THE EFFECTS OF SIMILARITY AND REPETITION OF RESPONSE ALTERNATIVES ON VARIOUS TYPES OF PAIRED ASSOCIATE LEARNING

K. A. JOHNSON, PhD

R. J. SENTER, PhD

F. W. SMITH

Foreword

This research represents a portion of the exploratory development program of the Technical Training Branch, Training Research Division of the Behavioral Sciences Laboratory. The report was done in part under Contract AF 33 (615)-1046 with the University of Cincinnati. Dr. R. J. Senter of the University of Cincinnati, was principal investigator, and Dr. K. A. Johnson, of the Technical Training Branch, was the technical contract monitor. The research was done in support of Project 1710, "Training, Personnel and Psychological Stress Aspects of Bioastronautics," Task 171007, "Automated Training and Programmed Instruction." Dr. G. A. Eckstrand was project scientist and Dr. R. L. Morgan was task scientist.

The authors wish to thank Erhardt Eimer, Gary Miller, and Mark Schulzinger, all of the University of Cincinnati, for their help in the preparation of experimental materials and in the collection and analysis of the data.

This technical report has been reviewed and is approved.

WALTER F. GRETHER, PhD
Technical Director
Behavioral Sciences Laboratory
Aerospace Medical Research Laboratories

Abstract

Previous research has shown that the simple simultaneous presentation of a stimulus term and the single correct response term is as efficient as any of the alternative training techniques that have been suggested for paired associate learning. The present investigation was an attempt to find learning materials for which the simultaneous presentation technique would be inferior to other techniques. Subjects learned a 40-item list of paired-associates under one of four training conditions. In the One Alternative Prompt condition subjects saw only the stimulus term and the correct response term; no anticipation was required. In the Two Alternative Anticipation condition subjects saw two response terms, one correct and one a distractor; they were required to select one of these before being told the correct response. The Five Alternative Anticipation condition was similar to the Two Alternative condition, but four distractors were used instead of one. Subjects in the Five Alternative Prompt condition also saw five response alternatives, but the correct alternative was indicated immediately; no anticipation was required. Three training trials were given under one of the above conditions. All subjects were then transferred to a criterion series that consisted of three trials in the Five Alternative Anticipation condition. The stimulus terms were the names of electronic circuits, the response terms, schematic diagrams of electronic circuits. Half the items had distractors that were very similar to the correct response term, the remaining half, distractors that were less similar. Half the items in each of these groups had distractors that were the correct response terms for other items in the list. The remaining items had distractors that were unique to a given item. The overall differences between training techniques were not large, but there was some indication that the Five Alternative Prompt condition was inferior to the remaining conditions. Interactions were found between training conditions and item types, but again the differences involved were not large. Separate comparisons on the various item types indicated that in no case was the One Alternative Prompt condition realiably inferior to any of the remaining conditions.

Table of Contents

List of Tables

List of Figures

SECTION I

Introduction

Until fairly recently psychologists relied almost exclusively on the anticipation-confirmation technique in their studies of human verbal learning. The subject was presented a stimulus term and asked to overtly anticipate the correct response term. After this attempted response he was presented the correct response term as a correction or confirmation. Although this procedure was fine as a method for studying learning, it was not very efficient as a method for teaching (ref 15). It was not until the last few years, however, with the increased use of programmed instruction on the one hand, and the increased use of alternative techniques in learning experiments on the other, that psychologists have shown much interest in the method itself. This interest has taken two forms: first, a practical interest in the anticipation-confirmation technique as a potentially useful training technique, and second, a more theoretical interest in the factors that distinguish this technique from other training techniques.

Most experimental investigations of the anticipation-confirmation technique have involved comparisons with some variation of what has generally been called the prompt technique[1]. In the prompt technique, the subject is presented the stimulus and response terms at the same time, or, in some cases, the stimulus term followed almost immediately by the response term. In neither case is the subject required to anticipate or guess the response term.

In a number of these comparisons, the experimental materials have been derived from existing instructional materials written in a programmed format. Most programmed materials employ the anticipation-confirmation technique; many of these can be converted to the prompt technique simply by filling in the blanks or underlining the correct alternatives. The comparisons between these modified and unmodified programs can be summarized as follows: (1) students working with the modified programs complete them much more rapidly than do students working with the unmodified programs; (2) differences in achievement have frequently failed to reach the usual levels of statistical significance, but the reliable differences that have been found have generally favored students working with the unmodified programs.

A second group of comparisons has been based on studies using the paired associates format. Since the present investigation employs this format, these studies will be examined in greater detail. In the paired associates format the student is required to learn a set of discrete stimulus-response pairs that are unsupported by a narrative context of the type present in most instructional programs. This format has a long history in the psychological laboratory, but it is also used in more practical applications, for example, in the teaching of foreign vocabularies. The published studies using the paired associate format have shown that the prompt technique is superior to the anticipation-confirmation technique (refs 3, 4, 5, 6, 7, 11, 12, 13, 14). This superiority is more than a more rapid progression through the required material; the subject actually learns more material per presentation when the presentation is by means of the prompt technique. These findings have remained remarkedly consistent across a variety of learning materials and several versions of both the anticipation-confirmation and prompt techniques. The exact limits to this superiority of

[1] Prompting is generally viewed as a quantitative variable; one will find discussions of various amounts of prompting that might be provided to students that are being trained by means of the anticipation-confirmation technique. In this paper the term "prompt technique" will be used only in cases of complete prompting, i.e., in cases in which the correct response is specified without ambiguity.

the prompt technique, in terms of type of material, amount of material, or manner of presentation, have not as yet been determined.

