THE EFFECT OF RELATIVE DIFFICULTY OF TASKS ON TRANSFER IN A VERBAL LEARNING SITUATION

DISSERTATION

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TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

The craftsman constructs a new item faster than his apprentice. The matron bakes a cake with less difficulty than the young bride. The psychology graduate reads a new article faster than students in an elementary course. Experience is a good teacher - so good in fact that this experience need not be with exactly the same task. The craftsman has never made that item before; the matron has not made that cake; and the graduate student has not read that particular article before. We are not dealing with practice effects, but with a general "know-how." This know-how forms a backdrop for many of the new things we learn.

On the other hand, we rarely find a person who does the right thing in each situation he faces. General know-how has its limitations. In fact there are situations in which our past experience is of no use at all or may actually make it harder for us to learn to do something new correctly.

Certain characteristics of the tasks learned seem to determine the use of this double-edged sword, experience. Psychologists, studying these phenomena under the rubric of transfer, are familiar with many such characteristics. The present study is an attempt to add to our information on transfer by studying the effect of order of learning tasks which differ in difficulty.

HISTORICAL BACKGROUND

From the time of the Greeks onward, certain activities have been thought to increase one's ability to learn new tasks. This view was more explicitly stated as the doctrine of Formal Discipline, or Formal Training, in the 1800's. Bennett (4) lists several meanings of the term, but perhaps most common is the idea that some tasks, often thought of as difficult, provide a general facilitatory effect on the learning of all new tasks.

This doctrine came to be discounted, if not disproven, by such American educaters and psychologists as Dewey, James, Jastrow and Thorndike (4, 15).

Thorndike (18) proposed instead the theory of identical elements, which stated that a change in one function alters another only in so far as the two have identical elements in common. Aside from an inadequate definition of elements, the theory was later criticized because of its inability to handle negative transfer. This was rectified by Poffenberger (16) who said negative transfer would occur when a task involved the breaking of old bonds and the formation of new. Wylie (23) set up a similar hypothesis: Transfer effect is positive when an old response can be transferred to a new stimulus, but negative when a new response is required to an old stimulus. The experimental data of Wylie (23) and Bruce (5) were consistent with this hypothesis.

The problem has more recently been phrased as transfer between classes of material as opposed to transfer within the same class. In general, there is high positive transfer within a class and variable transfer effects and amounts between classes (14). Transfer within a class is also a characteristic of the learning to learn experiments (14).

In the field of verbal learning, there has been little concern with difficulty per se. Most commonly, attention has been directed toward the effect of S and / or R similarity on transfer. However, in the field of motor learning, a number of studies have dealt more or less directly with transfer as a function of difficulty.

In 1937, Cook (6) varied task complexity by the number of discs in the Chinese ring puzzle. He found positive transfer from complex tasks to simple ones but little or no transfer from simple to complex tasks. Cook suggested that solution of the more difficult problem first involved more practice and opportunity to obtain insight into the nature of the problem. In 1950, Szafran and Welford (17) varied the order of presentation of three tasks: (1) throwing at a target on the floor, (2) throwing over a bar at the same target, and (3) throwing over a screen with the aid of a mirror. On the basis of their results, the authors stated: "If two tasks of unequal difficulty are presented, achievement at the two tasks considered together, after allowance has been made for practice effects, will tend to be greater when the harder task is presented first than when the easier is presented first."

Their data also indicate that difficulty of the first task is more important than difficulty of the second task. This, they say, may be due to receptor comprehension and effector organization (which is more easily built up than modified and which cannot adequately be secured on an initially easy task) or to motivational type factors. Gibbs (10), using two compensatory and two pursuit tasks, finds more transfer from difficult to easy and that tasks of equal difficulty lead to equal and often large amounts of transfer. The concept of levels of ability is offered as an explanatory device. A series of experiments performed by Gagne and his co-workers (3, 8, 9) support the conclusion that greater amounts of transfer are found between tasks of equal difficulty and more transfer when the first task is more difficult than the second. Gagne's theoretical approach to the problem is in terms of generalization.

