer

moment---belief

material---circuit

After the whole list is presented, you will hear only the first word: woods---

moment---

material---

Don't be discouraged if you can't remember many words at first. You will hear the word pairs 3 times.

Here is the list:

APPENDIX B

PAIRED ASSOCIATE

LISTS

APPENDIX B

PAIRED ASSOCIATE LISTS

APPENDIX B-1

LIST I

stub-victim	stub-victim	emergency-pleasure
instance-answer	fun-leader	democracy-tendency
emergency-pleasure	garden-star	victory-interview
car-ocean	soul-belief	grief-material
alligator-cigar	alligator-cigar	fun-leader
victory-interview	instance-answer	hypothesis-truth
hypothesis-truth	piano-baby	garden-star
fun-leader	hammer-automobile	elephant-tree
democracy-tendency	hypothesis-truth	hammer-automobile
elephant-tree	idea-chance	stub-victim
soul-belief	grief-material	car-ocean
idea-chance	car-ocean	alligator-cigar
piano-baby	victory-interview	charm-disease
charm-disease	emergency-pleasure	idea-chance
fate-occasion	elephant-tree	piano-baby
grief-material	charm-disease	instance-answer
garden-star	fate-occasion	fate-occasion
hammer-automobile	democracy-tendency	soul-belief

APPENDIX B-2

LIST II

policeman-fire	anger-belongings	happiness-convention
happiness-convention	core-link	robbery-master
advantage-origin	comedy-season	core-link
horse-kiss	situation-fact	advantage-origin
odor-death	apple-orchestra	revolver-mountain
situation-fact	theory-moment	coffee-woman
theory-moment	coffee-woman	anger-belongings
strawberry-blood	robbery-master	odor-death
comedy-season	advantage-origin	method-concept
method-concept	policeman-fire	hint-excuse
coffee-woman	hint-excuse	horse-kiss
anger-belongings	happiness-convention	apple-orchestra
revolver-mountain	horse-kiss	theory-moment
amount-thought	amount-thought	situation-fact
apple-orchestra	strawberry-blood	amount-thought
core-link	method-concept	policeman-fire
robbery-master	odor-death	strawberry-blood
hint-excuse	revolver-mountain	comedy-season

APPENDIX C

DIGIT SPAN AND I.Q.
TEST SCORES FOR SUBJECTS
BY S.E.S. AND SEX

APPENDIX C

DIGIT SPAN AND I.Q. TEST SCORES FOR SUBJECTS BY S.E.S. AND SEX

DIGIT SPAN AND I.Q. TEST SCORES

LOW S.E.S. FEMALES

	I.Q.	D.S.		I.Q.	D.S.
1.	95	66	16.	102	68
2.	97	77	17.	85	56
3.	92	77	18.	107	101
4.	91	73	19.	97	79
5.	99	71	20.	--	92
6.	104	100	21.	100	80
7.	86	56	22.	105	79
8.	87	73	23.	119	78
9.	103	65	24.	75	43
10.	--	70	25.	117	88
11.	96	95	26.	--	50
12.	107	81	27.	109	83
13.	90	68	28.	117	108
14.	97	89	29.	90	98
15.	103	71			

LOW S.E.S. MALES

	I.Q.	D.S.		I.Q.	D.S.
1.	95	66	16.	87	83
2.	100	83	17.	108	90
3.	90	71	18.	100	70
4.	91	71	19.	106	77
5.	87	71	20.	84	93
6.	93	108	21.	86	50
7.	125	102	22.	107	69
8.	100	78	23.	133	95
9.	88	73	24.	96	55
10.	100	75	25.	--	70
11.	93	76	26.	72	52
12.	--	99	27.	111	67
13.	94	77	28.	79	65
14.	--	77	29.	103	96
15.	102	93	30.	90	78

HIGH S.E.S. FEMALES

	I.Q.	D.S.		I.Q.	D.S.
1.	120	62	16.	136	77
2.	96	82	17.	101	73
3.	99	87	18.	122	88
4.	104	95	19.	107	82
5.	112	47	20.	109	92
6.	100	85	21.	105	109
7.	109	58	22.	103	100
8.	109	92	23.	122	99
9.	110	80	24.	109	118
10.	111	89	25.	127	100
11.	116	97	26.	109	108
12.	108	90	27.	97	113
13.	123	90	28.	113	111
14.	100	79	29.	125	110
15.	94	85			

HIGH S.E.S. MALES

	I.Q.	D.S.		I.Q.	D.S.
1.	126	82	12.	113	87
2.	109	63	13.	109	95
3.	100	100	14.	112	69
4.	-	99	15.	94	97
5.	119	103	16.	117	85
6.	106	97	17.	-	96
7.	99	83	18.	105	98
8.	-	79	19.	-	84
9.	104	81	20.	113	109
10.	102	62	21.	88	79
11.	104	81			

APPENDIX D

SUBJECT PROTOCOLS

APPENDIX D

SUBJECT PROTOCOLS

LOW S.E.S. MALES

IMAGERY

Some just came up to me; like alligator and cigar. Some words I'm used to. Piano and baby.

