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AUTHOR Feldman, David H.; Johnson, Lee Ellen
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ABSTRACT

To study the effects of task and sample variation upon paired-associates (PA) performance, six third-grade and six sixth-grade classes in two urban schools were tested on two PA tasks, one pairing pictures of familiar objects (PA-CF), the other pairing nonsense syllables with Japanese "kanji" (PA-K). Hypotheses tested were: (1) Mean level of performance is higher for PA-CF than for PA-K; (2) There is an SES-related difference in performance on PA-K but not on PA-CF; (3) PA-K is more highly correlated with school achievement than is PA-CF; (4) The variance shared by PA-K and school achievement is independent of variance shared by the two PA tasks. Results provided general support for the hypotheses, but some inconsistent results are discussed. (Author)

CORRELATION OF PAIRED-ASSOCIATE PERFORMANCE WITH SCHOOL ACHIEVEMENT AS A FUNCTION OF TASK AND SAMPLE VARIATION

David H. Feldman Lee Ellen Johnson

University of Minnesota

Paired-associates (PA) has been an important technique in the psychology laboratory for several decades; exhaustive discussions of experimental results have been provided by Underwood and Schultz (1960) and Goss and Nodine (1965). More recently, PA learning has taken on increased notoriety and controversy in educational research and theory, especially as it pertains to ethnic and social class differences in learning ability (Jensen, 1969; Rohwer, 1968, 1969; Stevenson, 1969) and in the relationship of laboratory learning to IQ and school achievement (Rohwer, 1969; Stevenson, Hale, Klein, & MIller, 1968). A good measure of the controversy centers around arguments over the processes involved in PA learning and their possible educational significance.

Jensen (1969), for example, has argued that PA learning tends to be a relatively simple, nonmediated, "level 1" task while Rohwer (1969), on the basis of his research, contended that successful PA performance often elicits highly imaginative conceptual activity called mental elaboration. Rohwer (1969) found that performance deficits on PA tasks among disadvantaged children could be remediated through training in the use of mental elaboration skills; he argued that the same skills that improved PA performance may also reduce differences in levels of school achievement between advantaged and disadvantaged children. Empirical support for the inference that PA learning is

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related to school achievement is to be found, according to Rohwer (1969), in studies by Stevenson, et al. (1968): "It has been shown empirically that performance on paired-associates tasks relates substantially with performance on tests of school achievement in heterogeneous populations of children [p. 7]." Rohwer's argument may be summarized as follows: Since mental elaboration skills improve PA learning, and since PA performance is correlated with school achievement, elaboration training should help eliminate differences in levels of school achievement between advantaged and disadvantaged children in the same way that it reduced differences in PA performance levels.

Feldman (1969), reviewing studies by Rohwer and by Stevenson et al., suggested that Rohwer may have been unjustified in speculation based on Stevenson's findings. The abstract nature of the PA tasks used by Stevenson et al. (as contrasted with Rohwer's concrete tasks) could account for their relatively high correlations with school achievement and IQ. Concreteness, meaningfulness and familiarity of the stimuli have been shown to affect level of PA performance (Klein, Hale, Miller & Stevenson, 1967; Paivio & Yuille, 1966; and Cieutat, Stockwell, & Noble, 1958); it is possible that they also affect PA performance qualitatively. At the same time, since the sample used by Rohwer differed in age, SES and ethnicity from Rohwer's sample, and since these characteristics have been shown to relate to many learning and achievement variables, the relationship of characteristics of the sample to correlations between PA performance and school achievement should be clarified before general process variables can be said to underly performance.

Stevenson tested white third- through seventh-grade subjects from schools in middle-class areas on PA tasks which paired nonsense syllables (e.g., TOR) with familiar abstract words (e.g., HEALTH). They found correlations of .39 to .61 between the PA performance and three composite scores (Language, Arithmetic and Work Study) from the Iowa Tests of Basic Skills (ITBS). Stevenson, et al. (1968) also tested seventh-grade subjects on two PA tasks, one pairing nonsense syllables with familiar abstract words and the other pairing nonsense syllables with abstract forms (Japanese kanji characters, e.g., 口). They obtained correlations of .33 to .74 between the PA tasks and school grades in English, social studies, science and math and correlations of .29 to .61 between the two PA tasks and ITBS scores.