Exception to the above results is reported by Green (11, 12) and Barch (1, 2). Green _et al_. (12) employed compensatory and pursuit tracking tasks, each of which could be continuous (compatible) or non-continuous (uncompatible). On the compensatory tasks, easy to hard yielded superior transfer. Actually no significant differences were found between the two following tracking tasks, but Green indicated that hard to easy was probably superior. Barch and Lewis (2) used pursuit tracking tasks, varying difficulty by the relations between control movements and light movements. They find greater positive transfer from an easy to a more difficult task than between tasks of equal difficulty ! The results are discussed in terms of Lewis' theory of transfer. These studies indicate that transfer is some function of difficulty but disagree as to its nature.

The present study is an attempt to study the parameter of difficulty in a verbal learning situation. To make our results somewhat comparable to those of the above-mentioned studies, we might select some sort of stimuli that are known to vary in the ease with which motor or verbal responses are attached to them.

Fitts et al. (7) have described sets of metric figures that seem to meet this requirement. These figures are generated in n x n matrices where the height which any column can attain is determined by reference to a table of random numbers. One type of these figures, random, is obtained by sampling with replacement. Another type of figure, constrained, is obtained by sampling without replacement, i.e., no two column heights within the same figure may be the same. Leonard and Anderson (13) used these figures in four motor tasks and a group paired-associate task. In three of the motor tasks and the paired-associate task, the use of random, metric, stimulus figures led to better performance than the use of constrained, metric, stimulus figures.

PROCEDURE

Subjects

The Ss were 180 volunteers from elementary psychology classes at Ohio State University: about 85 percent of these Ss were females.

Apparatus

The apparatus used was a Patterson memory drum, model S-FA-LB. The stimulus items of the paired-associate task were random and constrained metric figures. These figures were reproduced photographically, cut to size and glued on the tape. A sample of the figures used in the experiment is found in Appendix B.

The response items were three letter words selected from Thorndike and Lorge's count (19)of the 500 most frequently occurring words in the English language. The words were typed opposite the figures. Since Underwood (20) has indicated that generalization is greater between words within a continuum of meaning, an attempt was made to avoid words in the same continuum appearing on a list. The words selected are found in Appendix A.

Instructions:

> The following instructions were read to each S. "This is a learning experiment and this piece of apparatus is called a memory drum. During the experiment a figure will appear here (pointing) and remain here for two seconds: then this shutter will go up revealing a three letter word in this space. The pair will be shown together for two seconds; then a new figure will appear here, then a new word, and so on, until you have seen eight different pairs together. After you have seen them once, you will see them over and over again. Your task will be to learn the word for each figure so that you will be able to call it out just as soon as you see the figure. Be sure you call out the word for each pair before the shutter goes up and shows you what it is. After each of the eight pairs has appeared once, there

will be a short interval in which no words or figures will appear and then the words will repeat again. You will not be able to call out the words for the figures the first time through of course, but just as soon as you can, start calling out the words even though you may make a mistake. Don't bother to try to learn the order in which the figures and words appear, since they appear in a very scrambled order. Just try to learn what word goes with what figure as quickly as you can. Do you have any questions?"

Further instructions for experimental groups only:

"Before the experiment begins, you will look at the figures alone for one minute in order to be familiar with the type of material."

"Now I want you to learn a second task. The procedure is the same as the first except the figures and words are different and you will not have a chance to look at the figures before the experiment begins. Do you have any questions?"

Design and Method:

A list comprised 8 paired-associate items. Four different orders of presentation were used to minimize the occurrence of remote associations. Two different sets of the random and constrained-type figures were randomly selected. Two more sets were chosen, each of which contained 4 random and 4 constrained figures. These sets are hereafter referred to as mixed-type figures. The experimental Ss learned the correct responses to one set of figures to a criterion of 1 perfect anticipation of a list, rested for 5 minutes, and then were given the second paired-associate task. The figures for the second task were always of a different set, but could be of the same or different type. The number of trials to criterion and the number of correct responses were recorded for each S. The three types of figures are random, constrained and mixed. The design is abstracted in Table I. Fifteen Ss were assigned, in order of their appearance, to each group.