I thought of a car going into the ocean.

Animals and cigars are easier to remember; the order of the words makes a difference.

Some stuck with me more than others; I remembered the ones I missed each time. Mother and coffee came to mind because my mother drinks coffee in the morning.

Some words just get in my mind - horse-kiss, apple-orchestra - and they sound funny; policeman and fire go together.

A woman serving coffee, a horse kissing, helped me remember.

Then I tried pairing them up; some just came to my head.

LOW S.E.S. FEMALES

IMAGERY

I thought of a comparison. For garden, I thought of things being rounded (star).

I took a picture - like an alligator with a cigar in its mouth.

I thought of the outside and tried to place it (word) in a scene - like I thought of an alligator and put a cigar somewhere in there.

I remembered a baby playing a piano.

Low S.E.S. Female Imagery continued

Some were just wierd - like horse and kiss, strawberry and blood, woman and coffee.

I remembered horse and kiss; they are funny together; policeman and fire seem to go together. I tried to make them have a connection; some relate together.

LOW S.E.S. MALES

VERBAL ASSOCIATION

For stub-victim, I thought of a victim just robbed (stub of a gun?).

Soul-belief go together.

I picked the easiest ones each time. Some words - like policeman-fire go together. Strawberry and blood, too, because of the color.

I just remembered. Policeman and fire go together; shorter words were easier too.

Some just went together- red and strawberry, policeman and fire.

Strawberries and blood are red.

I tried to remember; strawberries are red; situations and facts are related. I thought of a woman serving coffee.

Coffee - woman go together and strawberry - blood do too.

VERBAL ELABORATION

Some words went together; for hammer and auto, I said, "if fixing, you need a hammer."

I made up a sentence: "The comedy is in season;" "the policeman came to the fire."

I said, "Fire a gun" to relate policeman and fire.

LOW S.E.S. FEMALES

VERBAL ASSOCIATION

Charm and disease - charm is the opposite of disease.

For piano, I thought "baby piano"; soul and belief seem related.

Soul and belief are both religious things.

"Baby piano" was easy to remember.

Charm and disease are just the opposite.

Some were odd sounding together - piano with baby(?).

I thought of baby piano; for stub-victim I thought of stab victim.

I tried to relate the words - strawberry-blood, both are red; also policeman and fire are related.

Some go together - both are food; policemen and fire go together.

Coffee and woman go together; some had something to do with each other.

I would say the words that go together and that are related.

VERBAL ELABORATION

I think of something to go along with it - "Fate would be a bad occasion."

For idea-chance, I said, "the chance to bring out ideas."

I said, "I have a tendency to forget democracy."

LOW S.E.S. MALES

ROTE

I remembered; I say it over and over. I just said the last word.

I just kept repeating.

I remembered the ones I didn't each time.

I memorized a couple each time. The simpler words - like piano and baby - can be memorized easier.

I just said it again and again.

I memorized the last word at the beginning - then I memorized each word with the other word. Some I heard more often.

I remembered them over and over again; the way they sounded made some easier.

I remembered them in order, the last words; small words were easier to learn (horse, kiss, fire).

I tried to remember the word after it; some were just easier words.

I repeated the same one.

First I tried listening; then I tried to remember belongings, link, in order.

LOW S.E.S. FEMALES

ROTE

I just tried to remember, I listened.

I just kept repeating.

I memorized them.

Low S.E.S. Females - Rote cont.

I tried to memorize the last word.

I tried to remember - I went down the list.

I said it with word, repeated; some words were more common to me.

I just kept listening to them; I don't know.

I just remembered and it got easier.

I would hear them over and over.

HIGH S.E.S. MALES

IMAGERY

Some I could just remember; alligator-cigar is one.

Some sounded wierd - piano, tree; for car-ocean I thought of driving by the ocean.

I tried picturing it in my mind - an alligator smoking a cigar; a baby playing the piano; gardeners looking at a star.

I couldn't bring democracy to mind.