Theoretical formulations have contributed relatively little to an understanding of these empirical findings. In fact, several of the studies cited above were conducted under the assumption that the anticipation-confirmation technique would be found superior to the prompt technique. These expectations were based on several of the more widely held principles or generalizations in the area of learning. One of these, for example, is the principle that an active involvement in the learning process will facilitate learning. Since the prompt technique would certainly permit a more passive approach to the learning situation, it would seem reasonable to predict that it would prove inferior to the anticipation-confirmation technique. The principles associated with transfer of training would also appear to favor the anticipation-confirmation technique. Differences between training situations and testing situations generally lead to decrements in performance, and these differences are far greater with the prompt technique than with the anticipation-confirmation technique.

The inferiority of the anticipation-confirmation technique does not, of course, invalidate these principles. There is actually considerable evidence for their operation even within the paired associates format, though in most cases their contribution is outweighed by the contribution of factors that favor the prompt technique. In a study by Angell and Lumsdaine (ref 2), for exemple, subjects trained by means of an uninterrupted series of prompt trials did not do as well as subjects trained by means of a similar series in which every fourth prompt trial was replaced by an anticipation-confirmation trial. Apparently, certain mixtures of the two techniques are better than either one of the techniques used alone. This interaction likely is based in part on the operation of the principles considered above.

The identification of the factors that favor the prompt trials is complicated to some extent by variations in the procedures that have been lumped together under the designations "anticipation-confirmation" and "prompt." Factors that probably make a substantial contribution to the superiority of the prompt technique in certain of the comparisons cited above could make no contribution at all to the superiority found in other comparisons. Several of the studies (refs 3, 6, 7, 13), for example, measured the progression of learning by means of test trials interspersed periodically within the learning series. Interspersed test trials of this type can lead to large improvements in performance (ref 10). Part of this improvement probably can be attributed to the fact that test trials provide many of the same advantages as do anticipation-confirmation trials: they insure a more active involvement in the learning task and also provide training for transfer to subsequent test situations. If this is the case, then one would expect a mixture of prompt and test trials to produce an interaction similar to that produced by the mixture of prompt and anticipation-confirmation trials in the experiment by Angell and Lumsdaine (ref 2). A mixture of anticipation-confirmation and test trials, on the other hand, would be far less likely to produce such an interaction. The anticipation-confirmation trials themselves would probably provide an optimum, or perhaps more than optimum, level of active involvement; they would certainly provide an adequate preparation for transfer to the test situation. If these assumptions are correct, then test trials would contribute more to a series of prompt trials than to a series of anticipation-confirmation trials. Any comparison based on mixed series would be biased in favor of the prompt condition.

Another factor that probably contributes to the superiority of the prompt trials is the closer temporal contiguity between the presentation of the stimulus term and the presentation of the

response term. A study by Sidowski, Kopstein, and Shillestad (ref 14), however, indicates that even when this S-R contiguity is manipulated so as to be greater for the anticipation-confirmation trials than for the prompt trials, the prompt technique remains the better of the two.

A third possibility, and the only one of the three that could contribute to all of the cited comparisons, is that the prompt technique is superior because it precludes errors. A pair of studies by Kaess and Zeaman (ref 11) provide convincing evidence that errors do indeed lead to a decrement in subsequent performance.

Even if one accepts the premise that errors have an undesirable effect on learning, one cannot, unfortunately, insure efficient learning by blindly reducing the opportunity for error. There are obviously situations where techniques that are conducive to errors are also conducive to improvements in learning. One such situation was demonstrated in the experiment by Angell and Lumsdaine (ref 2), in which the effect of errors committed on the anticipation-confirmation trials was more than offset by the positive effect of other factors associated with these trials. Other examples can be found in studies on discrimination learning in animals. Repeatedly an error on the initial trial has been shown to be more beneficial to subsequent performance than is a correct response (ref 9).

The present investigation was designed in an attempt to explore the limitations of one particular technique for precluding errors in paired associates learning: the simple simultaneous presentation of the stimulus and correct response terms. At this point it becomes necessary to make a finer distinction between two techniques that have heretofore been classified together as alternative versions of the prompt technique. Let us assume that we wish to train our subject to select the correct response to a given stimulus term from a set of five alternative response terms. One method of training the subject would be by means of the technique described above: on each presentation he would see only the stimulus term and the single correct response term. Another method would be to present the stimulus term and all five of the response terms; the correct response term, however, would be underlined or indicated in some other way.

There have been two studies that provide comparisons between these two techniques. Kaess and Zeaman (ref 11) employed a criterion test that consisted of 30 definitions of psychological terms (stimuli), each of which was followed by five terms that might fit the definition (responses). Training consisted of a single trial through the list of 30 definitions. They found no difference between the students who had seen the single correct term for each definition and those who had seen all five terms with the correct one underlined. The generality of these findings, however, is probably limited by the type of material employed. Since the incorrect response terms were unique to a single item the students in the single correct response group may have been able to respond correctly on the test trial by marking any response they remembered having seen before. They would not have enjoyed this advantage had the incorrect response terms for one item been selected from the correct response terms for other items. Another factor that might have favored the single correct response group is the high dissimilarity among response terms. The multiple response group might well be expected to enjoy an increased advantage if discriminations between response terms were more difficult. A study by Angell and Terry (ref 3) would appear to meet this last objection. Their materials consisted of English-German word pairs. Their distractors were selected so as to have high orthographic similarity to the correct German responses. The single and multiple response groups did not differ in achievement over a training series of eight trials, but students in the single response group completed these trials in approximately half the

time required by students in the multiple response group[1]. Once again distractors were unique to a given item, but this probably has less of an effect with highly similar response terms of the type used in this experiment. The fact that a test trial was given following each training trial, however, represents a more serious difficulty. These test trials provided the subjects in the single response group with an opportunity to make simultaneous discriminations among the response alternatives, thereby rectifying what would appear to be one of the most serious disadvantages associated with this technique. On the first test trial, though, the single response group saw the distractors for the first time. A separate statistical analysis was not reported for this trial, but even here, the performance of the single response group was slightly superior to that of the multiple response group.

