

SYNTACTICAL MEDIATION OF SERIAL AND PAIRED-ASSOCIATE LEARNING AS A FUNCTION OF AGE

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Groups of 20 Ss at each of seven age levels from 5 to 17 years of age, matched on IQ and socioeconomic background, were compared on serial and paired-associate (PA) learning. Half the Ss learned under instructions to use syntactical verbal mediators, and half had no mediation instructions. The results showed that PA and serial learning interact differently with age and with mediation instructions. Speed of serial learning was little affected by mediation and beyond the age of eight was scarcely correlated with age under either condition of instructions. PA learning, on the other hand, was markedly facilitated by mediation instructions, particularly in the age range from 7 to 13, and PA learning ability was strikingly correlated with age when Ss were given no mediation instructions.

How different would our conceptions of the learning process be if, instead of always using college sophomores in our experiments on rote learning, we replicated our procedures in various regions throughout the entire feasible range of IQ and mental and chronological ages? We have been trying this, with interesting results.

Theories of rote learning have been based almost exclusively on the results of investigations using college students as Ss. As a consequence, it has been relatively easy and fruitful to study the effects of certain independent variables on learning, such as distribution of practice, the length-difficulty relationship, the effects of interpolated learning on retention, and so on. But it has been difficult—in fact, it hardly occurred to anyone until recent years—to study the effects on laboratory learning of the S's pre-

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experimental experiences or, in more general terms, to study the interactions between subject variables and experimental variables.

A developmental approach to basic problems in the experimental psychology of learning is one way to overcome this narrowness of the data upon which our theories and models are constructed and tested.

Traditionally, serial and paired-associate (PA) learning—the two most widely used methods in the field of rote learning—have been regarded as practically equivalent and accountable in terms of the same independent variables and theoretical formulations. They have also been more or less interchangeable as methods of investigating the basic processes of verbal learning. It was not until we began to use institutionalized, mentally deficient Ss in our learning experiments (Jensen & Rohwer, 1963a, 1963b) that we began to appreciate the differences between PA and serial learning and the inadequacy of our conceptions of what goes on in these two forms of learning as they are represented in the literature on rote learning.

The present study stems from our experiments with retarded Ss (Jensen & Rohwer, 1963b), in which it was found that (1) serial learning is relatively much easier for retardates than PA learning, and (2) that PA learning could be markedly facilitated by giving retarded Ss appropriate verbal mediators, while serial learning showed no facilitation under similar conditions. This led to the hypothesis that PA and serial learning differ in the degree to which they depend upon transfer from previous verbal learning—the amount and availability of relevant verbal associations, including the S's tendency to verbalize spontaneously concerning the task set before him. The syntactical properties of the language are also known to be capable of mediating or facilitating the acquisition of new associations (Rohwer, 1964; Davidson, 1965) and, therefore, the degree of the S's mastery of this aspect of language should show up more in PA learning ability than in serial learning. In short, we hypothesize that PA learning ability reflects relatively more the richness of the S's past verbal experience and its spontaneous availability in a new learning situation, while serial learning constitutes a more fundamental kind of ability which is relatively unaffected by the amount of previous verbal experience.

If this view of the difference between these two forms of learning is essentially correct, we should expect serial and PA learning to interact differently with the age of the learners. Thus, with increasing age, from early childhood to late adolescence, we should expect there to be an increase in Ss' verbal experience and in the strength of their tendency to verbalize in learning and problem-solving situations. Consequently, there should be improvement in PA learning with increasing age over this range. Furthermore, if the improvement in learning with increasing age is due to the increasing spontaneous use of verbal mediation, then instructing Ss to make up appropriate mediators should markedly facilitate the learning of

the younger Ss but should have relatively little effect on the learning of older Ss, who are presumed to spontaneously mediate, so that instructing them to do so should make little difference. In serial learning, on the other hand, we should expect negligible age differences and no appreciable effect of instructing Ss to use verbal mediation.

If this prediction is borne out, assuming that serial learning reflects basic learning ability rather than transfer from prior verbal experience, it would seem to imply that basic learning ability does not change over the age range under investigation. The apparent superiority of older children in many forms of learning would be interpreted as being due to greater transfer from prior learning and not to any fundamental increase in the ability to learn.

METHOD

Design

The design was a four-way factorial with repeated measures on one factor (tasks). The independent variables were: (1) age or grade level (kindergarten and grades 2, 4, 6, 8, 10, 12, corresponding roughly to ages 5, 7, 11, 13, 15, 17), (2) verbalization (sentence versus naming), (3) tasks (serial versus paired-associate), and (4) order of performing tasks (serial first versus paired-associate first).