The purpose of the present study was not to question the argument that mental elaboration skills underly successful PA performance; the purpose was to question the variables underlying the empirical evidence upon which Rohwer's educational speculations were based, i.e., the variables accounting for the significant correlations between PA performance and school achievement cited in Rohwer (1969) and reported in Stevenson et al. (1968). The present study controlled some of the procedural differences found in the Rohwer and Stevenson et al. PA studies and investigated specific task and sample differences hypothesized to affect the relationship between PA performance and school achievement.

Hypotheses

It was the general hypothesis of this study that specific task and sample characteristics account for the covariance between PA performance and school achievement reported in Stevenson et al. (1968),

and that these characteristics are in general independent of the variance shared by PA tasks such as those used by Stevenson and by Rohwer. Two PA tasks--one using abstract and the other using concrete stimuli-were presented by the same method as that used by Stevenson et al. (1968). By varying the grade level and social class of the subjects, and by using both familiar (concrete) and unfamiliar (abstract) types of material for the PA pairs, the experimenters were able to examine the contributions of task and sample differences (similar to those found in the Rohwer and the Stevenson studies) to correlations between PA performance and school achievement. Since Rohwer's argument for the educational importance of PA learning is based on the relationship of PA performance to school achievement reported in Stevenson et al. (1968), his contention that mental elaboration skills (as suggested by Rohwer to explain his own findings) underly this relationship is weakened to the extent that the main hypothesis of the present study is supported.

Specific hypotheses tested were (i) Mean level of performance is higher for the PA task pairing pictures of familiar objects (PA-CF) than for the PA task pairing nonsense syllables with kanji figures (PA-K); (ii) Mean level of performance on both tasks is higher for sixth-grade subjects than for third-grade subjects; (iii) There is an SES-related difference in performance on PA-K but not on PA-CF such that (a) mean level of performance is higher for higher SES subjects than for lower SES subjects on the PA-K tasks, but all SES groups perform equally well on PA-CF, and (b) PA-K is more highly correlated with SES than is PA-CF; (iv) PA-K is more highly correlated with school achievement than is PA-CF; and (v) the variance shared by PA-K and school achievement is independent of the variance shared by the two PA tasks.

Method

Subjects

Subjects were students from two elementary schools in St. Paul, one in an upper-middle-SES area and one in a lower-SES area. Subjects from the upper-middle-SES school included 37 boys and 28 girls from three third-grade classes and 35 boys and 37 girls from three sixth-grade classes. Subjects from the lower-SES school included 24 boys and 23 girls from three third-grade classes and 29 boys and 26 girls from three sixth-grade classes. Both school populations were predominantly white; only white subjects were included in the analysis.

Materials

Film. Two paired-associate tasks were used in this study, each consisting of six stimulus-response pairs; the tasks were presented on a 16 mm. sound film. For the first task, both stimulus and response items consisted of line drawings of familiar objects, such as a chair, balloon, etc. The second task was designed to be as similar as possible to Stevenson et al.'s (1968) Abstract Forms task; all stimulus elements were nonsense syllables chosen from Archer's (1960) CVC trigrams (e.g., TOR) with association value ratings between 83 and 85 percent (no two trigrams had the same initial consonant; each vowel was used once and "0" was used twice); response elements were Japanese kanji characters containing four or five strokes in different configurations.

Booklet. The booklet in which the subjects responded contained six pages, with pages 1-3 depicting the pictures for the first task and pages 4-6 depicting the trigrams and kanji figures for the second task. On each page the stimulus elements were arranged in a column

on the left side of the page and all six response elements appeared in a row to the right of each stimulus element. The stimulus elements were presented in different orders on each page (and never in the same order as they were presented on the film), while the response elements were arranged in the same order in each row.