The single correct response technique is a model of simplicity; the materials are easy to prepare and easy to present. In the studies cited above, this technique was found to be superior to the anticipation-confirmation technique. It was found to be as good as the somewhat more elaborate multiple response prompt technique. The primary purpose of the present experiment was to determine whether there were paired associates materials for which the single correct response technique would not be the most efficient single presentation technique. An intentional effort was made, therefore, to select materials that would place the single correct response technique at a disadvantage. Response terms were selected so as to maximize intraset similarity. Nonverbal response terms were selected in an effort to reduce verbally mediated discriminations. The distractors in one set were selected from terms that were correct responses in other sets in an effort to preclude correct associations based on familiarity. Finally, the subjects were exposed to an uninterrupted series of training trials in an effort to rule out any contamination from interspersed test trials.

[1] Students in the multiple response group, however, were required to make an overt response by punching an IBM Port-A-Punch card, whereas students in the single response group were not. This may account for the difference in time.

SECTION II

Method

SUBJECTS

All subjects were male students from introductory psychology courses at the University of Cincinnati. All students in these courses are required to serve as subjects in a psychological experiment and those who participated in the present experiment did so in order to meet this requirement. Subjects were randomly assigned to one of four training conditions and all subjects in a given condition were run as a single group. The original groups varied somewhat in size as the result of subjects who failed to appear at their scheduled times. The groups were matched in size by discarding randomly selected subjects until each group contained 20 subjects. Data from the discarded subjects were not analyzed.

MATERIALS

The materials used in this experiment consisted of 40 multiple choice items. The stimulus terms were the names of electronic circuits, e.g., cut-off type triode limiter or impedance coupled amplifier. Each item had five response alternatives, each of which was the schematic diagram of an electronic circuit. These items were organized into four categories of ten items each. One basis for classification was the degree to which the five response alternatives for a given item resembled one another. Half the items were characterized by a high degree of intraset similarity (see fig 1), the remaining items by a relatively low degree (see fig. 2). A second basis for classification was the number of times a given response alternative was used. For half the items in each of the previously defined groups, each response alternative was unique to a given item. For the remaining items, each distractor was the correct alternative for another item within the group. Each response term used in this group actually appeared five times during a given trial, once as the correct response and four times as a distractor. This organization of items is diagramed in table I.

TABLE I

CLASSIFICATION OF ITEMS

	Similar Alternatives	*Dissimilar Alternatives*
Repeated Alternatives	10 Items	10 Items
Unique Alternatives	10 Items	10 Items

As will be seen, this classification of items is more immediately relevant to the criterion trials than it is to certain of the training trials.

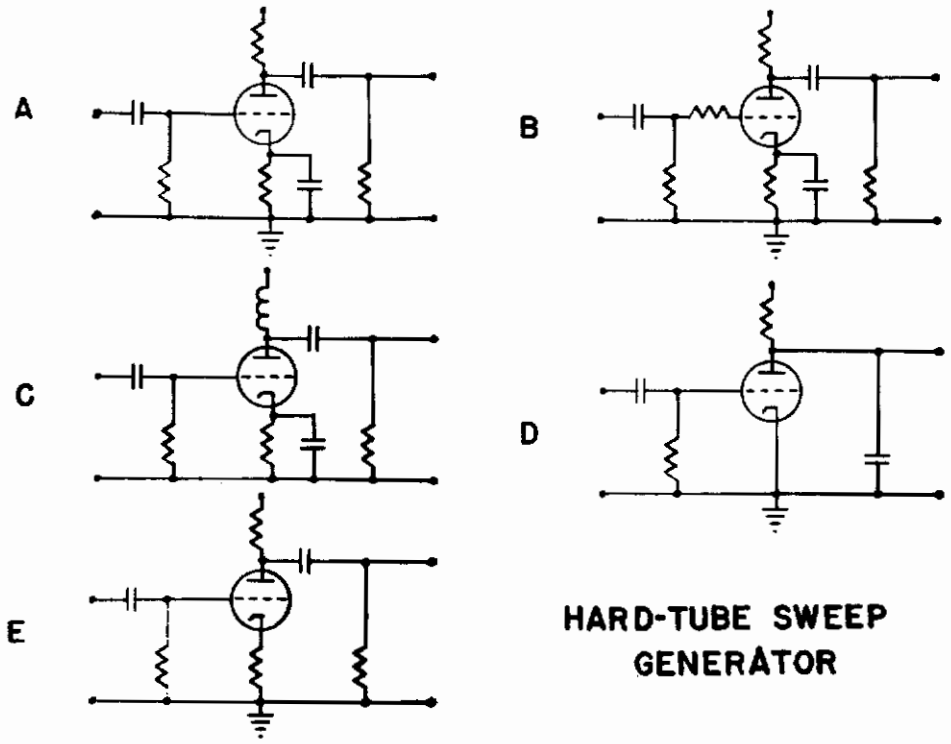

Figure 1

Example of Item with High Intraset Similarity between Response Alternatives

TRAINING CONDITIONS

Each subject was trained under one of the following four conditions:

Five Alternative Prompt (5AP) Under this condition, the stimulus term and all five response alternatives were presented simultaneously. The correct alternative was indicated by a rectangular frame.

One Alternative Prompt (1AP) Under this condition, the stimulus term and the correct response term were presented simultaneously. The incorrect alternatives or distractors were not presented.

Two Alternative Anticipation (2AA) Under this condition, the stimulus term, the correct response term, and one distractor were presented simultaneously. The distractor was randomly selected from the four available distractors; the same distractors were used on all training trials. The subject attempted to select the correct response term. After the subject had made his selection, he was told the term that should have been seleced.

Five Alternative Anticipation (5AA) Under this condition, the stimulus term and all five response alternatives were presented simultaneously. The subject attempted to select the correct response term. After the subject had made his selection, he was told the term that should have been selected.