Subjects

The Ss in kindergarten through grade 6 were selected from one elementary school which is attended almost exclusively by children from middle and upper-middle socioeconomic status. The samples of grades 8–12 were selected from junior and senior high schools in the same locality. In order to keep the samples as homogeneous as possible with respect to background factors throughout the entire age range, only those Ss in grades 8–12 were selected who had formerly come through the same elementary school from which the younger Ss were drawn. Furthermore, the 20 Ss at each grade level were so selected as to equate the groups in IQ as measured by the California Test of Mental Maturity. None of the sample means, therefore, differed more than two or three IQ points from the over-all mean of 119. The mean ages in years at each of the grade levels were: 5.4, 7.8, 9.4, 11.7, 13.1, 15.4, and 17.6; the corresponding SD's are: 0.25, 0.38, 0.31, 0.38, 0.34, 0.35, and 0.32. Ss within each grade level were randomly assigned to the four experimental conditions.

Learning Tasks

Each S was given both serial and PA tasks; the order of administra-

CHILD DEVELOPMENT

tion was counterbalanced. The materials of both tasks consisted of 30 colored pictures of common objects, taken from a preprimer workbook. Each picture was mounted on a heavy cardboard 3 inches square. The PA list consisted of 10 pairs of pictures; the remaining 10 pictures comprised the serial list. The PA's were chosen so as to minimize pre-experimental associations. The same materials were used for all age levels. It should be pointed out that these materials were used in previous studies, and it has been found that the response terms of the PA list when learned simply as a serial list were equivalent in difficulty to the set of pictures used as the serial list in the present study. It seems safe to say that the materials or content of both the serial and PA lists are quite equivalent with respect to factors affecting learning difficulty.

Procedure

The procedures were the same at all age levels. Because of the difficulty young children seem to have in performing in accord with an experimenter-paced rate, all groups were allowed self-paced performance. Therefore, total learning time was recorded in seconds from the beginning of the study trial. In all cases Ss continued in the task until they attained a criterion of mastery (one errorless trial) or had completed 15 trials, whichever occurred first.

In the *naming* condition of PA learning, the two pictures in each pair were shown simultaneously, and S was asked to name them. On subsequent trials the usual anticipation method of PA learning was followed. In the *sentence* condition, S was asked to construct a sentence containing the names of the two pictures in each pair as the pairs were presented one at a time in the study trial. The study trial was S-paced, each S taking as much time as needed to form a sentence. Following the study trial the procedure was the same as for the naming condition. The sentences were not repeated after the first trial. In the study trial care was taken to display the pictures for as much time in the naming condition as in the sentence condition. Ss anticipated the response terms on every trial after the first and were encouraged to guess if they were not sure of the correct response.

The procedures in *serial* learning were similar. In the *naming* condition, Ss merely named each picture as it was presented on the study trial and anticipated each picture on subsequent trials. In the *sentence* condition Ss were asked to make up sentences containing the names of each successive pair of pictures in the serial list. That is, successive pairs of items in the serial list were tied together in sentences in the same fashion as in the PA condition. In no case did the *E* provide the sentences.

RESULTS

Two measures of learning were analyzed: number of trials to criterion

(with a limit of 15 trials) and total time in seconds. Since the analysis of variance for both measures revealed no significant main effect or interactions for the order factor, it was eliminated from the subsequent analyses.

The results are presented in Figures 1 and 2. The picture is very much the same for both measures of learning, and the results of the analysis of variance of these two sets of measures are practically identical. The analysis

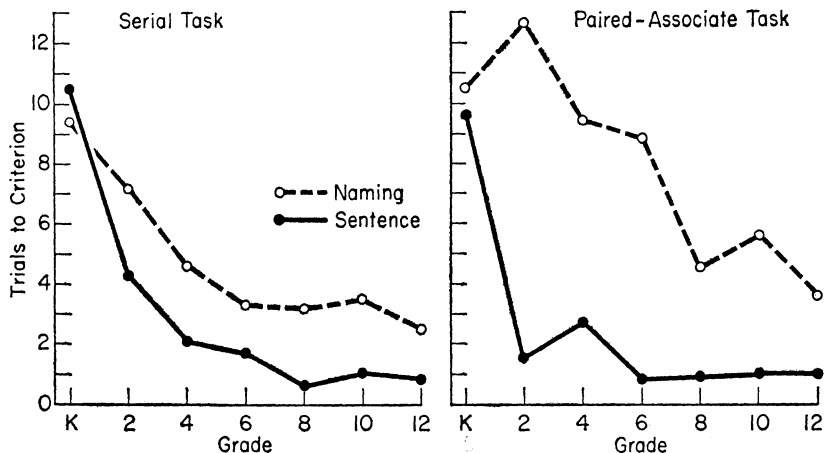


FIG. 1.—Mean number of trials to learn a 10-item list (serial or PA) to a criterion of mastery. The grades from kindergarten (K) to 12th correspond approximately to ages 5, 7, 9, 11, 13, 15, 17, respectively.

