DOCUMENT RESUME

ED 040 817 RE 002 478

AUTHOR Muller, Douglas G.
TITLE A Paired-Associates Analysis of Reading Acquisition.
PUB DATE Mar 70
NOTE 36p.; Paper presented at the meeting of the American Educational Research Association, Minneapolis, Minn., Mar. 2-6, 1970

EDRS PRICE EDRS Price MF-$0.25 HC-$1.90
DESCRIPTORS College Students, *Communication (Thought Transfer), Educational Methods, Education Majors, Learning Theories, *Paired Associate Learning, *Reading, Reading Instruction, Reading Research, *Relationship, Visual Stimuli, Word Recognition

ABSTRACT

A major objective of this study was to seek the relationship of principles derived from traditional paired-associates transfer experiments as applied to the reading task. In this experiment 10 subjects from upper-division education courses, all volunteers, received various types of preliminary training with letter stimuli; then all subjects learned a word reading task and a sentence reading task. The letters, words, and sentences were graphically, as well as aurally, meaningless. The results of this experiment indicated that transfer phenomena in stimulus-compound paradigms were generally consistent with phenomena in more conventional paridigms. This implies, says the author, that a generalized theory of transfer of associative learning is feasible and that this theory could be instrumental in the development of more efficient methods of reading instruction. Further research is recommended. References are included. (NH/Author)

A PAIRED-ASSOCIATES ANALYSIS OF READING ACQUISITION

by

Douglas G. Muller

Department of Educational Psychology
New Mexico State University

Presented at the
American Educational Research
Association Annual Meeting
Minneapolis, Minnesota
March, 1970

One of the major aspects of the beginning reading task is the association of an overt verbal response to the printed word. Typically, beginning readers are given preliminary training with letters prior to actual word reading instruction. In essence, this represents a form of transfer of paired-associates learning.[1] However, a major difference between the traditional paired-associates transfer task and reading is that in reading, the learner is exposed to stimulus elements (letters) in the first task and compounds of those elements (words) in the second, while in paired-associates transfer paradigms the second task stimuli are replicas or variants of the first task stimuli. A critical issue then is the relationship between these two paradigms. Namely, do the principles which have been derived in traditional paired-associates transfer experiments apply to the reading task? A major objective of this research is to explore this issue.

If the second task stimulus words in the learning-to-read (LTR) task are thought of as variants of the first task letter stimuli, then the A-B, A'-C (ABA'C) and the A-B, A'-B' (ABA'B') paradigms have relevance to LTR.

The classification of the LTR task as ABA'C or ABA'B' depends upon the relationship of the letter name in the first task to the letter sound within the word in the second task. If this relationship is high, the ABA'B' paradigm is appropriate, if it is low, the ABA'C paradigm is appropriate. For example,

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[1] A brief description of the paired-associates learning and transfer task is provided in Appendix A.

if the letter "A" is labeled ă and the word apple is read, there is high letter label-sound correspondence (ABA'B'). If, however, it is labeled ā and apple is read, there is low letter label-sound correcpondence (ABA'C).

In order to more easily maintain the distinction between the traditional A-B, A'-B' and A-B, A'-C paradigms, and the corresponding LTR compounding paradigms, the notation ABA_cB_c and ABA_cC_c will be used to designate the latter two.

The ABA'C paradigm typically yields negative transfer to the A'C task (Kjeldergaard, 1968), with apparently two exceptions: (1) when response class differences between B and C lists are large (Postman, Keppel and Stark, 1965), and (2) following massive overlearning of the first list (Mandler, 1962). On the other hand, the ABA'B' paradigm seems to yield positive transfer, (Kjeldergaard, 1968; Osgood, 1948).

At issue then is whether ABA_cC_c and ABA_cB_c paradigms produce analogous results.

The results of several studies seem to indicate that they do. Muehl (1962), for example, found that a variant of the ABA_cC_c paradigm produced negative transfer when compared to a no pretraining control. He, however, pretrained his Ss on only one of the stimulus elements in each of the second task stimulus compounds. That is, his ABA_cC_c Ss knew names for only one of the letters in each of the task II words. He used kindergarten children as subjects and real letters and words as stimuli.

Bishop (1964) using adults and arabic words compared ABA_cB_c transfer to a no pretraining control. His results conform to those of the ABA'B' paradigm.

Jeffrey and Samuels (1967) essentially replicated Bishop's experiment but with children and nonsense words. In addition, control group Ss learned an irrelevant initial paired-associates task as a control for nonspecific transfer. They report that the phonic letter training produced greater transfer to the word reading task than did irrelevant associative training.

In these studies, the experimental group was compared with either a no pretraining control or a nonspecific transfer control (ABC_cD_c). The transfer produced by the ABA_cB_c and ABA_cC_c task I training, however, may represent transfer effects from several sources. Another objective of this study was to evaluate some of these potential sources of transfer.

For example, it is possible that at least part of the positive effects of learning names for letters is due to experience in discriminating between or observing letters. Stimulus predifferentiation studies have repeatedly shown transfer from stimulus observation training to be positive when compared to a no preliminary training condition (Goss, 1953; Smith and Goss, 1955).