PROCEDURES

Each subject received three training trials under one of the four conditions described above. Following these three trials, all subjects were transferred to a criterion series that consisted of

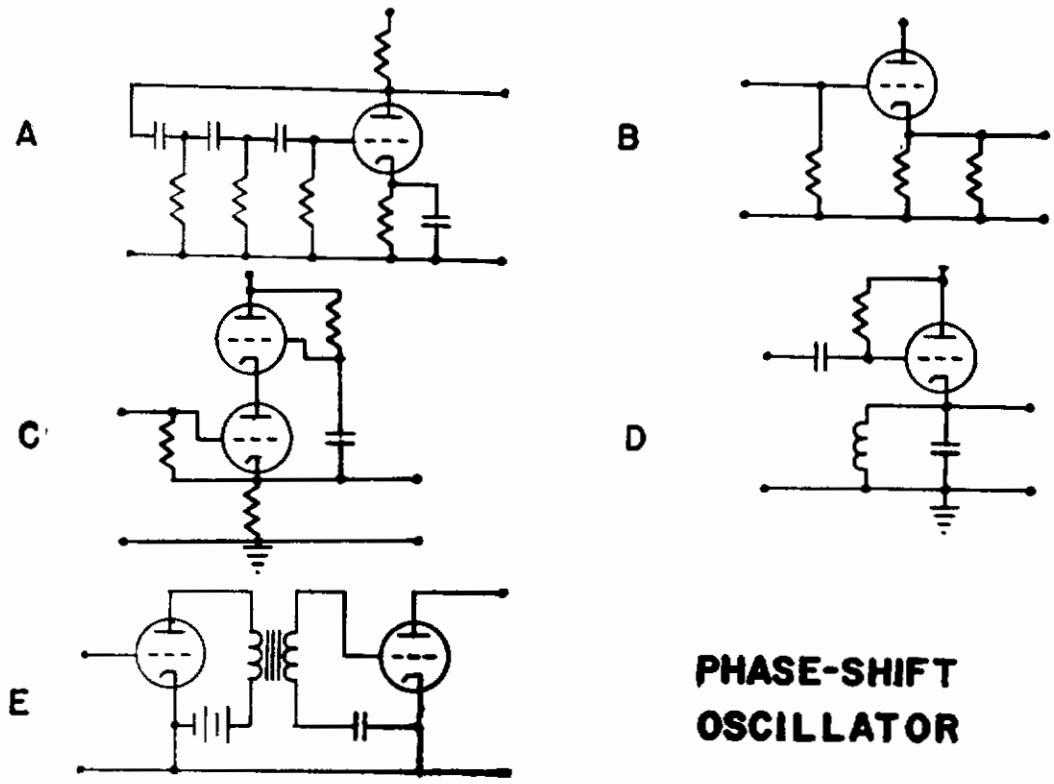

Figure 2

Example of Item with Relatively Low Intraset Similarity between Response Alternatives

three additional trials under the Five Alternative Anticipation condition. They were informed that this transfer would occur. All subjects were trained and tested on the same 40 items.

Instructions were given by means of a tape recorder. The training and testing materials were presented by means of a slide projector that had been slaved to the tape recorder. The order in which the items were presented was scrambled from trial to trial. Each item presentation required 30 seconds; a single slide remained visible throughout the entire interval. The slides, of course, differed from group to group, but the timing of the presentations was much the same for each of the four groups. During the first 12 seconds the subject could study the item and, if he wished, indicate his response. Responses were recorded by writing the letter appearing to the left of the selected alternative (see figs 1 and 2) on a multiple choice answer sheet. These sheets were enclosed in a cardboard mask that presented a single item at a time. In order to control for any distractions created by the recording process, subjects in the 1AP and 5AP groups were required to record the letter associated with the correct response term. The order of alternatives within an item were scrambled from trial to trial so as to prevent correct responses based on letters or positions. After 12 seconds, the subjects heard the word "Ready." Subjects who had not already responded were required to do so at once. After 5 additional seconds, the subjects heard the word "Stop." The subjects were required to place their pencils on the table and slide their answer sheets to the next item. At this point, the procedures for various groups diverged. Subjects in the 2AA and 5AA groups waited for 3 additional seconds and then heard the letter associated with the correct alternative; they spent the remaining 10 seconds in studying the item. Subjects

in the IAP and 5AP groups spent the 13 seconds between the word "Stop" and the changing of the slide in studying the item. A typical trial in either the 2AA or 5AA conditions might be summarized as follows: Slide appears — 12 sec. — "Ready" — 5 sec. — "Stop" — 3 sec. "D" — 10 sec. — slide change. A typical trial in either the 1AP or 5AP conditions would differ from the above in only one respect: the subject would not hear "D," the letter of the correct response alternative. All auditory signals were provided by the tape recorder. An interval of approximately 10 minutes separated the three training trials from the three criterion trials; intervals of approximately 1 minute each separated the trials within each category.

SECTION III

Results

The last three trials in the 5AA mode (the transfer or criterion trials) were scored in terms of items correct[1]. These data were analyzed by means of a 2 (response similarity) X 2 (response repetition) X 3 (trials) X 4 (training conditions) analysis of variance. A summary of this analysis

TABLE II

ITEMS CORRECT: ANALYSIS OF VARIANCE

Source	*df*	*MS*	*F*	*p*
Between Subj.	79			
Training Conditions (C)	3	75.51	2.64	NS
Subj. w/groups (SwG)	76	28.61		
Within Subj.	880			
Trials (T)	2	94.70	49.27	.001
TXC	6	3.81	1.98	NS
TXSwG	152	1.92		
Repetition (R)	1	100.75	29.54	.001
RXC	3	10.25	3.00	.05
RXSwG	76	3.41		
Similarity (S)	1	1168.21	196.34	.001
SXC	3	32.99	5.54	.01
SXSwG	76	5.95		
TXR	2	.58	.37	NS
TXRXC	6	1.23	.78	NS
TXRXSwG	152	1.58		
TXS	2	.66	.43	NS
TXSXC	6	2.77	1.82	NS
TXSXSwG	152	1.52		
RXS	1	.88	.31	NS
RXSXC	3	2.33	.82	NS
RXSXSwG	76	2.86		
TXRXS	2	3.45	2.03	NS
TXRXSXC	6	2.03	1.19	NS
TXRXSXSwG	152	1.70		

can be found in table II. The cell means on which this analysis was based can be found in table III. Subjects entered these criterion trials at a level considerably above chance and demon-