Procedure

The experimenter presented the film to intact classrooms (except for absences) in the morning on Tuesdays or Thursdays. There was a general introduction by the announcer (a professional radio announcer hired for the film), who said, "We want to see how well you can remember things that go together." The announcer indicated what the subjects would see, that "the same pictures always go together", and that they would see "each picture and the one that goes with it." Subjects were told to "watch carefully and try to remember which ones go together."

The first stimulus element appeared for three seconds on the left side of the screen; then the stimulus and response elements were presented together for three seconds, the response element appearing on the right side of the screen. The five succeeding pairs were presented in the same manner with a two-second interval separating all pairs.

After the sixth pair had been presented, the first page of the booklet was shown on the screen and the announcer's voice told the subjects to open their booklets to the first page. The announcer indicated how the pictures were arranged and that the subjects were to circle the one picture in each row that went with each picture on the left, starting with the one at the top and going down the list. Subjects were told to guess if they weren't sure. The projector was turned

off while the subjects were responding. The experimenter told them to close their booklets when they were finished with the first page. When all subjects had completed their responses, the experimenter indicated that they would see the same pairs again. The six pairs were then repeated in a different order. The projector was turned off and the subjects were told to open their booklets to page 2 and to circle the one picture in each row that went with the picture on the left. This procedure was repeated for one additional showing of the pairs.

After the subjects had completed their responses on page 3 of the booklet, the announcer appeared on the screen and told the subjects that now he would show them another list, saying, "This time it will be a made-up word that goes with a picture." The six pairs of the second task were shown, then page 4 of the booklet appeared on the screen, and the announcer's voice described how the subjects were to respond. The six pairs were presented two more times, as with the first task, and the subjects completed pages 5 and 6 of the booklet. The pairs were presented in a different order each time. Subjects were closely monitored to prevent them from referring to answers on previous pages or conferring with their neighbors.

All children in the classrooms were tested, though not all were included in the study. Children were excluded for the following reasons: some were non-white; some were observed cheating; some did not attend to the film or respond in their booklets (this happened with two third-graders); one came into the room after the introduction and first presentation of pairs; and some did not have any achievement test scores with which to correlate their paired-associate scores.

For the upper-middle-SES school, fourteen third-graders and nine sixth-graders were dropped. For the lower-SES school, eight third-graders and three sixth-graders were dropped. Judgments of ethnic background were based on observation by the experimenters and on information provided by school records, teachers, and office personnel.

Achievement and SES data was gathered on the subjects from their cumulative folders. For the third-grade subjects, Metropolitan Achievement Test (MAT) scores on Word Knowledge, Word Discrimination, and Reading were recorded from the tests they had taken in second grade, and Arithmetic scores were taken from the tests administered in first grade. For the sixth-grade subjects, Lorge-Thorndike verbal IQ scores and Iowa Tests of Basic Skills[2] (ITBS) scores (administered in sixth grade) for Vocabulary, Reading, Work-Study, and Arithmetic were obtained. Each subject was assigned to one of seven SES categories based on the occupation of the head of household (according to the salary, prestige and educational requirements for the position). The categories were largely based upon the Minnesota Scale for Paternal Occupations classifications with reference to the 1960 Census of Population Supplementary Reports; the Warner, Meeker, Eell's Revised Scale for Rating Population (Miller, 1964); and the Dictionary of Occupational Titles. The occupational categories used are shown in Table 1.

Insert Table 1 about here

Results

Hypothesis 1 stated that mean level of performance is higher for the PA-CF task than for the PA-K task. Hypothesis 2 stated that mean level of performance on both tasks is higher for sixth grade than for third grade subjects. As shown in Table 2, hypotheses 1 and 2 were supported. At the third grade level, the mean PA-CF score was 2.35 points higher than the mean PA-K score ($t = 4.30$; d.f. = 111, $p < .01$); at the sixth grade level, the mean PA-CF score was 2.49 points higher than the mean PA-K score ($t = 5.44$, d.f. = 126, $p < .01$). On the PA-CF task, mean score for the sixth grade was 2.77 points higher than the mean score for the third grade ($t = 4.43$, d.f. = 237, $p < .01$); on the PA-K task, mean score for the sixth grade was 2.63 points higher than the mean score for the third grade ($t = 4.36$, d.f. = 237, $p < .01$).