TABLE I

Experimental Design

Task 1	Task 2
random	random*
random	mixed*
random	constrained*
mixed	random*
mixed	mixed*
mixed	constrained*
constrained	random*
constrained	mixed*
constrained	constrained*

Control task

random*
mixed*
constrained*

*These figures were the same type but of a different set than those used in Task 1.

RESULTS

The data for the first and second tasks were analyzed in terms of the number of trials to criterion and the total number of correct responses on trials two through eleven. Group means for these measures are presented in Appendix C. The first of these measures is an over-all indicant of transfer and the second is an indicant of transfer early in learning. The variances of scores used in all the analyses were found to be homogeneous by the F max test (21).

Trials to criterion transfer scores were obtained by subtracting the second task scores from the appropriate control mean. An analysis of variance was performed on the transfer scores. The results of this analysis are presented in Table II. In view of the significant over-all F, F's were obtained for the task variables. A significant F was found for the first task variable ($p < .001$) and the second task variable ($p = .05$).

The analysis of variance on transfer scores for number correct is presented in Table III. A significant over-all F and a significant F for interaction were obtained in this analysis. The simple effects, when tested against the interaction estimate, did not attain significance. This interaction appeared to be due to the performance on the mixed tasks. Since the mixed group conditions were an addition to the type of design used in motor learning studies cited previously and since a deletion of the mixed tasks does not destroy the basic design of the experiment, the analysis presented in Table IV was deemed permissible. The interaction was not significant in this analysis; the effect of the first task was significant beyond the

.01 level of confidence and the second task was significant at the .05 level of confidence. This analysis leads support to the trials to criterion analysis and is felt to be informative.

It should be pointed out that our interest is not in the absolute amount of transfer in some particular group, but in comparisons of relative amounts of transfer accruing from particular first or second tasks. As the R_1's are the same for all first tasks and the R_2's the same for all second tasks, the variation of group differences may be attributed to changes along the stimulus continuum. This permits us to make comparisons between groups that have the same stimulus figures on the learning tasks or between groups that have the same stimulus figures on the transfer tasks. Therefore, an analysis was performed on the second task scores of number correct on trials two through eleven. This analysis is presented in Table V. A significant interaction was found in this analysis also and again appeared to be caused by combinations of learning and transfer tasks involving the mixed figure groups.

The task difficulty associated with the random and constrained-type figures was substantiated. The control groups' trials to criterion scores for random and constrained stimulus figures differed at the .05 level of confidence. Further evidence for task difficulty is found in the comparisons of column means in the various analyses. Significant differences were not found for the control groups of the number correct scores; however, the trend was in the same direction.

The learning and transfer scores for the mixed groups proved quite interesting. In terms of learning, the mixed figure tasks seemed as easy as or easier than the random figure tasks, whereas mixed learning tasks were consistently associated with high transfer performance.

TABLE II

Analysis of Trials to Criterion Transfer Scores

Source	Sum	d.f.	F	P
task 1	646.23	2	8.29	.001
task 2	241.22	2	3.09	.05
interaction	110.61	4	.71	
within	4911.12	126	3.20	.01
between	998.06	8		
total	5909.18	134		

differences on tasks 1	t	p
constrained-random	2.31	.05
constrained-mixed	.63	
mixed-random	2.94	.01

differences on tasks 2	t	p
constrained-random	1.53	
constrained-mixed	1.73	
random-mixed	.21	

TABLE III

Analysis of Number Correct Transfer Scores

Source	Sum	d.f.	F	P
task 1	623.29	2	.81	
task 2	493.20	2	.64	
interaction	1532.47	4	2.56	.05
within	18888.43	126	2.21	.05
between	2648.96	8		
total	21537.39	134		

