1976

Nonspecific transfer as a function of change in training method in a paired-associate learning task.

Richard A. Zuliani
University of Windsor

NONSPECIFIC TRANSFER AS A FUNCTION OF CHANGE IN TRAINING METHOD IN A PAIRED-ASSOCIATE LEARNING TASK

by

Richard A. Zuliani

Hons. B.A., University of Windsor, 1968

A Thesis
Submitted to the Faculty of Graduate Studies
Through the Department of Psychology
in Partial Fulfillment of the
Requirements for the Degree
of Master of Arts at the
University of Windsor

Windsor, Ontario, Canada

1975

ABSTRACT

This study investigated nonspecific transfer, or more specifically, its components of learning to learn and warm-up, as a function of change in training methods. The relative importance of learning to learn and warm-up was also considered. The two training methods utilized in this study, prompting (P) and confirmation correction (C), were compared for learning efficiency.

Sixty-four male Ontario high school students between the ages of 16 and 20 completed two consecutive paired-associate tasks under two training methods. Four experimental groups represented all possible combinations of the two training methods (i.e., PP, CC, PC, and CP). The learning to learn effect was separated from the warm-up effect by the use of warm-up control groups, who received random pairings of stimuli and responses on the preliminary task. The two training methods were equated as much as possible, and the procedure was automated by the use of the General Learning Apparatus (Cervin & Grewe, 1967).

The learning to learn effect was greater when the training method stayed the same than when it changed ($p < .02$). Warm-up was also shown to be training method specific but in the opposite direction. That is, there was a greater warm-up effect when the training method was changed ($p < .04$). This finding had added significance because in many previous transfer studies warm-up was assumed to be unaffected by the independent variable.

Groups which received learning to learn and warm-up were significantly better on the second task than groups which had received only warm-up ($p < .0001$). This highly significant learning to learn effect supports the conclusion that learning to learn has a greater transfer effect than warm-up for naive subjects.

The prompting and confirmation correction methods lead to almost identical performance on the preliminary task, resulting in F's well below unity. This indicates that sufficiently equated, these two training methods result in equal learning efficiencies.

ACKNOWLEDGEMENTS

I would like to thank my thesis adviser Dr. V. B. Cervin for his patience and generous allotment of time. It has been a stimulating and rewarding experience to work under his direction. I also thank my committee members Dr. J. L. Leavitt and Dr. T. T. Hirota for their constructive criticism and suggestions which helped broaden and clarify the issues. Appreciation is extended to Dr. A. Smith and Mr. M. Starr for their helpful comments on statistical design. Practically, this study owes much to Captain G. Rushmire for his assistance in obtaining the subject pool. I am grateful to Mrs. Mary Anne Marfin for typing this manuscript.

Without the constant support and encouragement of my wife, Margaret, and the needed diversion provided by my two sons, Michael and Mark, this project would never have been completed.

Finally, I am indebted to the Canadian Armed Forces for their sponsorship of my postgraduate study, which includes this thesis.

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CHAPTER I

INTRODUCTION

The current approach to the study of transfer is analytic; that is, the interest is in the relationship of specific independent variables to transfer (i.e., to "the proficiency with which successive learning tasks are performed", Postman, 1969, p. 256). The present study is concerned with the effect on nonspecific transfer of the change in the method of training as the independent variable. Nonspecific transfer between training methods has not been a variable of interest in previous studies.

Most transfer studies have been carried out with either a perceptual motor task, such as pursuit on a rotor, where the subject attempts to keep a stylus on a target; a verbal paired-associated task where the verbal units are usually adjectives, trigrams, or numbers and the subject must produce the correct verbal response (R), to the verbal unit which serves as a stimulus term (ST); or a selective learning task, where the subject learns to "produce available, discrete responses on cue" (Noble, 1969, p. 319) such as, "snap one of four toggle switches in response to the stimulus onset of a pair of red and green signal lamps" (p. 324).

Annett (1969) makes this comparison between verbal and perceptual motor tasks:

> In the paired-associate tasks...the intention is to establish an association between a specified stimulus term [S] and a

> specified response term [R], such that given S, R will occur with increasing relative frequency. (p. 87).
>
> Learning to associate pairs of words, the first of each pair being presented as the stimulus and the second being the required response, can readily be given a motor parallel where the stimuli are displays of lights and the response to be learned is which key to press. (p. 76).

Selective learning is defined by Noble (1969) to be:

> Any multiple-choice situation in which an organism acquires the threefold ability to (1) make a joint selection from the relevant stimuli present and from its own repertoire of available discrete responses, (2) form the necessary associative connections between the stimuli and the response required by the task, and (3) link these S-R pairs together in a coordinated behaviour sequence. (p. 325).

In this type of task, stimulus and response learning are de-emphasized (since stimuli and responses are available), while the associative process is emphasized.

A task that combines verbal paired-associate and perceptual-motor learning tasks was used by Cervin, Scheich, and Ladd (1970). The perceptual-motor arrangement served as a means of presenting the stimuli and collecting the responses. Subjects learned to replace their original (pre-experimental) response to a stimulus (ST) with a new response (R) indicated by information as to the correct response (RT). This task was used in the present study.

The two training methods that are frequently used in paired-associate learning are prompting (P) and confirmation-correction (C). In the P method advance information (RT) is offered to the subject as to the correct response to a given stimulus (ST), before he responds (R). Thus the subject sees the ST, then sees the RT, and finally makes an overt R; the order of events on every presentation being ST-RT-R. This method is known as cuing in perceptual tasks; is similar to study-recall in verbal tasks; and is related to guidance or action feedback in motor tasks (Annett, 1969, p. 63). In the P method complete information about the responses is given to the subject on every trial.