Insert Tables 2 - 7 about here

Hypothesis 3a stated that higher SES subjects have a higher mean score than lower SES subjects on PA-K but not on PA-CF. This prediction was partially supported by the data presented in Table 2; when the subjects were divided into upper-middle and lower SES schools, the upper-middle SES school had a higher mean score than the lower SES school on PA-K at both grade levels (but the difference was not significant), and a slightly higher mean score on PA-CF at sixth grade--but a lower mean score on PA-CF at third grade ($t = 2.05$; d.f. = 110, $p < .05$). However, when subjects were grouped into seven SES categories (Table 3), there was no clear relationship between SES category and mean PA score for either task at either grade level. It therefore cannot

be concluded that hypothesis 3a was supported. Hypothesis 3b stated that PA-K is more highly correlated than PA-CF with SES. This prediction was partially supported; at the third-grade level (Table 4), correlation with SES rating was -.03 for PA-CF and .16 for PA-K; at the sixth-grade level (Table 5), correlation with SES rating was .10 for PA-CF and .20 for PA-K. Differences between correlations were in the predicted direction but were not significant.

Hypothesis 4 stated that PA-K is more highly correlated with school achievement than is PA-CF. This prediction was supported at the third-grade level (Table 4). While PA-CF showed almost no correlation (-.03 to .09) with the MAT, PA-K showed moderate correlation (.29 to .36). The differences between correlations with PA-K and PA-CF were statistically significant ($p < .01$) for the Word Knowledge, Word Discrimination and Reading subtests of the MAT and for the Arithmetic subtest ($p < .05$). At the sixth-grade level (Table 5) a Task x Sex interaction emerged: for the girls, both PA tasks were moderately correlated with ITBS scores, while for the boys, PA-K was moderately correlated with ITBS scores, but PA-CF showed almost no correlation with ITBS (differences between these sets of correlations were not statistically significant, however). For the girls, correlation with IQ was higher for PA-CF (.39) than for PA-K (.28), while for the boys PA-K was more highly correlated with IQ (.16) than was PA-CF (-.08). The difference between the boys and the girls in the correlation of PA-CF with IQ (-.08 and .39 respectively) was significant ($p < .01$). In general, hypothesis 4 was supported for all third-grade subjects and for the sixth-grade boys--but not for the sixth-grade girls--when PA scores were correlated with standard achievement test scores and IQ.

Hypothesis 5 predicted that the variance shared by the PA-K task and school achievement is independent of the variance shared by the two PA tasks. The correlation between PA-K and the MAT scores was approximately .30 for third-grade girls; since there was no correlation (.00) between the two PA tasks, the correlation between PA-K and MAT was independent of any relationship between the two PA tasks. Partialling PA-CF out of the correlation between PA-K and MAT produced little change in the correlations for third-grade boys (Table 6). Results were replicated for all sixth-grade subjects (Table 7). Thus Hypothesis 5, which stated that the variance shared by PA-K and school achievement is independent of the variance shared by the two PA tasks, was supported.

Summary and Discussion

The main hypothesis of the study was that task and sample characteristics account for reported significant correlations between certain paired associates tasks and school achievement. It was shown that for the two PA tasks used in the present study, differing only in their stimulus elements (concrete versus abstract), the abstract task correlated significantly with school achievement, while the concrete task was generally not related to school achievement. Furthermore, the variance shared by the two PA tasks was independent of the significant positive correlations between the abstract task and school achievement. Thus, it appears to be the case that whatever skills the two PA tasks have in common, these do not account for the variance that relates PA performance on certain tasks to school achievement.

As stated previously, the PA-K (abstract) task was designed to be as similar as possible to Stevenson's (1968) Abstract Forms task, actually

utilizing some of the same specific trigrams and kanji figures, and presenting the task by the same method. The correlations between this task and ITBS scores provided fairly good replication of Stevenson's findings. Indeed, for the Arithmetic sub-test, correlations with PA-K were .53 for girls and .24 for boys as compared with Stevenson's correlations of .52 for girls and .29 for boys. The correlations for PA-K with the other subtests of the ITBS were not quite as large as Stevenson's, but they did replicate the sex differences which Stevenson found (girls' correlations between PA-K and ITBS averaged 18 correlation points higher than boys' correlations, as compared to a 20 point difference in the same direction in Stevenson's study).