TABLE IV

Analysis of Number Correct Transfer Scores with Mixed Groups Deleted

Source	Sum	d.f.	F	P
task 1	819.19	1	5.92	.01
task 2	556.33	1	4.02	.05
interaction	.30	1		
within	7748.31	56	3.32	.05
between	1375.82	3		
total	9124.13	59		

TABLE V

Analysis of Number Correct Transfer Task Scores

task 1	794.14	2	.89	
task 2	710.34	2	.79	
interaction	1791.49	4	2.89	.05
within	19525.97	126	2.66	.01
between	3295.93	8		
total	22821.04	134		

DISCUSSION

Task difficulty has been suggested as a parameter of transfer. But there is disagreement concerning the effect of this parameter. The results of the present study, considered in their totality, support neither position, whereas certain group comparisons are consistent with one position and certain other groups comparisons are consistent with the antithetical position. By considering the random and constrained figure groups (Table II), our results indicate that better transfer is obtained from difficult to easy tasks than from easy to difficult tasks, and so are in agreement with most of the motor learning studies cited previously (3, 10, 17). On the other hand, a comparison of transfer obtained from the mixed and constrained figures (Table II) indicates that transfer from the mixed tasks (easy in terms of learning) is equal or superior to transfer from constrained tasks.

The interactions obtained in Tables III and V appeared to result from high transfer from the mixed learning task to the constrained transfer task in particular and from large amounts of transfer from mixed learning tasks to transfer tasks in general. These interactions, while masking the simple effects, are quite interesting. If the learning and transfer performance on the mixed tasks is found to possess generality and reliability, it has as obvious practical significance. Performance on such tasks may also provide a clue in determining the effect of difficulty.

Conceptually, the subject's task involved the discrimination of a set of figures and the acquisition of the correct associations.

Several explanations of the results obtained should be considered.

Practice Effects:

Since all groups were run to a criterion on all tasks, *S*s having a constrained learning task received more learning trials or practice than *S*s having a random learning task, and therefore might be expected to perform better on a second, related task. However, this explanation cannot account for the performance of *S*s having a mixed learning task. These *S*s had relatively few learning trials but showed as much or more transfer than *S*s having a constrained learning task. In addition, a specified number of trials, rather than a criterion, was used in most of the motor learning studies.

Discrimination:

The discrimination task is a function of the intra-list similarity. Intra-list similarity is the greatest for the constrained figures which all have equal areas and an equal number of breaks in their contours, next greatest for the random figures, and least for the mixed. Predicting from the transfer of discrimination habits, we would expect most transfer from the constrained learning task and more transfer from the random than the mixed figure tasks. Incidently, the same predictions might be made on the basis of motivation. These predictions are supported by transfer comparisons based on random and constrained learning tasks, but are contradicted by transfer comparisons involving the mixed learning tasks. It could still be argued that even a small amount of discrimination training on a difficult task, i.e., the constrained figures of the mixed task, is sufficient to produce restricted generalization gradients. If this were maintained, our results could fit into a transfer of discrimination framework.

Similarity:

With regard to inter-list similarity, the experimental design is S_1--R_1 S_2--R_2, with group stimuli possessing three levels of physical similarity. Since the inter-list response similarity is a constant for all groups, our transfer comparisons involve only the inter-list degree of stimulus similarity. The mixed learning task is unique in that it possesses similarity to all transfer tasks. This might account for the superior transfer obtained from mixed learning tasks except that more transfer was obtained from mixed to constrained than from mixed to mixed. Stimulus similarity did not seem to be consistently related in any fashion to the amounts of transfer. But since non-specific transfer was not controlled, the effect of stimulus similarity could have been obscured. A further argument against inter-list similarity interpretations was mentioned by Gibbs (10), who found that transfer from task A to task B was not equal to transfer from task B to task A. Such inequalities were found in all the analyses performed in the present experiment.