Nonspecific factors may also contribute to transfer in the reading task. That is, while the child is learning names for letters, he is also learning-how-to-learn associations to graphic stimuli. This source of positive transfer has been long recognized in paired-associates transfer literature and was controlled for in the Jeffrey & Samuels experiment (1967).

Finally, letter name training might produce transfer to the word-reading task since it familiarizes or calls the attention of the S to the basic sound units of the words.

To summarize, it appears that preliminary letter-name training with high name-sound correspondence labels (ABA_cB_c) should produce positive transfer to the word-reading task. On the other hand, low letter name-sound correspondence training (ABA_cC_c) appears to produce negative transfer. However, the specific transfer effects may depend upon the similarity between response classes or degree of original learning.

This seems to indicate that the phonics approach to reading has the greatest potential for maximizing rate of reading acquisition. The tentativeness of this conclusion, however, should be quite apparent.

Further, the transfer produced by letter labeling pretraining appears to include transfer effects resulting from simple stimulus observation experience, learning-to-learn or warm-up, and response familiarization.

In order to evaluate the generality of the principles of P-A transfer, and to explore the importance of the various potential sources of transfer, the following experiment was performed.

METHOD

Design

In this experiment, subjects received various types of preliminary training with letter stimuli, then all Ss learned a word reading task and a sentence reading task. The letters, words and sentences were graphically as well as aurally meaningless. Table 1 outlines the six transfer paradigms employed in the study.

Paradigm I (ABA_cB_c) corresponds with the traditional ABA'B' paradigm. During task I, subjects in this group learned verbal responses to relevant stimulus elements (RS_e). That is, the stimulus elements that were subsequently combined to form the stimulus compounds of task II and were thus relevant to task II. The responses were relevant response elements (RR_e), that is, highly consistent with the sounds subsequently associated with the stimulus elements in task II.

Subjects in paradigm II (ABA_cC_c) similarly learned verbal responses to RS_es. However, these first task letter-names bore little relationship to the second task letter sounds and were thus irrelevant response elements (IR_e).

The AOA_cB_c paradigm is represented by treatment group III. This group merely observed the RS_es during task I.

TABLE I

Training Paradigm for Each of the Treatment Groups

Treatment Group	Training Paradigm	Task I	Task II	Task III
I	ABA_cB_c	RS_e-RR_e	S_c-R_c	$_cS_c$-$_cR_c$
II	ABA_cC_c	RS_e-IR_e	S_c-R_c	$_cS_c$-$_cR_c$
III	AOA_cB_c	RS_e-O	S_c-R_c	$_cS_c$-$_cR_c$
IV	ABC_cB_c	IS_e-RR_e	S_c-R_c	$_cS_c$-$_cR_c$
V	ABC_cD_c	IS_e-IR_e	S_c-R_c	$_cS_c$-$_cR_c$
VI	--A_cB_c	-------	S_c-R_c	$_cS_c$-$_cR_c$

Group IV (ABC_cB_c) <u>S</u>s associated RR_es with stimulus elements irrelevant to task II stimulus compounds (irrelevant stimulus elements (IS_e)). This was the response familiarization group.

Treatment group V (ABC_cD_c) <u>S</u>s learned IR_es to IS_es. This treatment was designed to reveal the effects of nonspecific factors.

Group VI was a no-training control and received no task I training prior to learning task II.

Following task I training, all <u>S</u>s learned a "word" reading task in which response compounds (R_c) were associated with stimulus compounds (S_c). These task II S_cs and R_cs were combinations of the RS_es and RR_e experienced by group I during task I training.

All <u>S</u>s then learned to read "sentences", that is, associate compound R_cs (${}_cR_c$) to compound S_cs (${}_cS_c$). These task III ${}_cS_c$s and ${}_cR_c$s were combinations of the S_cs and R_cs of task II.

Because level of training appears to be a critical variable in certain traditional paradigms, <u>S</u>s in each treatment group were either given six or thirteen task I training trial blocks. A trial block consisted of one presentation of each of the stimuli.

Thus, the design can be described as a five treatments by two levels factorial experiment with a single no-preliminary-training control group. This is outlined in Figure 1.