In the C technique, the subject responds (R) to a given ST, and is then given information about the correct responses (RT); the order of events on every presentation being ST-R-RT. In C, as in P, complete response information is given to the subject but only after initial guessing. The C method of training is analogous to the anticipation method in verbal learning.

According to Cervin, et al. (1970), "it is the order or grouping of these events [ST, RT, R which] determines the method of presentation [in training]". (p. 604).

A review of the literature indicates that findings concerning the relative efficiencies of these two verbal training methods are inconclusive. Study-recall, which is similar to P, was found to be superior to anticipation, which is similar to C (Battig & Brackett, 1961; Battig, & Wu, 1965; Kanak & Neuner, 1970). On the other hand, Bruder (1969) and Lockhead (1962) found no significant difference between the efficiency of anticipation and study-recall. Cofer, Diamond, Olsen, Stein & Walker (1967) and Wright (1967) obtained mixed results depending on the materials used (e.g., meaningfulness of materials). Cook (1958) and Cook and Spitzer (1960) concluded that P was superior to C. Levine (1965) reported mixed findings depending on the familiarity of the materials used. Finally, Cervin et al (1970) found performance under the P and C methods to be practically identical, and certainly there was no significant difference between these two methods.

Some notable differences between the two methods used might account for the different learning rates. For example, Battig and Brackett (1961) and Battig and Wu (1965) accounted for the superior learning efficiency of study-recall over anticipation by explaining that under study-recall, learning and performance measurement are separated, while in anticipation the learning and performance measurement are confounded, thus interfering with the learning process. In fact, when the testing for anticipation and study-recall were made more similar, there was no significant difference between efficiency of methods (Battig & Wu, 1965). In the Cervin et al. (1970) experiment, the training and testing trials were separated, and the testing trials were identical for P and C. That is, in the testing trials for either P or C conditions, the ST was presented and the subject responded with no information (no RT) being given.

A fundamental difference between the Cervin et al. (1970) study and all the other studies reported here is that the latter were based on recall (one exception is Kanak & Neuner, 1970), while the Cervin et al. study was based on recognition. In the Cervin et al. study all stimuli and responses were available, and when a particular ST was presented the subject tried to recognize and select the correct response, much as a person tries to recognize the correct answer in a multiple choice questionnaire (cf. Selective learning). Evidence that this process may affect training method efficiency comes from Kanak and Neuner (1970) who modified their anticipation method from a recall to a recognition task, and found no significant difference in learning efficiency between modified anticipation and study-recall.

Also germane to the recall versus recognition difference in tasking, is the concept that paired-associate learning is a two-stage process. The first stage is devoted to differentiating or learning the stimuli and responses, while the second stage consists of hooking up or associating a particular stimulus with its appropriate response (D'Amato, 1970, pp. 557-558; Martin, 1965; Postman, 1969, pp. 256-257; Underwood & Schultz, 1960).

When familiar, easily differentiated material is used along with a recognition task (Cervin, et al., 1970), the first stage of the paired-associate learning, response learning and stimulus discrimination, is virtually eliminated. This would explain the difference in findings with different materials used (Cofer, et al., 1967; Levine, 1965; Wright, 1967; Lockhead, 1962; and Battig & Brackett, 1961).

Efficiency of learning may also be a function of delay of RT after ST (Annett, 1969). This was shown to be the case empirically by Cook and Spitzer (1960). In most comparative studies the delay of onset of RT was greater in C than P methods. In the Cervin et al. study, during training, the ST remained on for the R and RT interval (delay condition), while in other studies ST was not available during the presentation of RT or during R interval (trace condition). Ladd, Cervin & Kozeny (1970) found that, under the delay condition, delay of RT did not affect learning rate, while Cook and Spitzer (1960) thought that, under the trace condition, it was the delay of RT that affected the learning rate. In both the P and C methods RT is not conditional on R; following Annett (1969) and others, RT can be considered as information about, rather than reinforcement of the correct response. That RT preceeds R during P or follows R during C is not important (provided that there is more than one trial), since "an information model would be indifferent to the time of arrival of the relevant information" (Annett, 1969, p. 153; Cervin & Kozeny, 1970). In both P and C, on all trials, equivalent information (i.e., the reduction of uncertainty concerning the correct response to a ST) is given the subjects. However, the C method of training with R coming before RT, requires guessing, some of which will be incorrect at the beginning of training. Guessing does not occur in the P method; in fact, no guessing habit should develop in P method since RT preceeds R.

Another effect of different sequencing of events in P and C methods may be as follows. In the P method the subject learns the ST-RT connections; the external RT provided by the experimenter is learned by the subject (cf. Waywell, 1974). Thus, in the P method the subject learns to respond to ST-RT during training, but during testing no RT is given and the subject must demonstrate his paired-associate learning by responding to ST only. In the C methods, RT comes after R during training, so that the subject is trained and tested to respond to ST only. It may be concluded that the information given by the P and C methods is equivalent and that by using the Cervin et al. (1970) task the P and C methods are equated for efficiency. Nevertheless, as has been discussed, the P and C training methods may have different learning effects on subjects, and thus lead to transfer phenomena. For these reasons the Cervin et al. task was chosen for this study.

Transfer is usually divided into two main classes: specific and nonspecific (Postman, 1969, p. 241). Nonspecific transfer arises from the general activity of learning, where the subject learns something about how to perform in the task (D'Amato, 1970, p. 593), such as "learning general approaches or modes of attack, becoming familiar with the situation, and learning related classes of materials" (Ellis, 1965, p. 33). As pointed out above, the P and C methods of training would generate different general approaches to a task; guessing or not guessing at correct responses, responding to ST-RT or to ST alone and would thus be a variable of non-specific transfer.