Difficulty:

As others have noted (1, 10, 17), the difficulty of the learning task is a more effective determiner of transfer than the difficulty of the transfer task (Table II). The following hypothesis might be proposed: a learning task which is difficult or has some difficult components will lead to larger amounts of transfer than an easy learning task. While consistent with the results, this hypothesis is unsatisfactory for a number of reasons. It does not account for the contradictory results of other studies. It gives only a general description of the present results. If offers no insight into the nature of difficulty.

Task difficulty and amount of transfer obtained are measured by performance. Since task difficulty does not seem to be a function of some single factor, such as similarity, we may have to consider an aggregate of factors which has an influence on performance, both in learning and transfer. Variation in this aggregate might account for the various results of different investigators. In view of this, considerable time and effort might be saved if the factors producing difficulty were isolated and dealt with directly. It may be that difficulty in the tasks used here is a function of stimulus similarity, discriminability, motivational effects, practice effects and other unknown variables. This experiment was not designed to discriminate between these possibilities, but merely to investigate the effect of difficulty in a verbal learning situation. Since some of these variables, such as stimulus and response similarity, are more easily controlled in verbal learning than in motor learning situations, research directed toward the nature of difficulty in verbal learning is suggested.

SUMMARY

Difficulty has been posited as a factor influencing transfer in motor learning tasks. This experiment was designed to explore the effect of difficulty in a verbal learning situation. Metric figures, previously shown to be associated with differential levels of performance on both motor and verbal learning tasks, were used. These figures served as the stimuli in a paired-associate task. Fifteen Ss were run in each condition of a 3 x 3 factorial design. The three variables were the difficulty of the three learning and the three transfer tasks.

The random and mixed figure tasks did not lead to differential learning but did produce differential transfer. With regard to the random and constrained tasks, more transfer occurred when the learning task was difficult; and with regard to the mixed and constrained tasks, as much transfer was obtained from an easy as from a difficult learning task.