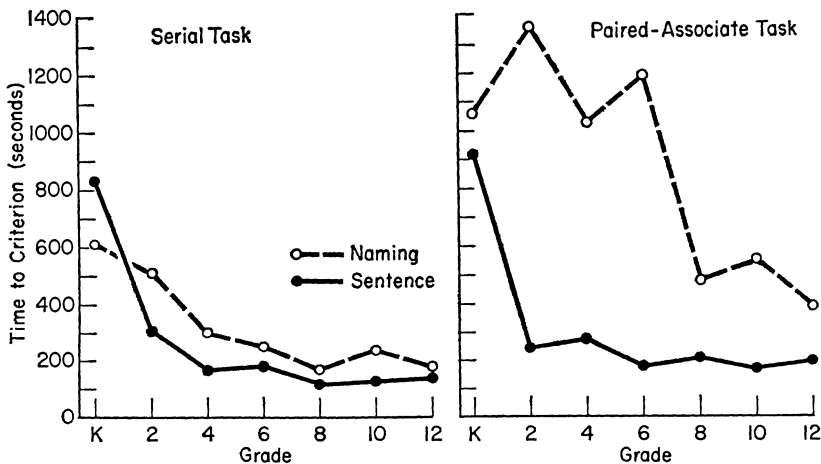


FIG. 2.—Mean total time to learn a 10-item list (serial or PA) to a criterion of mastery.

CHILD DEVELOPMENT

may be summarized as follows: (1) the main effects for ages, tasks, and verbalization condition are all significant beyond the .001 level; (2) the interactions of ages \times verbalization and of verbalization \times tasks are significant beyond the .001 level; and (3) the three-way interaction of ages \times verbalization \times tasks was significant beyond the .01 level. None of the remaining effects was significant even at the .05 level.

Tukey's method (see Scheffé, 1960, p. 417) was used to test the specific differences within each of the significant effects in the analysis of variance. This closer examination of the results revealed that the use of sentences produced significant facilitation only in the case of PA learning, where the mean for the naming condition was significantly ($p < .01$) greater than for the sentence condition. The corresponding means in serial learning did not differ significantly. Furthermore, the amount of facilitation produced in PA learning varied with age level. The differences between the naming and sentence conditions for ages 7, 9, and 11 were significant beyond the 0.01 level, and for age 15 the difference was significant beyond the 0.05 level. For ages 5, 13, and 17, however, the differences were non-significant.

DISCUSSION

It is apparent from these results that sentential verbal mediation has a much greater facilitating effect on PA than on serial learning, in which the effect is practically nil. This finding is entirely consistent with the results of a previous study which compared the performance on serial and PA learning by mentally retarded adults under mediation and nonmediation conditions (Jensen & Rohwer, 1963b) and also with another study which made the same comparisons among retarded adults and normal children of the same mental age (Jensen, 1965).

The fact that in serial learning six out of seven of the means shown in Figures 1 and 2 are higher for the sentence than for the naming condition might suggest that despite the lack of statistical significance of these differences as determined by the analysis of variance, some true, though slight, superiority of the sentence condition might exist in serial learning as well as in PA learning. If a true difference between the sentence and naming conditions in serial learning were found to exist, we would be inclined to interpret the difference as being attributable to facilitation of *response* learning rather than to facilitation of serial learning per se. This interpretation would, of course, have to be tested in another experiment in which one group would be given pretraining on the responses to a criterion of perfect free recall. Then, we would predict, the mediation instructions (i.e., sentence condition) would produce no facilitation of serial learning whatsoever.

Of further interest is the fact that instructions to use mediators tends

to wipe out age differences in speed of learning from about eight years of age and above. A reasonable interpretation of the steep age gradient in PA learning under the nonmediation instructions is that with increasing age, and consequently with the increasing store of past verbal experience, there is a corresponding increase in the proportion of Ss who spontaneously use mediators in PA learning as well as an increase in the availability and effectiveness of relevant verbal mediators. By high-school age, at least among generally bright Ss, as those in this study were, the instructions to use mediators has relatively little facilitative effect. The fact that there is any difference at all between the naming and sentence conditions at age 17 does suggest, however, that instructions to mediate gets Ss to mediate earlier in the process than they tend to do spontaneously. The mediation instructions result in virtually one-trial learning of the whole list.