In general, it is thought that the greater the similarity (Psychological fidelity, McCormick & Tiffin, 1974, p. 243) between learning situations the greater the expected positive nonspecific transfer. It has been demonstrated by a number of investigators (e.g., Battig & Brackett, 1961; Wright, 1967) that as a subject gains experience in a given learning situation, his learning performance improves in subsequent, similar situations. However, if the training method in the subsequent task is changed, this change would create less general similarity between the consecutive learning situations than would be found between situations with the same training method and thus would generate less positive nonspecific transfer in the former case.

Specific transfer occurs when a specific element of one task affects the learning of another task (D'Amato, 1970, p. 598; Jung, 1968, p. 79). "Specific transfer effects depend on the manipulated similarity relations between the components of successive tasks, as in the acquisition of new responses to old stimuli" (Postman, 1961, p. 241). However, "nonspecific factors...operate even when there is no specific transfer between two tasks" (Jung, 1968, p. 80). Although specific transfer is not important in this study, the methodology of its investigation is. These relationships can be described in the form of transfer paradigms in a conventional notation; for instance, A-B, A-D refers to the transfer paradigm in which the stimuli for both lists are identical but the responses for both lists are unrelated: 47-82, 47-31. The basic paradigms are presented in Table I.

Originally, similarity had been defined by Osgood in terms of similarity in meaning (Martin, 1965). Martin (1965) redefined similarity to include associative relatedness, where "associative relatedness is the basis for both synonymity and antonymity" (p. 329). This change is in agreement with empirical findings (Martin, 1965).

Postman (1969) feels that nonspecific transfer is a misnomer, in that although it does "not represent the carry over of specific discriminations from one task to the next" (p. 242), nonspecific transfer does represent the carry over of habits and skills which are subject to experimental manipulation and analysis. Thus these variables are in principle as specifiable as variables subsumed under the heading of specific transfer. Furthermore, "in the absence of evidence to the contrary, [non-specific factors are] governed by the same laws [as specific factors]" (p. 242).

Postman and Schwartz (1964) with adjectives, and Postman, Keppel and Zacks (1968) with trigrams, demonstrated better second task learning due to familiarity with class of materials used. Only

TABLE I

Basic Transfer Paradigms

Paradigm		Interlist Similarity	
List I	List 2	Stimulus Terms	Response Terms
A-B,	A-D	identical	unrelated
A-B,	C-B	unrelated	identical
A-B,	C-D	unrelated	unrelated
A-B,	A-Br	identical[a]	identical[a]
A-B,	A'-B'	similar	similar

[a]Stimuli and responses of the first list were re-paired to form the second list.

Note.--From Jung, J. Verbal learning. New York, Holt, Rinehart and Winston, 1968, p. 83.

the second experiment (Postman, et al., 1968) had significant results. Speed of learning to criterion and total number of correct responses were greater when type of task remained the same (paired-associate to paired-associate), than when it changed (serial to paired-associate). The same results for the nonspecific transfer to the serial task were not quite significant (Postman & Schwartz, 1964). Previous practice on transfer from serial to paired-associate learning facilitated subsequent transfer from a serial to paired associate list (Postman & Stark, 1967).

Another variable of interest was prior experience with a transfer paradigm. Keppel and Postman (1966) and Martin, Simon, and Ditrich (1966) found no reliable differences between groups which changed paradigms, and those which maintained the earlier transfer paradigm. By introducing retention tests during the training phase and making the task more complex, Postman (1968) was able to demonstrate that the transfer effect was paradigm specific. That is, performance was better when the paradigm remained the same than when the paradigm was changed.

In general these findings support the contention that greater positive transfer can be expected when the subject has had prior experience with the variables of the second task (i.e., the tasks are similar), and thus would justify hypothesizing that nonspecific transfer would be greater when the training method remained the same.

A more indepth analysis of the problem of nonspecific transfer as a function of training method might be possible by decomposing the nonspecific transfer process into its subprocesses of learning to learn and warmup. The question becomes: Are warm up and learning to learn training method specific?

Learning to Learn

Learning to learn refers to higher order, instrumental habits or skills which produce lasting effect in the subject's mode of attack on a task (Thune, 1951). The use of mnemonic or coding devices of stimuli and the ability to generate effective mediators are thought to be part of the learning to learn process (Postman, 1969, p. 242). This learning to learn concept is very similar to Harlow's learning sets derived from animal studies. In these studies, Harlow demonstrated that monkeys not only learn specific discriminations but also learn a general approach to discrimination problems. This general approach transferred to other problems. In other words, there was a learning set formation; the learning how to learn discrimination problems.

The subject, in order to associate pairs, must utilize the training method. That is, the subject must learn a method of attack. Thus, although learning to learn would generalize to paired-associate learning as a whole, a certain part of the learning to learn process would be expected to be specific to a particular training method. For example, under C method it would be advantageous for the learner to ignore his own responses or at least not rehearse his guesses early in training since there is a high probability that his responses would be incorrect and interfere with the learning. On the other hand, under P, rehearsal of the subjects' responses would be appropriate since the probability of R being correct is near one. Thus, it seems reasonable to assume that once a mode of attack is learned that is appropriate for a specific training method then this learning to learn would have greater positive transfer on a subsequent task with the same training method than if the training method were changed. Thus learning to learn should be training method specific.

Warm-Up

Now the question of warm-up:

> In the rote learning situation warm-up denotes the establishment of appropriate adjustments for the reception of stimuli and for an optimal rhythm of responding. These attentional and postural adjustments not only facilitate the performance of the prescribed responses under a given experimental arrangement, but also provide a feedback of stimulation which becomes part of the distinctive context of the learning activity. (Postman, 1969, p. 242).