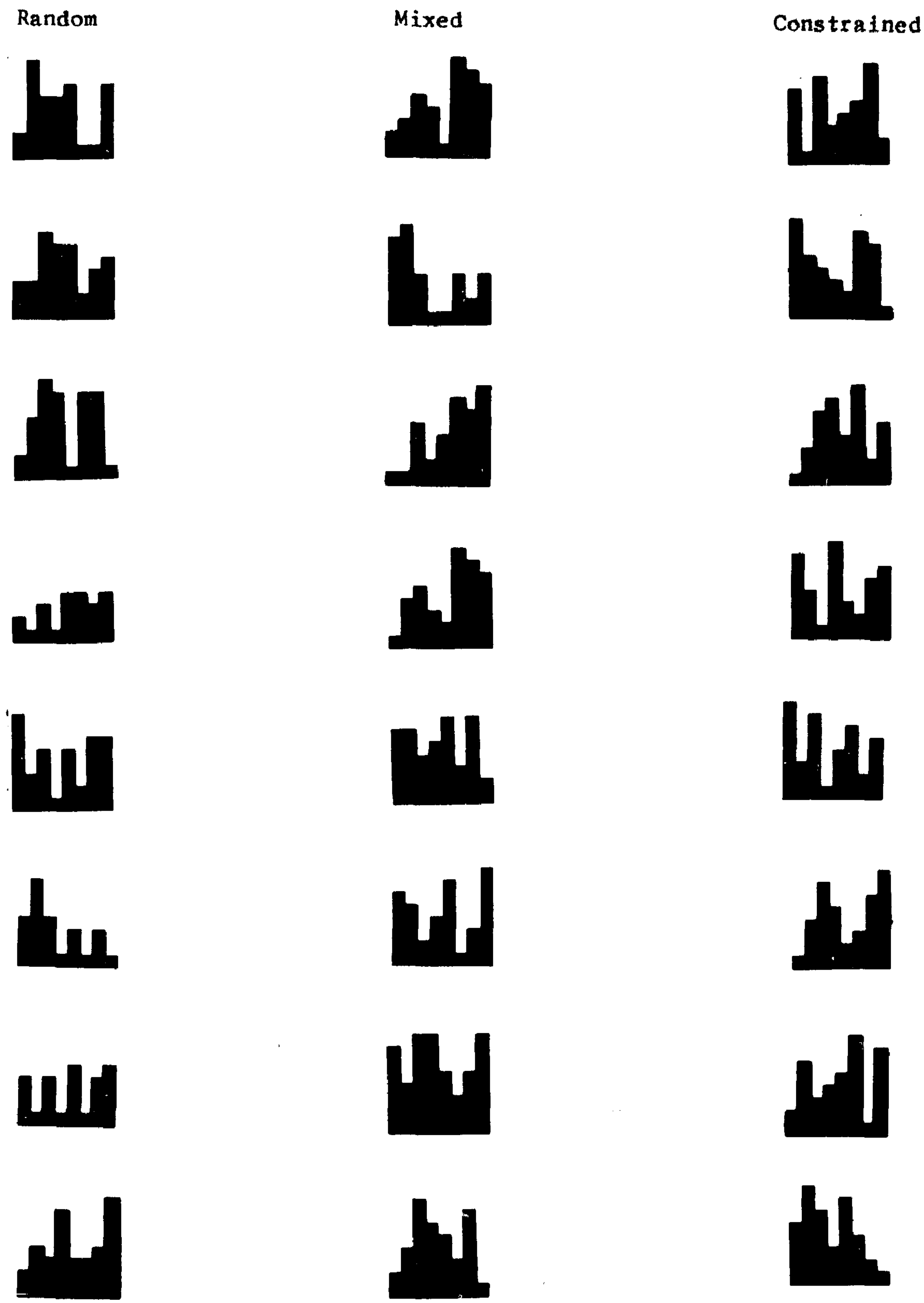
Several explanations of the transfer obtained were considered and found to be unsatisfactory.