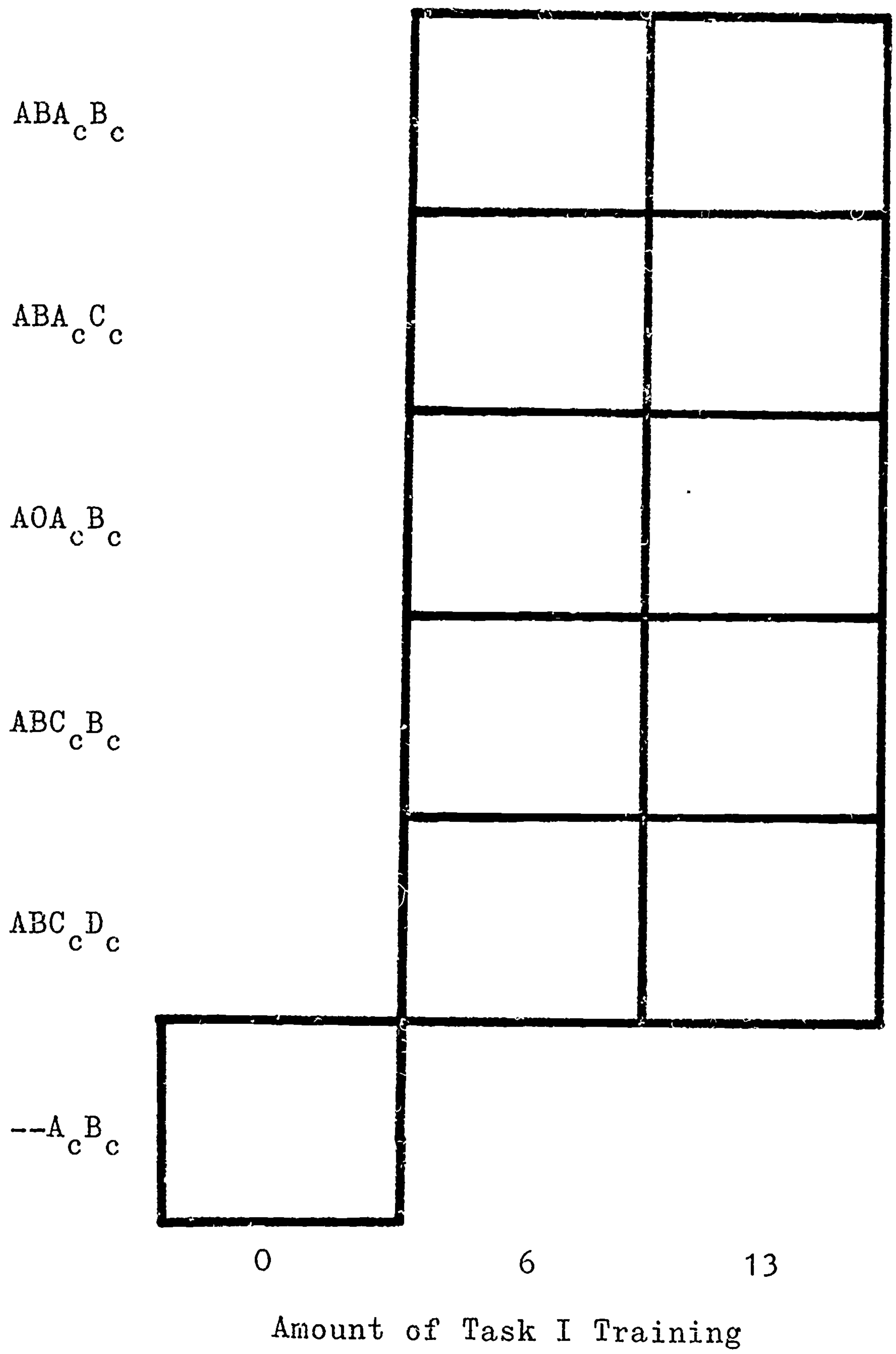

Fig. 1. The experimental design.

Stimuli and responses

Vanderplas and Garvin (1959) six-point random shapes were used as stimulus elements and nonsense monosyllabic words were used as response elements. Each training group saw six different stimulus elements (S_e) in task I, six S_cs during task II and six $_cS_c$s during task III.

Complete lists of stimuli and responses for each of the tasks are found in Tables 2, 3, and 4. Several of the stimulus elements are presented in Figure 2.

Subjects

Ten volunteer Ss from upper division education courses were randomly assigned to each of the eleven treatment conditions. Adults were used because they do not appear to qualitatively differ from first grade children with regard to learning abilities in paired-associate tasks (Keppel, 1968).

Procedure

Stimuli in tasks I and II were presented individually by a slide projector in a 4:2.5-sec paired-associates procedure. That is, the stimulus appeared for 4 seconds then the label was presented and the stimulus remained visible for another 2.5 seconds. There was a one-second inter-trial interval. Labels were presented aurally by a tape recorder. The same procedure was followed in task III but the presentation rate was 9:5-sec.

Task I training continued for either 6 or 13 trial blocks. A trial block consists of one and only one presentation of each of the six stimuli. Task II

TABLE 2

List of Vanderplas and Garvin (1959) Six-Point Random

Shapes Used as Task I Stimulus Elements and Their Labels

Stimuli		Responses	
Relevant	Irrelevant	Relevant	Irrelevant
5	1	GA (as in GOT)	JI (as in JIP)
12	8	PE (as in PECK)	COO (as in COOL)
15	16	RI (as in RIP)	VAY (as in WAY)
17	21	FO (as in ROW)	QWE (as in Qween)
23	26	DU (as in DUCK)	NI (as in NIGHT)
27	29	ZI (as in SIGH)	MUH (as in MOTHER)

TABLE 3

List of Vanderplas and Garvin (1959) Six-Point Random Shapes Used as Task II Stimulus Compounds and Their Labels