A warm up effect would manifest itself as positive nonspecific transfer. In the present context it would be expected that all experimental groups would benefit from warm up effects due to such things as attentional set to the learning machines used, becoming attuned to the rhythm of going from training to test trials, etc.

Warm-up effects can also be associated specifically to a method of training; for instance, the P and C methods with their different orders of events (ST-RT-R for P and ST-R-RT for C), may necessitate different rhythms of responding for P and for C. Thus a different warm-up effect would be expected depending on whether the subsequent method is the same or different.

The paired-associate learning situation could be considered a dual task: a performance task; making an overt response in the proper sequence (depending on the training method used) within a given time frame, and a learning task; associating specific responses with specific stimuli. Combining these two tasks could result in a "divided attention effect". ("the requirement to perform two tasks at the same time often yields a reduction in the performance of at least one of the tasks", Johnson, Greenburg, Fisher, & Martin, 1970, p. 167). This effect has been demonstrated empirically (Johnson, et al., 1970; Lindsey & Normal, 1969; Shulman & Greenburg, 1971; Taylor, Lindsey & Forbes, 1967).

When a subject enters the learning situation with the ability to make the overt responses on cue (e.g., button pressing) then all that is required is a period of relearning. It follows that if a subject practices the response task (i.e., is warmed up) then less or no relearning is required in a subsequent task. Therefore, it is postulated that warm-up indirectly affects associative learning through its influence on the performance task.

Warm up may also be related to arousal; that is, nonspecific afferents which "have the function of 'toning up' the cortex, providing a general facilitation to aid cortical transmissions and so make it possible for the messages from the specific pathways to reach the motor system and have their guiding influence on behavior [and thus on learning]" (Hebb, 1972, p. 173). It seems reasonable to consider warm-up as one operationalization of arousal.

Peterson and Brewer (1963) suggested that C would give rise to a different emotional state (and "emotion depends on the mechanism of arousal", Pribram, 1967, p. 833) than P, by nature of the fact that the subject during training had to guess and sometimes was wrong, while in P there was no guessing and virtually no errors in training. Arousal in turn, is a function of the mismatch of the "expectation, based on the mechanism of habituation, [which] serves as the stable background against which sensory stimuli are matched or appraised as familiar or novel" (Pribram, 1967, 832). The subject habituated to a training method in the preliminary task, "expects" this training method in subsequent tasks. When the training method is changed a mismatch occurs, which is disruptive and results in a greater amount of arousal (Pribram, 1967). When the training method remains the same on a subsequent task, a match should occur leaving the arousal at the same level.

The discussion of warm-up and learning to learn leads to two hypotheses. A portion of the warm-up should be training method specific. Assuming that the subject was operating at an optimal level of arousal (Hebb, 1971, p. 223) on the preliminary task, and that the task complexities were equated (i.e., they required the same optimal arousal level for maximum performance), then maximum warm-up effect would occur when the training method stayed the same. Thus, it was hypothesized that there would be a greater warm up effect (i.e., greater nonspecific transfer attributed to warm up) when the training method stayed the same than when it changed.

A portion of the learning to learn is training method specific; this portion of the training set developed in the preliminary task would transfer to the subsequent method, when the method remained the same. Vice versa, this learning to learn would interfere with the learning of a second task by a new method. This situation can be conceptualized by utilizing the transfer paradigms and applying them to training methods rather than materials. The situation where the training method remains the same would be represented by the A-B, A-B paradigm. Since, as explained previously, there are a number of factors common to both the P and C methods and only a portion of learning to learn is training method specific; thus A-B, A'-B'; would be the most appropriate paradigm to represent the changed-training-methods condition. This conceptualization leads to the conclusion that there would be positive transfer with both paradigms but it would be greater for A-B, A-B, then for A-B, A'-B'. On this basis it was hypothesized that there would be a greater learning to learn effect (i.e., greater nonspecific transfer attributed to learning to learn) when the training method stayed the same than when it changed.

The two hypotheses concerning learning to learn and warm-up imply a third one. That there would be greater total nonspecific transfer when the training method stayed the same than when it changed.

In order to test these hypotheses the following procedures and controls were used: Subjects consecutively learned two paired-associate lists, comprised of sets of pairs of two digit numbers, under the two training methods. Four possible sequences of the P and C training methods (PP, CP, CC, PC) were assigned to four experimental groups. The two paired associate lists were constructed by random pairing, from the same number pool, in order to equate list difficulty. Task difficulty was controlled by presenting these lists to subjects in two counterbalanced orders. The stimulus terms were placed on a panel (Cervin & Grewe, 1967), in a horizontal row with a lamp above each. Lighting a lamp presented an ST to the subject. The response terms were mounted on a horizontal row of buttons immediately below the ST's. A button was lighted in order to present the RT corresponding to a given ST, and the subject responded by pushing a numbered button (either before or after RT, constituting the C and P methods, respectively). Subjects were not allowed to proceed from presentation to presentation at their own speed as all presentations were paced by the experimenter (i.e., presentation times and intervals were the same for all subjects). Subjects were required to perform on each task until they achieved zero errors on two consecutive test trials. The number of training trials required to reach this criterion was used as the dependent variable.

The efficiencies of P and C training methods were equated in the sense that the information given to subjects on each training trial by the two methods was the same, and the learning interference resulting from the incorrect guessing at the beginning of the C method would be compensated for by the RT interference in the P method. Therefore, it was assumed that on the preliminary task, the number of trials to criterion under the P method of training would equal that of the C method. This assumption was tested.