APPENDIX A

List 1	List 2
END	TOP
SEA	CAN
PAY	BOY
DAY	LIE
USE	AIR
LAW	SUN
WAR	EGG
AGE	WAY

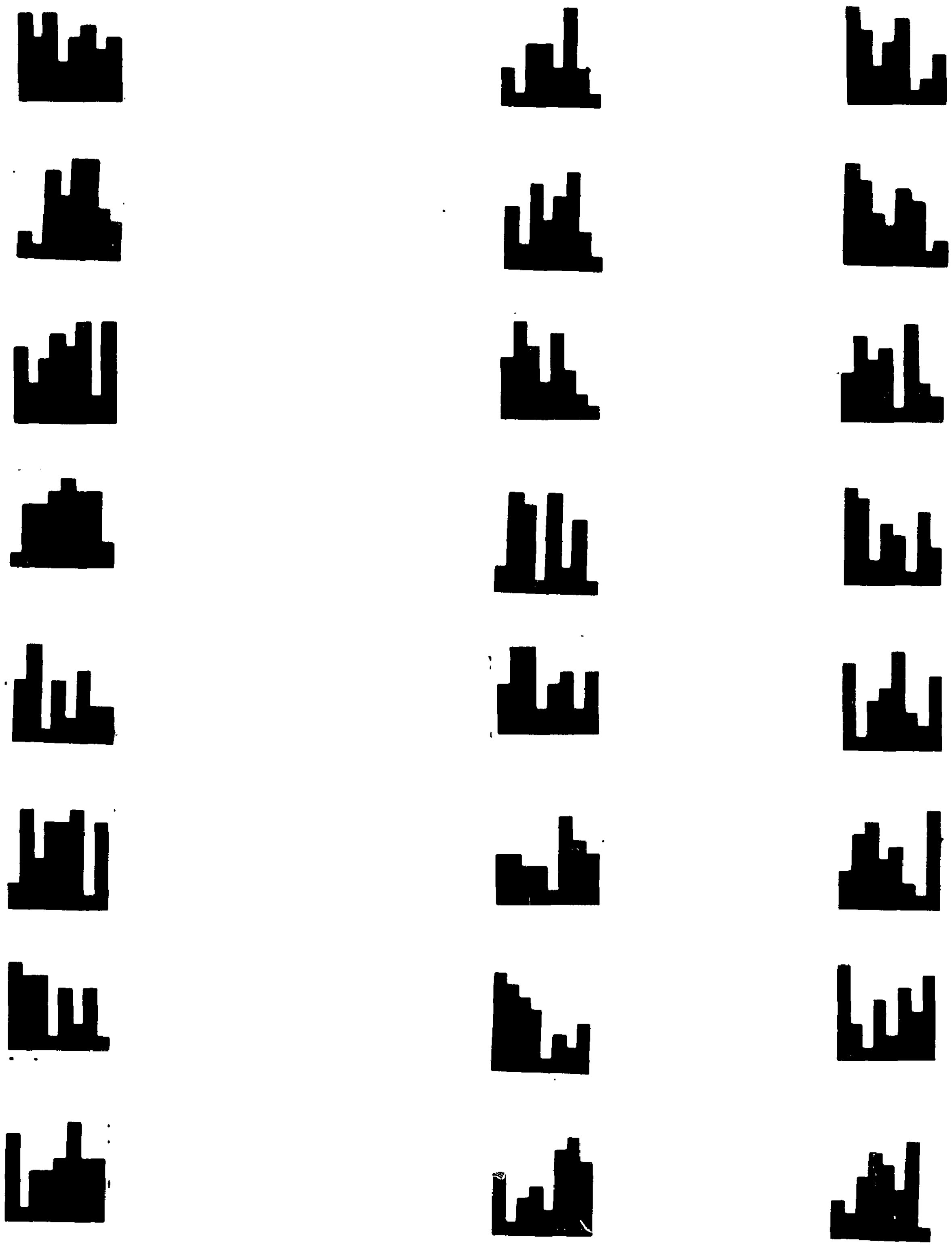
List 1 was always associated with the figures used in the first task. List 2 was associated with the second task figures and the figures for the control groups.

APPENDIX B



APPENDIX B (continued)

Random* Mixed* Constrained*



APPENDIX C

Trials to Criterion Transfer Scores

	Random		Mixed		Constrained	
	M	σ	M	σ	M	σ
random	7.9	6.3	9.0	7.2	8.9	2.8
mixed	12.6	3.8	12.1	5.6	16.4	5.0
constrained	12.1	4.0	10.5	6.9	15.2	5.0

Number Correct Transfer Scores

	Random		Mixed		Constrained	
	M	σ	M	σ	M	σ
random	18.2	11.2	24.4	10.2	14.6	10.4
mixed	17.2	14.9	21.5	13.6	25.8	7.9
constrained	25.7	7.4	25.2	13.3	19.5	13.1

Number Correct Second Task Scores

	Random		Mixed		Constrained	
	M	σ	M	σ	M	σ
random	43.8	11.2	45.6	10.2	32.5	14.6
mixed	42.8	14.9	42.7	13.6	47.9	7.9
constrained	51.3	7.4	46.5	13.3	41.6	13.1

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AUTOBIOGRAPHY

I, Sara Rader Staats, was born May 23, 1932 in Akron, Ohio. I received most of my primary school training at Otterbein Elementary School, near Front Royal, Virginia. Most of my secondary education was obtained at Butler High School, Butler, Ohio, where I graduated in 1949. I entered Ohio State University in 1949. I obtained a B. S. from Ohio State University in 1953 and an M. A. from Ohio State University in 1954.

While pursuing my graduate training at Ohio State University, I was employed as a research assistant for one year and as a teaching assistant for two years. I am currently employed as a research associate at Columbus Psychiatric Institute and Hospital.