Stimulus Compound	Vanderplas and Garvin Stimulus Elements		Label
	First	Second	
1	5	12	GAPE
2	5	27	GAZI
3	15	12	RIPE
4	15	23	RIDU
5	17	23	FODU
6	17	27	FOZI

TABLE 4

List of Vanderplas and Garvin (1959) Six-Point

Random Shapes Used to Construct Task III

Compound Stimulus Compounds

and Their Labels

Compound Stimulus Compound	Vanderplas and Garvin Stimulus Elements			Label
1	5,12	15,23	17,27	GAPE RIDU FOZI
2	5,27	15,12	15,12	GAZI RIPE FODU
3	15,23	17,27	5,12	RIDU FOZI GAPE
4	15,12	17,23	5,27	RIPE FODU GAZI
5	17,27	5,12	15,23	FOZI GAPE RIDU
6	17,23	5,27	15,12	FODU GAZI RIPE

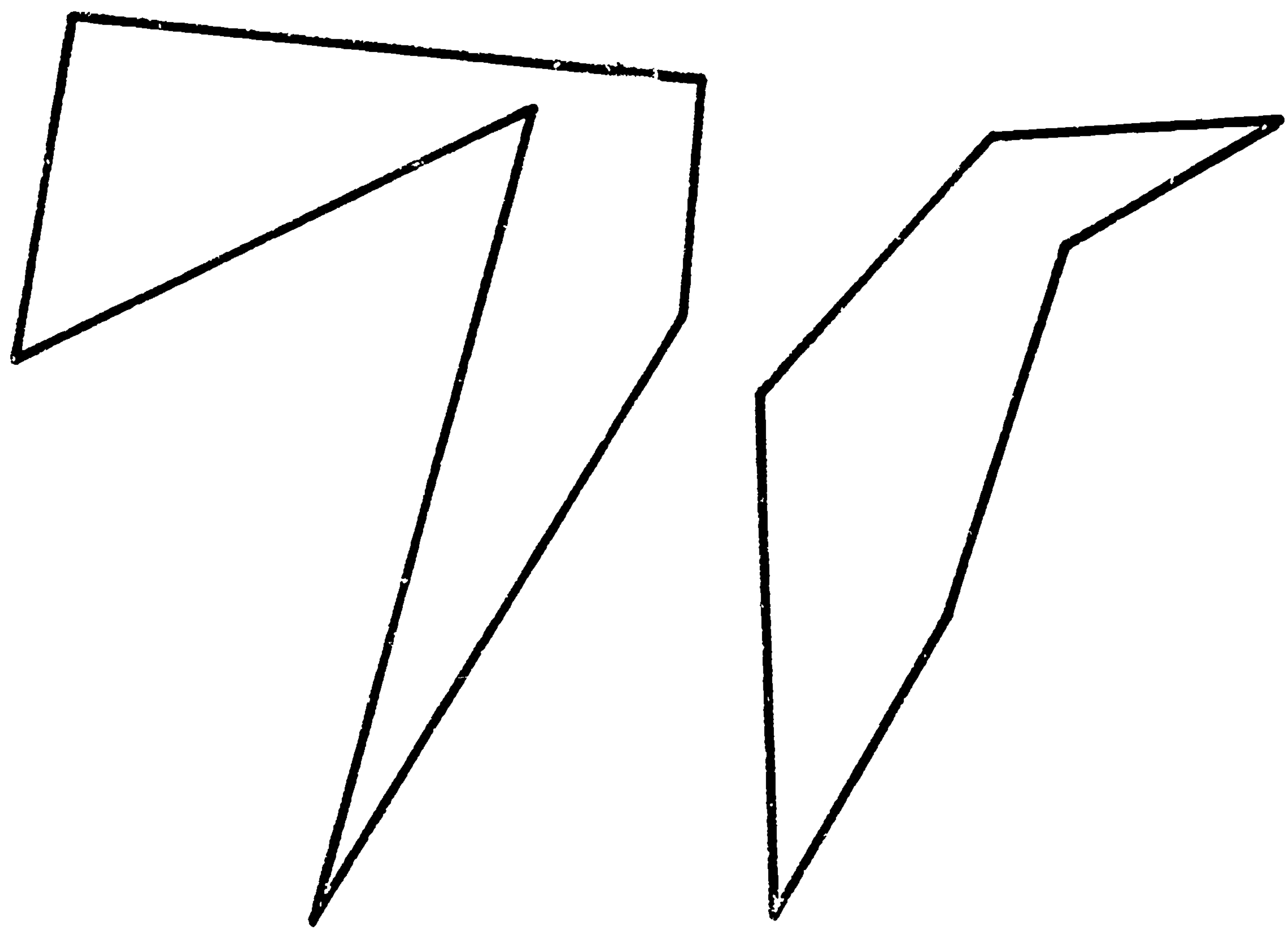

Fig. 2. Illustration of two Vanderplas and Garvin (1959) six-point random shapes.

training continued until the S reached a criterion of five successive errorless trial blocks. Task III continued for two trial blocks.