Thus, despite the consistent positive correlations and replicated findings, the cognitive processes accounting for the relationships between PA performance and school achievement are yet to be adequately specified. The mental elaboration skills proposed by Rohwer (1969) to explain these relationships are apparently not always common to the two kinds of tasks used in the present study; or if they are common, they are not sufficient for successful performance of the abstract task. Other skills must also be present in the completion of the abstract task, and these may be more closely related to school achievement. It is therefore reasonable to question the efficacy of the mental elaboration training techniques designed to improve performance on concrete PA tasks for the remediation of deficient school achievement. It should be noted, however, that the variables manipulated in the present study are at best preliminary steps toward the elucidation of the processes underlying performance on PA tasks.

Correlations between PA scores and achievement test scores for the third graders indicate possible differences in the processes involved in doing the two PA tasks at this level. PA-K was correlated approximately .33 with Metropolitan Achievement Scores while PA-CF was correlated approximately .02 with MAT scores; although correlations for the sixth-grade boys followed a similar pattern as those for third-grade children (i.e., PA-K was correlated more highly with ITBS than was PA-CF) correlations for the sixth-grade girls were different (PA-K and PA-CF correlated similarly with ITBS, and both tasks correlated more strongly with ITBS than either PA task for the boys). Thus, at the sixth grade there was an apparent Task x Sex interaction; the hypothesis that the two PA tasks do not share common variance with school achievement should be qualified to take into account the results for sixth-grade girls. It may be that mental elaboration skills are used by sixth-grade girls on both PA tasks and in acquiring knowledge in school. In addition, the fact that the correlation between the two PA tasks was greater at the sixth-grade level (.51) than at the third-grade level (.21), suggests that there is less difference in the way older subjects handle the two tasks. This inference is supported by the fact that levels of correlation between each of the PA tasks and achievement test scores were found to be closer at the sixth grade (mean difference of seven correlation points between PA-K and PA-CF correlations with achievement test scores) than at the third grade level (mean difference of 31 points). Research effort should be expended to find variables which help to explain these findings in ways that are useful to education, i.e., at the level of cognitive processes and training procedures.

Rohwer's attempt to define, operationalize, and train mental

elaboration skills represents a praiseworthy attempt to explain paired-associates performance at a process level. Future studies will benefit from Rohwer's work if they imitate his research strategy and aim at illuminating processes involved in a task through training in skills presumed to account for successful performance on that task. The results of the present study suggest, however, that of the many specified and unspecified processes involved in performing PA tasks, the presence or absence of mental elaboration skills does not appear to adequately explain the relationship of PA to school achievement. It is therefore premature to suggest that differences in school achievement among advantaged and disadvantaged children are explained by a lack of mental elaboration skills of the sort postulated by Rohwer.

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Footnotes

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[2]In a recent study (Finley, 1963), correlations of .79, .74, and .80 were reported between Metropolitan Achievement Test scores and Iowa Tests of Basic Skills scores for third-grade subjects in reading comprehension, arithmetic and language, respectively.

TABLE 1

SES Ratings Based Upon Occupational Status of Head of Household

SES Rating	Occupational Category
7	Top professional (e.g., doctor, lawyer, school principal)
6	Second-level professional (e.g., high school teacher); managerial; technical (e.g., science writer)
5	Clerical; skilled trades; retail business; salesman
4	Semi-skilled (e.g., hairdresser, welder); minor clerical; minor business
3	Slightly-skilled (e.g., truck driver, meat packer)
2	Unskilled (e.g., cashier, gas station attendant)
1	Unemployed; Aid to Families with Dependent Children

TABLE 2

Mean Number of Correct Responses and Standard Deviations for Each PA Task by Grade Level and School