Before testing the above three hypotheses, the learning performance under the second training method of each of the four experimental groups was compared to that of a base line control group. This control group had received no preliminary training, and had learned the second task under the same training method as the experimental group. Ideally, any experiences the experimental groups had in the preliminary task, that might transfer to the subsequent task, should not have been available to the base line control groups. Any difference in performance between an experimental and a base line control group was defined as "net nonspecific transfer". This net nonspecific transfer would be equivalent to an experimental group's total nonspecific transfer (p. 15).

The hypothesis that total nonspecific transfer (see p. 15) would be greater for the same-training-method condition than for the changed-methods condition could then be tested. The net nonspecific transfer of the experimental groups that had received the same training method was compared to the nonspecific transfer of the experimental groups that had changed training methods. This second order difference could be attributed to the operation of the independent variable "change in training method".

In order to separate the nonspecific transfer into its components of learning to learn and warm-up, four warm-up control groups, one for each experimental group, were run. Each warm-up control group received training identical to its matched experimental group; except that, on the preliminary task RT's were randomly paired with ST's on each training trial, so that no learning could occur. Thus, any differences in subsequent performance between the warm-up control groups and their corresponding experimental groups could not be due to warm-up and therefore were ascribed to learning to learn.

The hypothesis that the warm-up effect would be greater for the same-training-method condition than the changed-training-method condition was tested by first calculating the net nonspecific transfer for each warm-up control group (i.e., performance on the second task by the warm-up control compared to the base line control that had received the same second training method as the warm-up control). Then the net nonspecific transfer for warm-up controls that had received the same training methods was compared to warm-up controls that had changed training methods. This second order difference was attributed to the warm-up effect as a function of change in training method.

The hypothesis that the learning to learn transfer effect would be greater for the same-training-method condition than the changed-training-method condition was tested by comparing the learning to learn nonspecific transfer attributed to the same-training-method condition, to that ascribed to the changed-training-methods condition.

In summary, the general purpose of this experiment was to determine the affect of a change in training methods on nonspecific transfer and more specifically, on its warm-up and learning to learn components.

The specific hypotheses tested were:

1. The total nonspecific transfer will be greater when the training method stays the same than when it is changed.

2. The nonspecific transfer attributed to warm up will be greater when the training method stays the same than when it is changed.

3. The nonspecific transfer attributed to learning to learn will be greater when the training method stays the same than when it is changed.

CHAPTER II

METHODOLOGY AND PROCEDURE

Subjects

The subjects were 67 male Ontario high school students between the ages of 16 and 20 who were undergoing summer training with the Canadian Armed Forces. Participation in this experiment was a training requirement. All subjects were naive to rote-learning experiments. There were eight groups: four experimental (one for each possible sequence of the two training methods) and four warm-up control (one for each experimental group). The eight groups were further subdivided in order to accomodate the two orders of list learning, giving 16 subgroups. Assignment to the 16 subgroups was random, with the restriction that there be two subjects in each subgroup before the next subject was assigned (Postman, 1969, p. 288). Three subjects were replaced: two because of equipment failure, and one because he could not understand the instructions.

Apparatus

The General Learning Apparatus (GLA) of the University of Windsor (Cervin & Grewe,1967) was used. Situated in the top half of each GLA panel were two horizontal lights, one had the word "train" below it, the other light the word "test". In the bottom half of each panel was a horizontal row of eight white lights and below these white lights, was a horizontal row of eight buttons, each with a lamp inside. Each of the six interior white lights, which served to present ST, had a two digit number immediately below it. The six interior buttons, which served to present RT as well as being available for the subject's R, were identified by a two digit number on each button.

Two sets of three GLA panels, identified as panels H, A, B and D, E, F each panel separated from the others by a screen, were used in this experiment. The centre panels of each set, A and E, were employed for subject instructions and practice; the panels to the left of A and E, B and F respectively, were used for LIST 1 or warm-up LIST 1; while the panels to the right of A and E, H and D respectively, were used for LIST 2 or warm-up LIST 2.

In another room was a control panel, which allowed the experimenter to present the subject with the test-train, white, and button lights in the programmed sequence and timing relations required by the experiment. An automatic event recorder for registering the subject's responses was also contained in this room. Both experimenter's and subject's room were sound-insulated. The experimenter could observe the subject through a one-way mirror and communicate with him through a public address system.

Procedure

Lists

There were two experimental group lists (LIST 1 and LIST 2) each constructed of six pairs of two digit numbers, randomly assigned to lists and pairs. The lists conformed to the A-B, C-D paradigm. The entire pool of 2 digit numbers consisted of the 24 numbers from 0 to 100 with the lowest rated association value (Battig & Annette, 1962). These 24 numbers contained no zeros or repeated digit numbers.

For each list, the stimulus numbers were randomly assigned to the six interior white lights; the response numbers to the six interior buttons, with the following restrictions:

1. No stimulus number could be paired to the response number immediately below it, and
2. There could be no identical positional pairings between LIST 1 and LIST 2 (e.g., if the second white light from the left was paired to the third button from the left in LIST 1, then second white light from the left could not be paired to the third button from the left in LIST 2).

A third list (PRACTICE LIST) of six pairs of two digit numbers, selected from the next 15 lowest rated association value numbers (Battig & Annette, 1962), was constructed according to the procedures already mentioned. The PRACTICE LIST was assigned to panels A and E, and was used for instructional and practice purposes. These three lists with their positional pairings, are contained in Appendix A. In addition there were two warm-up control lists (Warm-up LIST 1 and Warm-up LIST 2). These two lists used the elements and positions of LIST I and LIST 2, respectively, but instead of each of the six stimulus digits being paired to an individual response digit, there were five sets of such pairings for each warm-up list. In practical terms the stimulus number response number pairs were random for the warm-up lists.