RESULTS AND DISCUSSION

Task I

The number of correct label anticipations on the final two trial blocks was recorded for those Ss who were given task I label training. Analysis of variance indicated that type of training did not differentially affect task I performance ($F = 1.39$, $df = 3, 72$, $p > .10$), but that level of training did ($F = 25.61$, $df = 1, 72$, $p < .05$). That is, task I performance varied only as a function of amount of training but not as a function of type of training. This finding was required as a necessary condition of the levels-of-training design. The treatments by levels interaction was also not significant ($F = 0.13$, $df = 3, 72$, $p > .10$). The mean number of correct responses per S on the final two trial blocks for the six-trials groups was 8.1 out of a possible 12, and for the thirteen-trials groups, 10.9 out of 12. individual group means are presented in Table 5.

Task II

Task II performance was evaluated in terms of trials to criterion. A summary of these data are presented in Table 6 and Figure 3. Inspection of these data reveals that all the experimental groups display positive transfer when compared to the control group.

The experimental groups' data were analyzed as a factorial experiment via analysis of variance and the control group was then compared to each of

TABLE 5

Task I Performance: Mean and Standard Deviation of Correct Response Anticipations on the Final Two Trial Blocks of Task I Label Training for Each of the Labeling Groups

Group	Training Paradigm		Level of Task I Training	
I	ABA_cB_c	M	9.20	11.50
		SD	2.09	1.02
II	ABA_cC_c	M	8.00	10.80
		SD	3.32	2.14
IV	ABC_cB_c	M	7.30	10.60
		SD	2.76	1.20
V	ABC_cD_c	M	7.70	10.50
			2.53	2.77

TABLF 6

Task II Performance: Mean and Standard Deviation of the Number of Trials to Criterion for Each of the Treatment Groups

Group	Training Paradigm		Level of Task I Training 6	13
I	ABA_cB_c	M	13.40*	7.80*
		SD	7.24	1.99
II	ABA_cC_c	M	25.10	21.90*
		SD	6.36	8.08
III	AOA_cB_c	M	27.60	17.50*
		SD	10.72	4.61
IV	ABC_cB_c	M	19.20*	14.90*
		SD	7.77	4.48
V	ABC_cD_c	M	21.40*	27.00
		SD	9.32	6.96
VI	$--A_cB_c$	M	32.20	
		SD	7.03	

*Significantly different from control group ($p < .05$)