Policeman and fire go together from what I've seen; for woman-coffee, you know, my ma drinks coffee; strawberries and blood are red; the ones you've heard before are easier.

Words like strawberry-blood, horse-kiss, I could get them in mind; some were stupid and some didn't correspond.

The words that sounded funny - horse-kiss; that sounds dumb, you kiss a horse, or shoot a mountain(?).

Some are so stupid - horse and kiss; strawberry and blood - the color is the same.

Coffee and woman goes together - my mom always drinks coffee; strawberry and blood are red.

HIGH S.E.S. FEMALES

IMAGERY

Some were just queer, like alligator-cigar.

Some just came better.

Some matched, they were in the same area or similar ideas.

Some were just wierd.

I thought of someone robbing. I thought of someone robbing a

High S.E.S. Females - Imagery cont.

store owned by a master.

I thought of someone shooting a mountain with a revolver.

I thought of the color; horse and kiss were opposites.

Some are objects; I just made an association.

You just put them together - like you kiss a horse.

Some are related - like colors; I thought of men playing violins inside a huge apple.

HIGH S.E.S. MALES

VERBAL ASSOCIATION

For alligator-cigar, I have a cousin who went to the Everglades and smokes cigars.

I tried to think of a match with some phrase; the easier ones had odd things to match them with.

"Soul-belief" is a phrase.

I thought of green for grief, and "green material"; cigars come from Florida and so do alligators; short, common words that don't have anything to do with each other were better to learn.

I tried to find some meaning of how they related.

Soul-belief, baby-piano were everyday words.

Easier ones had something to do with each other.

I tried to connect the words, like fate-disease, fatal disease.

Some had a better connection than other ones.

Policeman and fireman are both on defense but they kinda clash too; strawberry and blood are red.

I associated strawberry and red with blood; policeman and fire, too; horse-kiss, advantage-origin I just remembered.

Strawberry and blood are red.

Some I tried harder on; some were ridiculous.

Strawberries and blood are red; policemen and firemen are the same.

Well, policemen and firemen work together.

Strawberry-blood go together.

HIGH S.E.S. MALES

VERBAL ELABORATION

I thought "a baby plays a piano."

I thought "a soul to heaven."

I said, "Elephants eat trees."

I remembered some because they were stupid - like there's a joke about an "elephant up a tree."

I thought about a "tendency for democracy."

I tried to make a phrase "You're a victim of an accident with stubbed toe."

I said, "Car went into ocean."

I tried to match them by making sentences: I said, "Comedy is in a certain season."

I related excuse and hint by "you hint at an excuse."

I said, "Women drink coffee breaks"; "Policeman goes to fire"; "Robbing a master, you know in Spain."

HIGH S.E.S. FEMALES

VERBAL ASSOCIATION

Baby and piano go together.

I thought of a car and a boat, and a boat and the ocean.

Soul-belief are, like associated - you know, I believe in a soul; charm and disease - they're opposites.

Strawberries are red and so is blood; I said "Seasonal comedy"; apple reminded me of orange - orange sounds like orchestra.

Season and comedy seem to go together.

I tried to relate them; strawberry and red go together but revolver and mountain are so different.

Strawberry and red go together; policeman and fireman do, and so does concept and method.

Some were related, like strawberry and blood - the color.

VERBAL ELABORATION

I made an association - like I said, "The car drove into the ocean."

I thought of "Hammer the car."

I thought you're "Happy at a convention."

I said, "Happiness is a convention"; "It would be terrible to have blood on your strawberry."

HIGH S.E.S. MALES

ROTE

I tried to memorize.

I tried to remember the first word; like soul-belief, I just repeated each one.

I memorized some.

I repeated last words in order.

I just remembered some. I tried the first words at first.

I repeat them in my mind.

I tried to think down the line, comedy, convention, etc.

HIGH S.E.S. FEMALES

ROTE

I said them over and over.

Each time I was thinking of <u>those</u> words (ones remembered before).

I just kept repeating.

I said them back and forth.

I heard them again.

I tried to remember the first ones.

I repeated them ever and over.

HIGH S.E.S. MALES

MNEMONIC

The first letters were b - c.

Some sounded alike.

I tried to rhyme.

If they sounded alike they were easier.

HIGH S.E.S. FEMALES

MNEMONIC

The endings were sometimes the same - like tendency-democracy.

Some were associated, they sounded different or the same.

Alligator didn't sound like the rest.

Apple reminded me of orange, orange sounds like orchestra.

For core-link I remembered Lancelot Linc and his girl friend Cora.