[1] Performance on this task might vary as a function of previous experience in electronics. In order to control for this, all subjects were given a 15-item multiple choice test that covered recognition of schematic symbols and knowledge of simple electronic principles. The four experimental groups made almost identical scores on the test and the correlation between test scores and performance on the criterion trials was only .08.

strated a significant improvement over the three trial criterion series. Mean items correct per trial were 18.1, 19.8, and 22.4. It was anticipated that the different training conditions would produce different amounts of transfer and that these transfer effects might dissipate over the cri-

TABLE III

AVERAGE ITEMS CORRECT

Criterion Trial	*Training Condition*	*Item Group*				
		Similar-Repeat	*Similar-Unique*	*Dissimilar-Repeat*	*Dissimilar-Unique*	*Total*
1	5AP	3.25	2.95	4.30	5.15	15.65
	1AP	3.30	2.90	6.10	6.55	18.85
	2AA	3.60	4.40	5.15	6.20	19.35
	5AA	3.10	4.00	5.20	6.25	18.55
	Mean	3.31	3.56	5.19	6.04	18.10
2	5AP	3.10	3.25	4.70	5.35	16.40
	1AP	3.25	3.30	6.85	6.85	20.25
	2AA	3.85	5.20	5.10	5.90	20.05
	5AA	3.65	5.05	6.25	7.35	22.30
	Mean	3.46	4.20	5.73	6.36	19.75
3	5AP	2.85	4.20	5.40	5.85	18.30
	1AP	4.45	4.30	6.75	7.55	23.05
	2AA	4.85	5.35	6.45	7.25	23.90
	5AA	4.25	5.65	7.00	7.50	24.40
	Mean	4.10	4.88	6.40	7.04	22.42

TABLE IV

AVERAGE ITEMS CORRECT PER CRITERION TRIAL

Training Condition	*Item Group*				
	Similar-Repeated	*Similar-Unique*	*Dissimilar-Repeated*	*Dissimilar-Unique*	*Total*
5AP	3.07	3.47	4.80	5.45	16.79
1AP	3.67	3.50	6.57	6.98	20.72
2AA	4.10	4.98	5.57	6.45	21.10
5AA	3.67	4.90	6.15	7.03	21.73
Average	3.63	4.21	5.77	6.48	20.09

terion series. The conditions X trials interaction, however, was not significant. Since none of the remaining variables interacted with trials, the data were averaged over the three criterion trials. These data can be found in table IV.

Both of the response term variables had their anticipated effects on overall performance. Subjects did better on the items with unique response terms than on items with repeated response terms. They did better on items with a relatively low degree of similarity between response terms than on items with a high degree of similarity between response terms. Each of these variables interacted with training conditions; these interactions can be seen in figs. 3 and 4. None of the remaining interactions was significant.

The effect of training conditions was not significant. An examination of figs. 3 and 4 indicates that the effects of training under the 1AP, 2AA, and 5AA conditions were quite similar. Subjects trained under the 5AP condition, however, do not appear to do as well as those in the other groups. A Newman-Keuls test on the differences between the various groups indicated that the 5AP condition differed significantly ($p<.001$) from each of the remaining conditions. No other differences were significant.

Even though the triple interaction between training conditions, response term similarity, and response term repetition was not found to be significant, an analysis of variance was performed over the four training conditions for each of the four classifications of items. The only significant difference between training conditions ($p<.01$) was found on the Similar-Unique items.