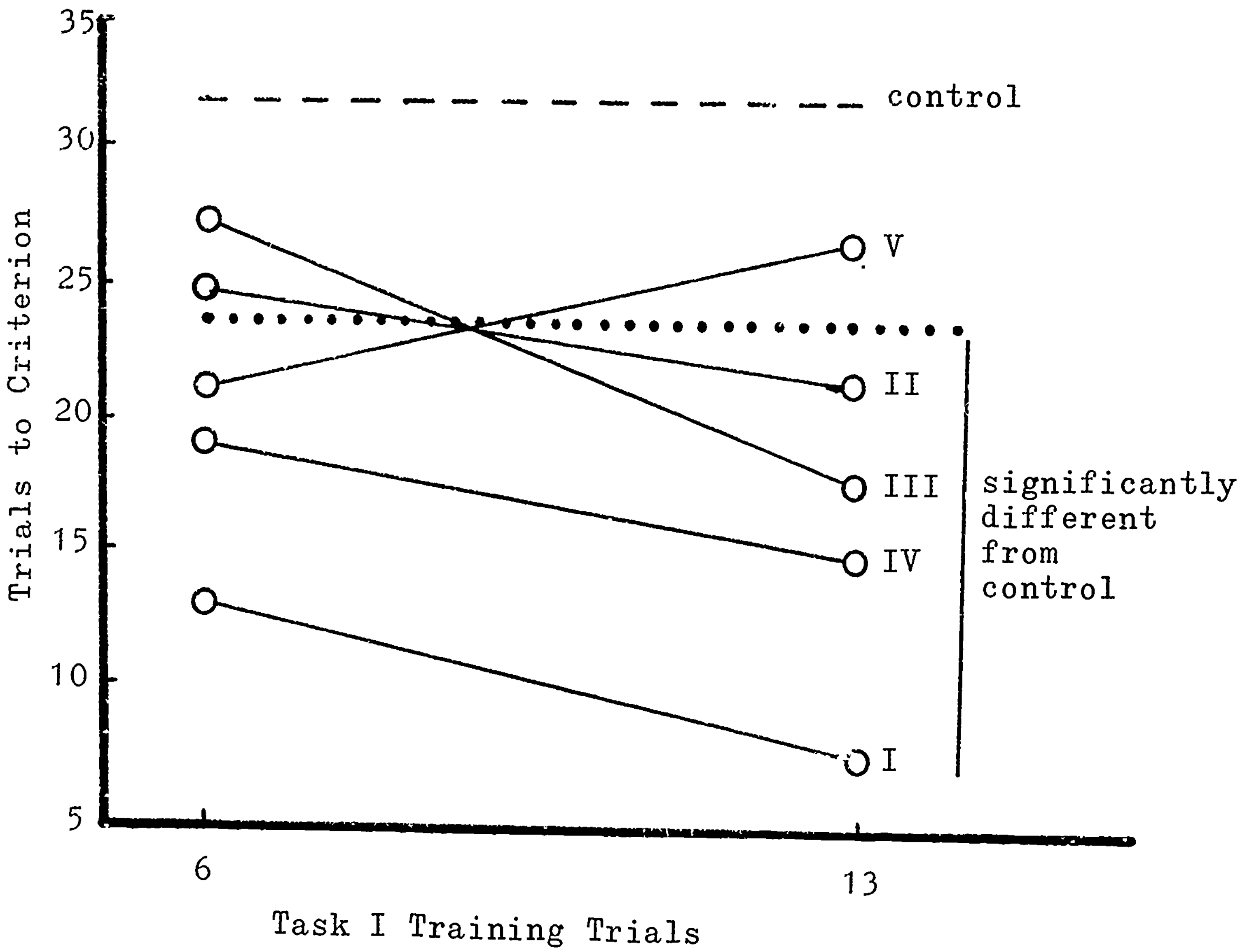

Fig. 3. Mean number of task II trials to criterion following six or thirteen trials of task I learning.

the experimental groups by means of a t-test procedure (Winer, 1962, p. 263). Both main effects and their interaction proved to be significant at the .05 level (treatment $F = 11.61$, $df = 4, 90$; levels $F = 5.42$, $df = 1, 90$: interaction $F = 2.88$, $df = 4, 90$.). The t-test comparisons of the control group with each of the treatment groups are also summarized in Table 6 and Figure 3. The positive transfer exhibited by the ABA_cB_c groups is as expected and clearly consistent with those typically observed in the ABA'B' paradigm.

The fact that 13 trials of ABA_cC_c training produced a significant amount of positive transfer is quite interesting since this paradigm is analogous to the ABA'C which typically yields negative transfer. These results indicate that the task I and task II responses represent distinct response classes. This notion of distinct response classes is further supported by the fact that the Ss in the two RS_e-IR_e groups made no task I response intrusions during task II learning. This indicates that the Ss were able to keep lists differentiated during task II training.

The transfer exhibited by the ABA_cC_c groups could possibly be accounted for in terms of nonspecific transfer since their task II performances did not statistically differ from those of ABC_cD_c groups. (Duncan's new multiple range statistic). A more reasonable explanation of this lack of difference between the ABC_cD_c and ABA_cC_c groups might be that the responses of the two RS_e-IR_e tasks represented moderately different response classes. Muller and Ellis (1965) found ABAC transfer to be positive and much greater than ABCD transfer when response class similarity was very low (verbal-motor); Porter and Duncan (1953) found it to be definitely negative when similarity was high (adjectives-adjectives); in the present study, transfer was found to be slightly positive when the response class similarity was apparently only moderate. If the responses of the ABA_cC_c condition do represent moderately different response classes, it must be due to the number of syllables in the responses; that is, one syllable response in the first task, two syllable responses in the second.

Also worthy of note is the fact that thirteen trials of AOA_cB_c training produced positive transfer while six trials did not. The improvement in task II performance brought about by additional task I practice is greatest for this group.

One plausible account for this exceptional steepness in the AOA_cB_c curve is that Ss do not have sufficient time to generate their own labels for the stimuli in six trials of task I training but do have time in thirteen trials. The presence of these labels then mediates the association of task II responses. Specifically, Muller (1968) argues that in P-A learning, the response is learned to both the E supplied stimulus as well as to an S generated covert label or name for that stimulus. The rates of direct S-R association and mediated S-label-R association are determined by the level in meaningfulness of the nominal stimulus, S, and the functional stimulus, label. When the label is much more meaningful than S, the response will be learned more rapidly via the mediational chain than through the direct

S-R hookup. Thus, if AOA_cB_c Ss had not generated a set of covert labels for the task I stimuli, learning in task II would be slower than if they had generated labels.

Another interesting result was that ABC_cB_c training produced positive transfer at both levels. This indicates that response familiarization in this task is an important source of transfer. This, however, would probably not be a major factor in the LTR task where responses are highly familiar to the learner.

Finally, note that six trials of ABC_cD_c training produced positive transfer, while thirteen trials did not. Nonspecific transfer research would indicate the reverse of this to be true; i.e., greater positive transfer with increasing amounts of training. This discrepancy may have been due to fatigue. Thirteen trials of task I training, plus many trials of task II training, may have produced an excessive amount of fatigue. If this was the case, one would have to assume that fatigue also affected the performances of most of the other groups receiving thirteen trials of task I training. However, for the other groups the additional task I trials could have produced an increase in specific transfer which obscured this effect.