Training, Warm-up and Testing Methods.

The appropriate white lights and response buttons were electrically connected according to the number pairings. The white lights were used as a means to present the stimulus numbers (ST) while the response button lights were operated in order to present the correct response numbers (RT). The subject indicated his response (R) by pushing the numbered response button.

In the P training method the ST (6 sec duration) and the RT (3 sec duration) were presented together. When the RT light went off the subject was expected to push this response number R (3 sec to respond). The order of presentation of ST-RT pairs was randomized, but every pair came on once within each set of six presentations. One presentation of all six pairs was defined as a training trial.

The C training method was identical to the P training method except for the order of presentation of events. The ST (6 sec duration) was presented and the subject was expected to R (3 sec to respond) with the number connected to the ST. After the ST had been on for three seconds the RT (3 sec duration) came on.

In the prompting warm-up (Pw) method a stimulus number ST (6 sec duration) and a response number RT (3 sec duration) were presented together. When the RT light went off the subject was expected to push this response number, R (3 sec to respond). The orders of presentation of ST and RT were randomized but the six ST's came on once within each set of six presentations. One presentation of all six ST's constituted a warm-up trial.

The conformation-correction warm up (Cw) method resembled the Pw method except for order of events. The ST (6 sec duration) was presented and the subject was expected to R (3 sec to respond) by pushing one of the response numbers. After the ST had been on for three seconds the light under one of the response numbers came on, RT (3 sec duration).

In the testing phase the ST (6 sec duration) was presented; the subject was expected to R (6 sec to respond); and if the response number pushed was paired to the ST, the R was recorded as a correct response. Again, the order of presentation of ST was randomized, with one presentation of all six ST's constituting a test trial. The ST interpresentation interval for all warm-up, training, and testing trials was 2 seconds. The order and timing relations for the P, C, Pw, Cw, and the testing method are given in Figure 1.

Test trials and training trials (or warm-up trials for warm-up methods) were alternated, with a 12 second interval between trials. In order to avoid serial learning, the order of presentation of the six ST's (and thus the six pairs in training trials) was changed

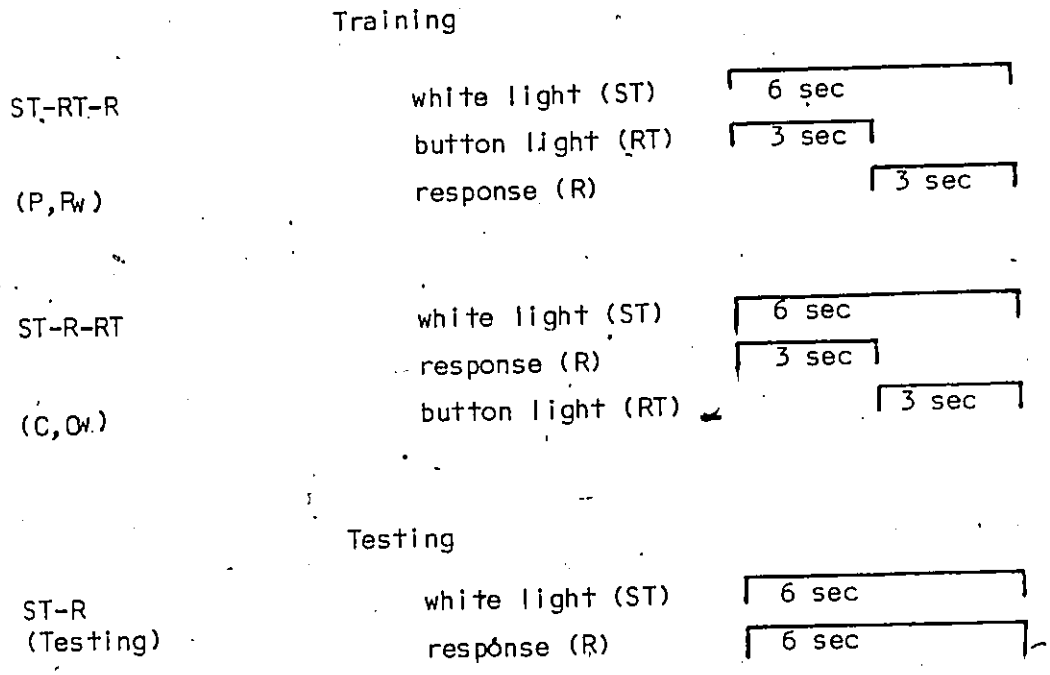


Figure 1. Timing and sequence chart for the two paired associate training methods, warm-up methods, and the testing procedure.

every trial for five trials. (Order of presentation of ST's and RT's are in Appendix A). Then the apparatus was recycled to the first trial order.

Tasks

Each experimental group subject was required to learn a preliminary paired-associate list (TASK I), and a transfer paired associate list (TASK 2) to a criterion of zero errors on two consecutive test trials. Given the two training methods and the two tasks, four orders of sequencing of training method are possible: PP, CP, CC, and PC. In order to equate TASK I and TASK 2 for difficulty, half the subjects in each training sequence condition learned LIST I followed by LIST 2, while the other half learned the lists in the opposite order. Since the tasks were equated for difficulty, and the experimental group that learned TASK I under the P method and TASK 2 under the C method is independent of all the groups (experimental and warm-up) that received the P method on TASK 2, then this group's performance on TASK I under the P method is equivalent to a group that received no preliminary training and learned TASK 2 under the P method. (i.e., P base line control group (p. 16)). Thus, TASK I performance of the group that received P followed by C on TASK 2 was used as the P control group. Similarly, the TASK I performance of the group that received C followed by P on TASK 2 was used as the C control group.