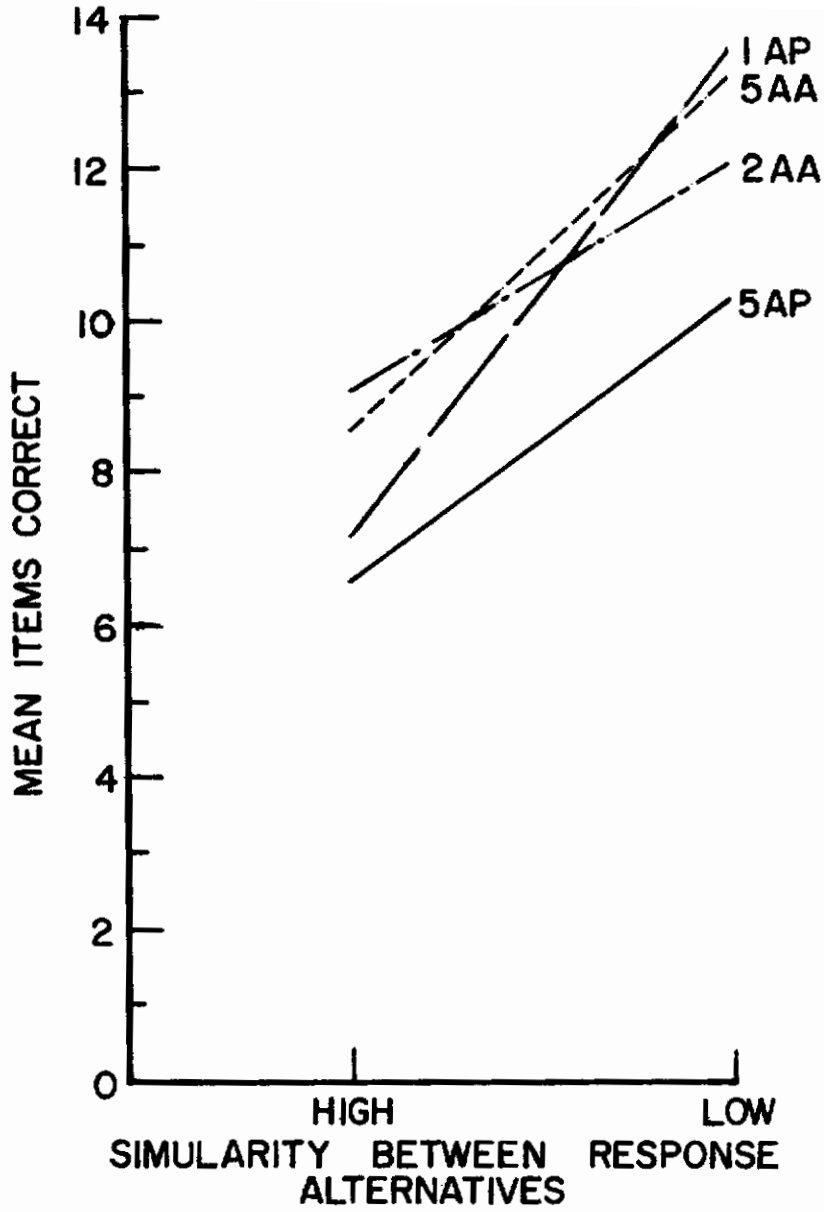

Figure 3

Interaction between Training Conditions and Similarity of Response Alternatives

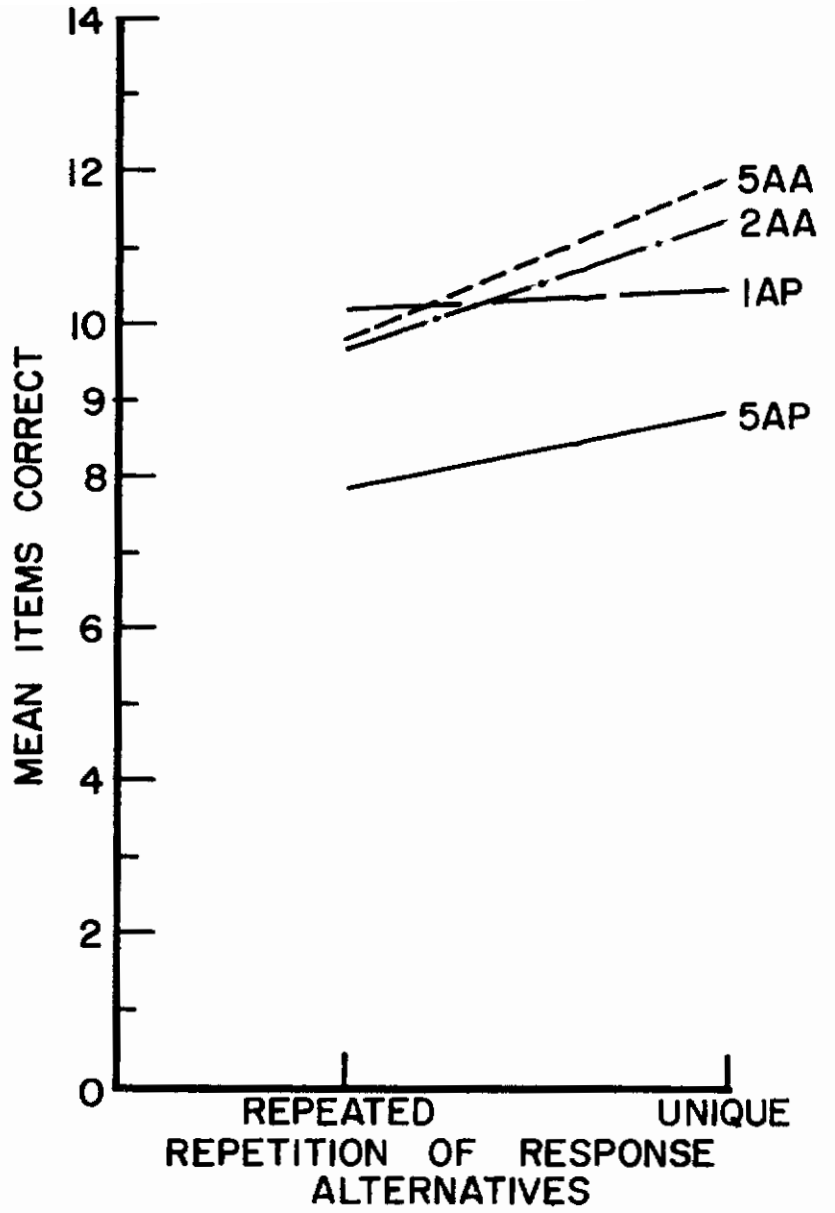

Figure 4

Interaction between Training Conditions and Repetition of Response Alternatives

SECTION IV

Discussion

We anticipated that performance on the Dissimilar-Unique items would be similar to that found in previous work with the paired associates format, i.e., that the prompt techniques would be superior to the anticipation-confirmation techniques. This was not found to be the case. Of the four training conditions, one of the anticipation-confirmation techniques, 5AA, was found to be the best, and one of the prompt techniques, 5AP, was found to be the worst. Even though the items in this group are most similar to the items used in previous experiments, there are obvious differences, not only in the materials themselves, but also in the procedures. It is difficult, however, to explain the obtained results in terms of these differences. One might be tempted, for example, to explain the inferiority of the 5AP group by an appeal to the boredom that must have been generated by the unusually long item presentation times and the unusually long duration of the experiment itself. If this were the case, then why wasn't the 1AP group, for whom these conditions should be even more boring, affected in a similar manner? One might attempt to explain this latter discrepancy by an appeal to associations based on recognition, but how then would one explain the superiority of this same group on the Dissimilar-Repeated items?