If the transfer exhibited by the ABA_cB_c group is in fact due to a combination of transfer effects, then performance of that group should be superior to the performances of those groups reflecting only a portion of those same transfer effects. For example, if ABA_cB_c transfer includes, in part, specific stimulus learning produced by stimulus observation, LTL associations and response element familiarization, then AOA_cB_c performance should be inferior to ABA_cB_c since it reflects only specific stimulus learning produced by observation. Similarly, the ABC_cD_c groups exhibit transfer effects due only to LTL and thus should also be inferior to the ABA_cB_c groups. ABC_cB_c performance reflects both LTL effects and response familiarization effects, and thus should be superior to ABC_cD_c but inferior to ABA_cB_c. Inspection of Figure 3 indicates that the empirical results are consistent with these predictions. A Duncan's new multiple range statistic reveals Task II performance for ABA_cB_c to be significantly superior to that of AOA_cB_c, ABC_cB_c, and ABC_cD_c at both levels of task I training. The difference between ABC_cD_c and ABC_cB_c is significant only after thirteen trials of task I training. A complete Duncan's New Multiple Range analysis is presented in Table 10.

The results for task II were then analyzed in terms of relative training efficiency. The training efficiency index (TEI) was defined as the ratio of the control group's trials-to-mastery to the experimental group's total trials-to-mastery. Total trials-to-mastery for the experimental groups included both task I and II trials. Since task II training was continued to a criterion of five successive errorless trial blocks, the first trial on which S demonstrated mastery of the task was four trials prior to his reaching criterion. To compensate for this, four was subtracted from the task II means for both the control group and the experimental groups.

$$\text{TEI} = \frac{(\text{task II mean, cont}) - 4}{(\text{task II mean, exp}) - 4 + (\text{number of task I trials, exp})}$$

The TEI's for the treatment groups are presented in Table 7. The higher the TEI, the greater the efficiency of training. A t-test analysis of the differences between the total trials-to-mastery of the experimental groups and the control group revealed that only ABA_cB_c training was significantly more efficient than no task I training.

In looking at the educational implications of preparatory learning, the issue of training efficiency is vitally important. For example, in the LTR task, even if an initial letter experience does produce positive transfer to the word-reading task, it does not necessarily follow that total instructional effort will be reduced by using that approach.

From the results of the training efficiency analysis, it would appear that the only prereading letter training that would provide a reduction in instructional effort is letter label training in which high letter name-sound correspondence is maintained.

A question which arises at this point is the relationship between training efficiency for ABA_cB_c training and the degree of letter name-sound correspondence. A comparison of the transfer produced by ABA_cB_c and ABA_cC_c training indicates that training efficiency decreases as name-sound correspondence decreases. Another aspect of this issue is variability in the sounds associated with a given element as it appears in different compounds. For example, S m learn response R_1 to stimulus S_1 during initial training and then learn to associate response element R_1' to element S_1 as it appears in one compound and R_1'' to S_1 as it appears to another compound. This is

TABLE 7

Task II Training Efficiency Index for

the Various Experimental Groups

Group	Training Paradigm	Level of Task I Training 6	13
I	ABA_cB_c	1.83*	1.67*
II	ABA_cC_c	1.04	0.91
III	AOA_cB_c	0.95	1.06
IV	ABC_cB_c	1.33	1.17
V	ABC_cD_c	1.20	0.78

*Significantly different from the control at the .05 level of confidence the case with the sounds associated with letters in the reading task. The critical question is whether the added efficiency of high letter name-sound correspondence label training can be maintained when a given stimulus element has several variants of the original label associated with it in the second task. In the LTR task, the word response is almost always familiar to the S and thus a slightly inaccurate "sounding-out" response to the stimulus elements should still effectively mediate the correct pronunciation response. Thus, it is probably not essential to the maintenance of maximum efficiency that each sound of the language have an unique visual representation.

Task III

The mean numbers of correct responses per S and mean response latencies for each of the treatment groups are presented in Tables 8 and 9. These data were subjected to separate analyses of variance, which revealed that neither of the main effects nor their interaction was statistically significant. Since the control group means fell within the range of experimental group means, the t-test analysis was not performed on either of the dependent variables. The failure to find any significant differences in the task III performances of the various groups is interesting in light of a frequent criticism of the phonics approach to reading. Namely, critics of this method frequently argue that it produces slow reading. The results of this experiment fail to support this contention. This finding, however, is at best suggestive.

TABLE 8

Task III Performance, Correct Anticipations: Mean and Standard Deviation of the Number of Correct Response Anticipations During Task III Training for Each of the Treatment Groups

Group	Training Paradigm		Level of Task I Training 6	Level of Task I Training 13
I	ABA_cB_c	M	11.40	11.80
		SD	0.92	0.40
II	ABA_cC_c	M	11.10	11.00
		SD	0.70	1.18
III	AOA_cB_c	M	11.10	11.50
		SD	1.37	0.92
IV	ABC_cB_c	M	10.80	11.10
		SD	1.17	0.94
V	ABC_cD_c	M	10.70	11.20
		SD	1.55	0.98
VI	$--A_cB_c$	M	11.40	
		SD	0.66	

TABLE 9

Task III Performance, Latency: Mean and Standard Deviation of Response Latency During Task III Training for Each of the Treatment Groups