Each warm-up control subject was required to perform in a preliminary warm up task (warm-up TASK I) until their number of trials matched the average trials to criterion or TASK I of their appropriate experimental group. Then the subject learned a transfer paired-associate list, TASK 2. This arrangement permitted four sequences of methods: PWP, OWP, OWC, and PWC. Henceforth, each experimental and warm-up group will be referred to by its training method sequence (e.g., the group that learned TASK I under the P method and TASK 2 under the C method will be referred to as the PC group). In order to equate the warm-up control groups to the experimental groups, half of each warm-up control group performed on warm-up LIST I followed by LIST 2, while the other half performed on warm-up LIST 2 followed by LIST I. A summary of this methodological organization is contained in Table 2. The intertask interval was seven minutes.

Instructions

Warm-up subjects were run in subgroup pairs while each experimental group subject was run with a confederate (this allowed a constant inter-task interval). When they arrived, they were thanked for coming to participate in the experiment, told the experiment was not meant to rate their mental ability, seated in front of panels A and E, asked not to talk, and not to mark on the teaching machines. Then they were informed that they would receive instructions through the public address system, and could follow along with the oral instructions by referring to the printed set of instructions they were handed. They were also informed that the experimenter would be behind the one way mirror during the experiment. The experimenter then

TABLE 2

Training Method by Task

Group	TASK 1 training method	TASK 2 training method
PP	P	P
PwP	Pw	P
CP	C	P
CwP	Cw	P
P control		P
CC	C	C
CwC	Cw	C
PC	P	C
PwC	Pw	C
C control		C

went to the experimenter's room and read the following instructions from a mimeographed sheet:

> The teaching machine that is in front of you will only be used to give you instructions about the experiment. The teaching machines for the actual experiment are exactly the same as this one except the numbers under the white lights, and the numbers on the response buttons will be different.
>
> There are two parts to this experiment; each part done on a different teaching machine. It is very important that you follow the instructions. These are the instructions for the first part of the experiment.

Next a tape recording of the P, C, Pw, and Cw method instructions (as appropriate), identical to the subject's printed instructions, was played over the public address system. (See Appendices, B, C, D, and E for complete subject instructions).

An example of the C method instructions follows:

1. Each number under a white light is connected to a different number on a button. Your task is to find out and learn which button number is connected to which white light number. I'll repeat that.

The underlined sentence was repeated.

2. During the experiment there will be training phases and testing phases. The light will come on above the word "TRAIN" for the training phases and above the word "TEST" for the testing phases.

3. The training phase will work like this: A white light over a number will come on. You are to firmly push the button number you think is connected to this white light number. You will have 3 seconds to make your response. Please respond whenever a white light over a number comes on. Then a light will come on under the button number that is connected to this white light number. For example, if white light 93 was connected to button 29, light 93 would come on, you would firmly push one of the numbers on the buttons, and then the light under button 29 would come on.

4. The testing phase will work like this: A white light over a number will come on. You are to firmly push the button number you think is connected to this white light number. You will have 6 seconds to make your response. Please respond to each white light number.

5. To acquaint you with the operation of the machine you will now have some practice. In the actual experiment the white light numbers that are connected to the button numbers will not be the same as in the practice.

6. First an example of testing. Don't forget when the white light over a number comes on, firmly push the button number you think is connected to this white light number. (PRACTICE). In the actual experiment you will be tested on all 6 white light numbers, one at a time, but the white light numbers will not be presented in any special order. Then there will be a 12 second break before the training phase begins.

White light 93 was lit for six seconds. The subject was expected to push one of the response numbers during this interval. The instructions continued:

7. Now an example of training. Don't forget you will have 3 seconds to push the button number when the white light over a number comes on. (PRACTICE). In the actual experiment you will be trained on all 6 white light numbers, but the white light numbers will not be presented in any special order. Then there will be a 12 second break before the next testing phase begins.

White light 93 was lit for six seconds. The subject was expected to push one of the response numbers in the first three seconds. After light 93 was lit for three seconds the light under button 29 came on for three seconds. The instructions continued:

8. Raise your hand if you have any questions. If you have any questions ask them now because once started the sequence cannot be interupted.

Questions were answered by referring back to the appropriate passages of the printed instruction. The subject was then moved to panel B or F if he was to start on LIST I (or Warm-up LIST I) or to panel H or D if TASK I was to commence on LIST 2 (or Warm-up LIST 2). The subjects were told to leave their instructions before they moved. When seated in front of the appropriate panel they were read these instructions:

> This part of the experiment will begin with a test phase. Please respond to each white light number and continue to respond until you no longer receive any lights. Remain seated until you are told that this part of the experiment is over.

This part of the experiment started with a test trial, in order to get the base line correct response rate, and ended when the subject reached criterion. All subjects had a seven minute inter-task interval. During this interval the subject was moved back to panel A or E and given instructions for TASK 2.

The procedure for TASK 2 was identical to that of TASK I with the following exceptions:

1. The instructions started at, "The teaching machine that is in front of you...",
2. The sentence "These are the instructions for the first part...", was changed to, "These are the instructions for the second part...",
3. The subject was given the P method or C method instructions as appropriate, and
4. The subject was moved to the panel he had not operated.

When the subject had completed both tasks he was asked not to discuss the experiment with anyone. Subjects were moved to separate rooms and asked to respond to the following question (the complete questionnaire is in Appendix F): Indicate the connections you learned on the second part of the experiment?