We also anticipated that as response alternatives became more similar to one another, the performance of the 1AP group relative to the performances of the 5AP and 5AA groups would decline. This expectation was based on evidence from a number of sources that as discriminations become more difficult, the relative efficiency of successive as compared to simultaneous presentation techniques declines. This expectancy is independent of any group factors that might have contributed to the results cited above; what was expected was an interaction between training conditions and response term similarity. This interaction was found to be statistically significant ($p<.01$). An examination of fig. 3 indicates that the interaction is in general compatible with the expectations outlined above; the drop in efficiency between the low similarity items and the high similarity items is greater for the 1AP group than for any of the remaining groups. The 2AA group represents the only departure from expectations. Since the discriminations made by the 2AA group are based on a mixture of the simultaneous and successive techniques, one would anticipate that, in terms of a drop in efficiency, this group would fall between the 1AP group and the 5AA and 5AP groups. Actually, there was less of a drop for this group than for any of the remaining groups.

Finally, we anticipated that the decline in performance on the items with repeated response alternatives would be greater for the 1AP group than for the 5AP or 5AA groups. This expectation was based on the belief, outlined previously, that on the items with unique responses subjects in the 1AP group would be able to select the correct response alternative on the basis of familiarity alone, i.e., they would select the only response term they remembered having seen during the training trials. Such selections would not be possible for items with repeated responses. They would be quite unlikely, regardless of item type, for subjects in the 5AP and 5AA groups, since these subjects had ample opportunity to become familiar with all of the distractors during the training trials. Once again, one would expect an interaction, this time between training conditions and response term repetition. This interaction was found to be statistically significant ($p<.05$). An examination of figure 4, however, indicates that the interaction is *not* compatible with the expectations outlined above; the drop in efficiency between the unique alternative items

and the repeated alternative items is actually less for the 1AP group than for any of the remaining groups.

These repeated disconfirmations of relatively independent expectations are rather disturbing. In the absence of alternative explanations, one is tempted to regard the experiment as the conjunction of several highly unlikely chance events. Nevertheless, the experiment is relevant to certain additional matters that should be mentioned.

The study by Angell and Terry (ref 3), portions of which were described earlier, was actually designed to test a hypothesis advanced by Ansel (ref 1). Amsel felt that when both correct and incorrect response tendencies were at a high level, an effective separation of the two could most readily be obtained by reducing the incorrect tendencies. He suggested that this be done by permitting the subject to emit the incorrect responses so that they could be weakened by nonreinforcement. Evans, Glasser, and Homme (ref 8), on the other hand, felt that such incorrect response tendencies could be reduced more effectively by simply showing the incorrect alternatives to the subject and telling him that they were wrong. Angell and Terry approximated these alternative procedures by means of conditions similar to the 5AA and 5AP conditions of the present experiment. The competing response tendencies were not at a high initial level, as suggested by Amsel. Apparently they assumed that generalizations between highly similar response terms would eventually lead to a situation in which there were fairly strong response tendencies associated with each of the alternatives. They found that the prompted condition was superior to the anticipation-confirmation condition.

The present experiment might be viewed as another test of these two alternatives. Once again the initial response tendencies were not high. The response tendencies eventually associated with certain distractors in the present experiment, however, may well have been higher than those in the previous experiment. In addition to generalizations based on similarity, each of the repeated response alternatives in the present experiment was reinforced as the correct responses to one of the items within the list. In the present experiment, there were no test trials interspersed within the training series. As was noted before, the interspersed test trials used in the previous experiment may have led to an inflated estimate for the efficiency of the prompt trials. They may also have provided an opportunity for a much delayed nonreinforcement of incorrect responses, even in the prompt condition.

The results of the present experiment do not agree with those of the previous experiment. On the Similar-Repeated items, where competing response tendencies should be at a maximum, the 5AA group was found to be slightly superior to the 5AP group.

The present study was designed to explore the limitations of the 1AP training technique. More specifically, an attempt was made to discover materials for which this technique would prove inferior to the 5AP and, possibly, the 5AA techniques. Such materials were not found. For some item types the 1AP technique was found to produce slightly fewer correct responses than one or another of the remaining techniques, but in no case was the difference found to be statistically reliable. The present study, therefore, strengthens the contention that for the paired associates format the 1AP technique is the best single presentation technique. Under a wide variety of conditions it either equals or exceeds the efficiency of other paired associate techniques and the preparation of materials for the 1AP technique is much easier than for other techniques.

The materials used in the present experiment were selected for two reasons: (a) they forced the subject to make discriminations of a type that might be required in an Air Force training

situation, and (b) they were amenable to the manipulations dictated by the experimental design. No effort was made to select a task that could be learned most efficiently by means of the paired associates format. The experiment was oriented toward certain comparisons within the paired associates format rather than comparisons between this and alternative formats. The average subject in this experiment learned less than half of the 40 items in a two-hour session. Probably subjects trained by other methods, for example, a program based on carefully selected mnemonic mediators, or even the free study method used by Wulff and Emerson (ref 15), might have done better. In fact, the study by Angell and Lumsdaine (ref 2) suggests that subjects might have done better if the 5AA trials of the criterion series had been intermixed with the training trials.

References

1. Amsel, A. "Error Responses and Reinforcement Schedules in Self-Instructional Devices," *Teaching Machines and Programmed Learning:* A Source Book, A. Lumsdaine and R. Glaser, Eds., Washington, D. C., National Educational Association, 1960.

2. Angell, D. and Lumsdaine, A. A. "Prompted and Unprompted Trials versus Prompted Trials Only in Paired Associate Learning," *Student Response in Programmed Instruction,* A. Lumsdaine, Ed., Washington, D. C., National Academy of Sciences — National Research Council, 1961.

3. Angell, D. and Terry, D. F. *Response Guidance, Response-Term Similarity, and Test Type in the Learning and Retention of Word Pairs,* San Mateo, Calif., American Institute for Research, AIR-C14-9/62-TR, 1962.

4. Briggs, L. J. "Prompting and Confirmation Conditions for Three Learning Tasks Employing the Subject-Matter Trainer," *Student Response in Programmed Instruction,* A. Lumsdaine, Ed., Washington, D. C., National Academy of Sciences — National Research Council, 1961.