Group	Training Paradigm		Level of Tax I Training 6	13
I	ABA_cB_c	M	5.20	5.09
		SD	0.90	0.56
II	ABA_cC_c	M	5.40	5.08
		SD	0.87	0.67
III	AOA_cB_c	M	5.40	4.63
		SD	0.85	0.54
IV	ABC_cB_c	M	5.06	5.58
		SD	0.62	0.53
V	ABC_cD_c	M	5.30	5.03
		SD	0.59	0.59
VI	$--A_cB_c$	M	5.40	
		SD	.68	

COMMENTS AND CONCLUSIONS

An issue greatly in need of further study is that of adult versus child Ss. To investigate LTR using adult Ss would certainly be inappropriate if there were real differences in relevant learning phenomena between adults and children. Previous research has failed to reveal any such differences, however, a direct comparison of these groups on this type of task seems advisable.

The results of this experiment indicate that transfer phenomena in stimulus compound paradigms are generally consistent with phenomena in more conventional paradigms. This implies that a generalized theory of transfer of associative learning is feasible. While the results of this present research have moderate applicability to reading, it is felt that additional research in this area will make a substantial contribution to the development of an associative learning theory of reading. This theory should then be instrumental in the development of more efficient methods of reading instruction.

TABLE 10

Summary of the Duncan's New Multiple Range Analyses of the Task II Performance Means

		Duncan's New Multiple Range Analysis									
		ABA_cB_c, 13	ABA_cB_c, 6	ABC_cB_c, 13	AOA_cB_c, 13	ABC_cB_c, 6	ABC_cD_c, 6	ABA_cC_c, 13	ABA_cC_c, 6	ABC_cD_c, 13	AOA_cB_c, 6
	Mean	7.8	13.4	14.9	17.5	19.2	21.4	21.9	25.1	27.0	27.6
AEA_cB_c, 13	7.8			*	*	*	*	*	*	*	*
ABA_cB_c, 6	13.4							*	*	*	*
ABC_cB_c, 13	14.9								*	*	*
AOA_cB_c, 13	17.5								*	*	*
ABC_cB_c, 6	19.2									*	*
ABC_cD_c, 6	21.4										
ABA_cC_c, 13	21.9										
ABA_cC_c, 6	25.1										
ABC_cD_c, 13	27.0										
AOA_cB_c, 6	27.6										

*Significant at .05 level of confidence

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APPENDIX A

A DESCRIPTION OF THE PAIRED-ASSOCIATES LEARNING AND TRANSFER TASKS

Paired-associates learning. -- In the paired-associates learning task, the subject is asked to learn a specific response to each of a set of stimuli. For example, the learner may be required to learn a specific girl's name to each of a set of pictures of girls. Generally, the stimulus term is referred to as S or S_k where k is an integer identifying the specific stimulus. For example, if one were using three stimuli, he would refer to them as S_1, S_2 and S_3. Similarly, the response terms are designated R or R_k such that R_k is paired with S_k. That is, R_1 is learned to S_1, R_2 to S_2 and so on.

In the paired-associates learning experiment, stimulus and response presentations are rigidly controlled. The stimulus term is presented first alone and then with the response term. A typical presentation sequence might be: S_1 for two seconds, $S_1 + R_1$ for two seconds, S_2 for two seconds, $S_2 + R_2$ for two seconds and so on.

Generally, the stimuli are presented in trial blocks. A trial block is one presentation of each of the stimulus terms. The order of the stimuli within the trial blocks is almost always varied from block to block so the subject cannot learn the responses through serial order.

The stimulus and response terms are usually presented visually. That is, the stimulus may be a printed word or a picture; the response, a printed word. However, S and R terms could be presented in any of a number of modes. The response the subject makes is usually a verbal utterance but is not necessarily restricted to that domain. For example, the subject may learn a particular manipulatory response to a stimulus.

The subject is instructed to anticipate the response term by making the response prior to the presentation of the response term. Performance is evaluated in terms of the number of correct response anticipations per trial block.

Transfer of paired-associates learning.--Transfer of paired-associates learning is studied by having the subject learn an initial paired-associates list and a subsequent paired-associates list. Transfer is defined as the effect of learning the initial list upon the learning of the subsequent list.

The nature of the two lists is usually described with two pairs of letters, e.g., A-B, C-D. This description is referred to as a transfer paradigm. The first letter in each of the pairs, A and C, symbolizes the set of stimulus terms in each list. The second letter in each of the pairs, B and D, symbolizes the set of response terms in each list.

When two letters in the paradigm are identical, the corresponding stimulus or response terms are identical. For example, in the A-B, A-C transfer paradigm the stimulus terms in the initial list are identical to those in the subsequent list. In the paradigm A-B, C-B, the response terms are identical. In the A-B, C-D paradigm, neither the stimulus nor response terms are identical.

On occasion the stimulus or response terms of the second task will be similar to, but not identical with, the corresponding terms of the first task. In this case the mathematical prime-symbol is used to designate similarity. For example, in the A-B, A'-C paradigm, the first and second task stimulus terms are similar.

Further, in the A-B, A'-B' paradigm, both the first and second task stimulus and response terms are similar.