It should be noted that using a single learning task which can be mastered in a reasonable amount of time by even the youngest Ss but which can still present some challenge to the oldest Ss will almost inevitably involve some "ceiling" or "basement" effect. Thus there is, of course, the possibility that with a much more difficult learning task the mediation instructions would produce greater evidence of facilitation at the higher age levels.

The naming or nonmediation condition, however, does not seem to be subject to this disadvantageous "ceiling" effect in the present study, for there is still, obviously, plenty of room for improvement in performance, as indicated by the superior performance under the sentence condition. This fact makes it interesting and worthwhile to compare serial and PA learning as a function of age under the normal conditions of rote learning (i.e., the naming condition). As can be seen in Figures 1 and 2, the age gradient for serial learning is quite shallow and is almost nonexistent beyond the fourth grade (age 9). On the other hand, the gradient for PA learning is very steep. Our interpretation of this finding is that PA learning benefits much more than serial learning from transfer from past verbal experience. The S's verbal experience enriches his "associative network" and increases the availability of relevant verbal mediators, which are already known to play a prominent role in PA learning (Underwood & Schulz, 1960). Serial learning, on the other hand, seems to be a somewhat more "primitive" form of learning and depends little, if at all, on mediating associations. It is also interesting to note that other studies have generally shown that serial-learning performance is more highly correlated with IQ than with MA, while just the reverse holds true for PA learning (Lipman, 1963, pp. 392-401; Jensen, 1965). The basic difference between the processes involved in PA and serial learning are further highlighted by the very low correlations between individual differences in ability in the two forms of learning, at least among Ss within the normal range of intelligence (Jensen, 1962). The nature of serial learning is presently far from

CHILD DEVELOPMENT

being clearly understood; it is quite certain that Ss do not learn a serial list as if it were composed of a chain of paired associates, and it is doubtful if what the S learns is the association of each item with its ordinal position. These theoretical issues have been discussed in detail elsewhere (Jensen & Rohwer, 1965).

One other feature found in both Figures 1 and 2 that deserves comment is the conspicuously negligible facilitation of PA learning in the kindergarten (5-year-old) group; the instructions to combine the pairs in sentences seem to yield no appreciable benefit. The explanation is suggested by the E's observation that although children in this group are able to utter sentences in their ordinary conversation, many of them seemed unable to construct sentences on call, as it were. When confronted with the task of making up a sentence containing the names of two pictures, many of the kindergarten Ss connected the two nouns only by the conjunction *and*, as in "the cow *and* the ball." This hypothesis was formally tested in subsequent studies by Rohwer (1964) and Davidson (1965), and it was found that, in fact, mere conjunctions do not produce a significant facilitation effect, while prepositions and especially verbs are capable of producing marked facilitation. In the present study no formal record was made of the mediators actually used at the various age levels.

REFERENCES

- Davidson, R. E. Mediation and ability in paired-associate learning. *J. educ. Psychol.*, 1965, in press.
- Jensen, A. R. Transfer between paired-associate and serial learning. *J. verb. Learn. verb. Behav.*, 1962, 1, 269-80.
- Jensen, A. R. Rote learning in retarded adults and normal children. *Amer. J. ment. Def.*, 1965, 69, 828-834.
- Jensen, A. R., & Rohwer, W. D., Jr. The effect of verbal mediation on the learning and retention of paired-associates by retarded adults. *Amer. J. ment. Def.*, 1963, 68, 80-84. (a)
- Jensen, A. R., & Rohwer, W. D., Jr. Verbal mediation in paired-associate and serial learning. *J. verb. Learn. verb. Behav.*, 1963, 1, 346-52. (b)
- Jensen, A. R., & Rohwer, W. D., Jr. What is learned in serial learning? *J. verb. Learn. verb. Behav.*, 1965, in press.
- Lipman, R. S. Learning: verbal, perceptual-motor, and classical conditioning. In N. R. Ellis (Ed.), *Handbook of mental deficiency*. New York: McGraw-Hill, 1963, Pp. 391-423.
- Rohwer, W. D., Jr. The verbal facilitation of paired-associate learning. Unpublished doctoral dissertation, Univer. of California, 1964.
- Scheffé, H. *The analysis of variance*. New York: Wiley, 1960.
- Underwood, B. J., & Schulz, R. W. *Meaningfulness and verbal learning*. Philadelphia: Lippincott, 1960.