5. Cook, J. O. "Supplementary Report: Processes Underlying Learning a Single Paired Associate Item," *Journal of Experimental Psychology, 56,* 455, 1958.

6. Cook, J. O. and Kendler, T. S. "A Theoretical Model to Explain Some Paired Associate Learning Data," *Symposium on Air Force Human Engineering, Personnel, and Training Research,* G. Finch and F. Cameron, Eds., Washington, D. C., National Academy of Sciences — National Research Council, 1956.

7. Cook, J. O. and Spitzer, M. E. "Supplementary Report: Prompting versus Confirmation in Paired Associate Learning," *Journal of Experimental Psychology, 59,* 275-276, 1960.

8. Evans, J. L., Homme, L. E. and Glaser, R. "The Ruleg System for the Construction of Programmed Verbal Learning Sequences," *Journal of Educational Research, 55,* 513-518, 1962.

9. Harlow, H. F. "Learning Set and Error Factor Theory," *Psychology: A Study of a Science, General Systematic Formulations, Learning, and Special Processes.* Volume II, S. Koch, Ed., New York: McGraw-Hill, 1959.

10. Johnson, K. A. *The Effects of Test Trials on the Learning of Paired Adjectives,* AMRL Technical Report 64-105, AD 609317, 6570th Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio, 1964.

11. Kaess, W. and Zeaman, D. "Positive and Negative Knowledge of Results on a Pressey-Type Punchboard," *Journal of Experimental Psychology, 60,* 12-17, 1960.

12. Kopstein, F. F. and Roshal, S. M. "Verbal Learning Efficiency as Influenced by the Manipulation of Representational Response Processes: Pictorial-Verbal and Temporal Contiguity Factors," *Student Response in Programmed Instruction,* A. Lumsdaine, Ed., Washington, D. C., National Academy of Sciences — National Research Council, 1961.

13. Kristofferson, A. B., Modrick, J. A. and Morgan, R. L. *A Comparison of Modes of Presentation of Paired Associates on the Subject-Matter Trainer*, AMRL Memorandum Report P-46, AD 421795, 6570th Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio, 1963.

14. Sidowski, J. B., Kopstein, F. F. and Shillestad, I. J. "Prompting and Confirmation Variables in Verbal Learning," *Psychological Reports, 8,* 401-406, 1961.

15. Wulff, J. J. and Emerson, D. L. "The Relationship Between 'What is Learned' and 'How it's Taught'," *Student Response in Programmed Instruction,* A. Lumsdaine, Ed., Washington, D. C., National Academy of Science – National Research Council, 1961.

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Aerospace Medical Research Laboratories, Aerospace Medical Div., Wright-Patterson AFB, Ohio 45433 and University of Cincinnati, Cincinnati, Ohio 45221	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP N/A

3. REPORT TITLE

THE EFFECTS OF SIMILARITY AND REPETITION OF RESPONSE ALTERNATIVES ON VARIOUS TYPES OF PAIRED ASSOCIATE LEARNING

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Final report

5. AUTHOR(S) (Last name, first name, initial)

Johnson, K. A., PhD
Senter, R. J., PhD
Smith, F. W.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
December 1965	24	15

8a. CONTRACT OR GRANT NO. Prepared in part under AF 33(615)-1046 b. PROJECT NO. 1710 c. Task No. 171007 d.	9a. ORIGINATOR'S REPORT NUMBER(S) AMRL-TR-65-214 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. AVAILABILITY/LIMITATION NOTICES

Distribution of this document is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Aerospace Medical Research Laboratories, Aerospace Medical Div., Air Force Systems Command, Wright-Patterson AFB, Ohio

13. ABSTRACT Previous research has shown that the simple simultaneous presentation of a stimulus term and the single correct response term is as efficient as any of the alternative training techniques that have been suggested for paired associate learning. The present investigation was an attempt to determine the generality of this finding. Subjects learned a 40-item list of paired-associates under one of four training conditions. In the One Alternative Prompt condition subjects saw only the stimulus term and the correct response term; no anticipation was required. In the Two Alternative Anticipation condition subjects saw two response terms, one correct and one a distractor; they were required to select one of these before being told the correct response. The Five Alternative Anticipation condition was similar to the Two Alternative condition, but four distractors were used instead of one. Subjects in the Five Alternative Prompt condition also saw five response alternatives, but the correct alternative was indicated immediately; no anticipation was required. Three training trials were given under one of the above conditions. All subjects were then transferred to a criterion series that consisted of three trials in the Five Alternative Anticipation condition. Half the items had distractors that were very similar to the correct response term, the remaining half, distractors that were less similar. Half the items in each of these groups had distractors that were the correct response terms for other items in the list. The remaining items had distractors that were unique to a given item. The overall differences between training techniques were not large, but there was some indication that the Five Alternative Prompt condition was inferior to the remaining conditions. Separate comparisons on the various item types indicated that in no case was the One Alternative Prompt condition realiably inferior to any of the remaining conditions.

DD FORM 1 JAN 64 1473

Security Classification

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Paired associate learning						
Programed instruction						
Training techniques						
Learning, performance tests						
Recall						
Verbal behavior						
Astronautics						
Statistical analysis						

INSTRUCTIONS

1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization *(corporate author)* issuing the report.

2*a*. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2*b*. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year, or month, year. If more than one date appears on the report, use date of publication.

7*a*. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7*b*. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8*a*. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8*b*, 8*c*, & 8*d*. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9*a*. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9*b*. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers *(either by the originator or by the sponsor)*, also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

(1) "Qualified requesters may obtain copies of this report from DDC."

(2) "Foreign announcement and dissemination of this report by DDC is not authorized."

(3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through _____."

(4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through _____."

(5) "All distribution of this report is controlled. Qualified DDC users shall request through _____."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring *(paying for)* the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as *(TS)*, *(S)*, *(C)*, or *(U)*.

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.

Security Classification