School	N	PA-CF		PA-K	
		M	SD	M	SD
Lower SES					
Grade 3	47	11.05	4.62	7.02	3.78
Grade 6	55	12.72	4.88	9.62	4.87
Upper-Middle SES					
Grade 3	65	9.16	5.10	7.96	4.67
Grade 6	72	12.85	4.84	10.77	4.98
Both					
Grade 3	112	10.06	4.82	7.71	4.37
Grade 6	127	12.83	4.84	10.34	4.95

TABLE 3

Mean Paired-Associates Scores and Mean IQ Scores
by Grade Level and SES Rating

Grade 6

SES	N	$\overline{\text{PA-CF}}$	$\overline{\text{PA-K}}$	$\overline{\text{IQ}}$ (N)*
7	36	13.72	11.31	117.39 (28)
6	11	12.09	9.27	121.89 (9)
5	19	11.95		
	20		11.75	110.88 (17)
4	17	13.59	8.76	105.00 (14)
3	22	12.27	11.14	100.53 (17)
2	10	13.10	9.30	102.78 (9)
1	9	11.00	5.67	91.63 (8)

Grade 3

SES	N	$\overline{\text{PA-CF}}$	$\overline{\text{PA-K}}$
7	33	10.33	
	34		9.29
6	9	9.78	5.22
5	18	11.22	8.17
4	14	10.29	
	15		7.27
3	15	7.13	5.33
2	11	11.18	
	13		7.92
1	5	13.60	
	6		8.00

*IQ scores were not available for all Ss; the number available is therefore included.

TABLE 4

Correlations Between Paired-Associates Tasks and Achievement Test Scores -- Third Grade

Task	SES	Metropolitan Achievement Test				PA-CF
		Word Know.	Word Disc.	Read.	Arith.	
			Girls (n = 51)			
PA-CF	-.00	-.04	-.14	-.13	.10	
PA-K	.01	.29*	.29*	.31*	.27	.00
			Boys (n = 61)			
PA-CF	-.08	.18	.06	.07	.03	
PA-K	.25*	.36**	.39**	.40**	.30*	.41**
			Both (n = 112)			
PA-CF	-.03	.07	-.03	-.03	.09	
PA-K	.16	.33**	.34**	.36**	.29**	.21*

*p < .05
**p < .01

TABLE 5

Correlations Between Paired-Associates Tasks and Achievement Test Scores -- Sixth Grade

			Iowa Tests of Basic Skills				
Task	SES	IQ	Vocab.	Read. Comp.	Work-Study	Arith.	PA-CF
Girls (n = 63)							
PA-CF	.28*	.39**	.39**	.38**	.42**	.46**	
PA-CF	.29*	.28*	.38**	.27*	.40**	.53**	.46**
Boys (n = 64)							
PA-CF	-.06	-.08	.04	-.00	.12	.09	
PA-K	.12	.16	.24	.11	.26*	.24	.55**
Both (n = 127)							
PA-CF	.10	.14	.21*	.19	.27**	.28**	
PA-K	.20*	.20*	.31**	.20*	.33**	.39**	.51**

*p < .05
**p < .01

TABLE 6

Correlations Between PA-K and Achievement Test Scores Before and After PA-CF was Partialled Out -- Third Grade

Boys				Girls			
Word Know.	Word Disc.	Read.	Arith.	Word Know.	Word Disc.	Read.	Arith.
Correlations before PA-CF partialled out							
.36**	.39**	.40**	.30*	.29*	.29*	.31*	.27
Correlations after PA-CF partialled out							
.32*	.40**	.41**	.32*	.29*	.29*	.31*	.27

*p < .05
**p < .01

TABLE 7

Correlations Between PA-K and Achievement Test Scores Before and After PA-CF was Partialled Out -- Sixth Grade

Boys				Girls			
Vocab.	Read. Comp.	Work-Study	Arith.	Vocab.	Read. Comp.	Work-Study	Arith.
Correlations before PA-CF partialled out							
.24	.11	.26*	.24	.38**	.27*	.40**	.53**
Correlations after PA-CF partialled out							
.28*	.13	.23	.23	.25*	.16	.26*	.40**

*p < .05
**p < .01