In summary, two lists were constructed according to the A-B, C-D paradigm. Subjects were required to perform in two tasks under a combination of two methods. All subject responses were button presses and since all the stimuli and responses were always before them, the availability of stimuli and responses were equalized (Cervin, et al., 1970). Furthermore, the GLA allowed the differentiation between P and C methods to be made solely on the basis of order of presentation of the RT and R events.

CHAPTER III

PRESENTATION AND ANALYSES OF RESULTS

The basic performance measures used were the number of trials to a criterion of zero errors on two successive test trials, and the total number of correct responses on test trials administered after training trials one to five. The number of correct responses were limited to the first five trials because by the sixth trial all the members of one group (PP) had reached errorless performance, and thus their scores from that point on had zero variance. Therefore, the use of analysis of variance for correct response data beyond the fifth trial would have been questionable. The product-moment correlation between the two dependent variables is reported along with each analysis of variance.

For all analyses performed, the data were first tested for homogeneity of variance according to the Cochran test (Winer, 1971, p. 208). Only one test (comparison of experimental groups' variance to the warm-up control groups' variance on task 2, for both trials to criterion and correct responses) exceeded the .05 significance level, and no test exceeded the .01 level of significance. Since the null hypothesis was accepted for the between cells variance in all cases, a transformation of the data was not warranted. Furthermore, the F test is robust with respect to departures from homogeneity of variance, and the comparison that was significant was in the order of a 2:1 ratio, thus there should be very little bias in the analysis of variance (Winer, 1971, pp. 205-206).

The two paired associate lists proved to be closely comparable (see Appendix G), so that the list scores were combined for further analyses.

The learning performance and net nonspecific transfer results are summarized in Tables 3 and 4. The net nonspecific transfer is presented in terms of the dependent variables rather than percentages since this conveys more information, and is preferred in principle to derived measures (Postman, 1971, p. 1027).

In order to test whether experimental groups had been equated for amount of practice, an analysis of variance (Winer, 1971, pp. 160-167) was performed on their task I scores. The results of this analysis are presented in Table 5. There was no significant difference between the experimental groups' trials to criterion on the preliminary task. This lack of significance was supported by the correct response data. Since all experimental groups were run to the same criterion, and there was no significant difference between the groups' trials to criterion on task I, it can be concluded that these groups were equated for amount of practice as well as amount of learning. Thus there were equal opportunities (excluding the warm-up effect which was measured by suitable control groups) for transfer effects to be observed (Postman & Schwartz, 1964).

The significance of the net nonspecific transfer for the experimental and warm-up control groups was tested by comparing these pretrained groups to their appropriate base line control group using Dunnett's t test (Winer, 1971, pp. 201-204). The

TABLE 3

Mean Learning Performance on Task 1 and Task 2 and Net Nonspecific Transfer

in Terms of Trials to Criterion by Group

Group	Task 1		Task 2		Net Nonspecific Transfer		
	M	SD	M	SD	Total (control -experimental)	Warm-up (control -warm-up)	Learning to Learn (warm-up -experimental)
PP	10.75	3.99	4.63	1.51	4.62		3.62
PwP			8.25	4.03		1.00	
CP	11.12	2.59	6.50	3.51	2.75		2.75
CwP			9.25	2.76		0	
P control[a]			9.25	3.54			
CC	10.50	3.85	5.12	1.96	6.00		5.75
CwC			10.87	3.76		.25	
PC	9.25	3.54	5.37	2.07	5.75		1.88
PwC			7.25	3.06		3.87	
C control[b]			11.12	2.59			

a. As explained in the previous chapter (p. 25), the learning performance of PC on task 1 was used as the P control task 2 score.

b. Similarly, the learning performance of CP on task 1 was used as the C control task 2 score.

TABLE 4

Mean Learning Performance on Task 1 and Task 2 and Net Nonspecific Transfer in Terms of

Number of Correct Responses on Trials 1 to 5 by Group

Group	Task 1 M	Task 1 SD	Task 2 M	Task 2 SD	Net Nonspecific Transfer: Total (experimental -control)	Net Nonspecific Transfer: Warm-up (warm-up -control)	Net Nonspecific Transfer: Learning-to-Learn (experimental -warm-up)
PP	12.87	6.56	23.50	4.04	8.63		6.12
PwP			17.38	7.73		2.51	
CP	14.00	4.00	21.50	4.34	6.63		5.75
CwP			15.75	6.65		.88	
P control[a]			14.87	6.73			
CC	13.88	4.73	22.38	4.84	8.83		10.95
CwC			11.88	6.90		-2.12	
PC	14.87	6.73	21.75	4.89	7.75		2.37
PwC			19.38	3.54		5.38	
C control[b]			14.00	4.00			

a. As explained in the previous chapter (p. 25), the learning performance of PC on task 1 was used as the P control task 2 score.

b. Similarly, the learning performance of CP on task 1 was used as the C control task 2 score.

TABLE 5

Analysis of Variance of Trials to Criterion and Correct Responses on Trials 1 to 5 for Experimental Groups on Task 1

Source	df	Trials to Criterion SS	MS	F	Correct Responses SS	MS	F
Groups	3	15.84	5.23	.42	16.09	5.36	.17
Error	28	349.88	12.50		886.62	31.67	

Note. Product-moment correlation between dependent variables
$r = -.64^*$ df = 30
$^*p < .0002$

results are presented in Table 6 (the preliminary analyses required to obtain the MS error for the Dunnett's test are found in Appendix H). For both trials to criterion and correct responses on trials 1 to 5, the net nonspecific transfer was significant for all experimental groups except the CP group. The net nonspecific transfer was significant for only one of the warm-up control groups, the PwC group, and then only for trials to criterion.

The mean proportion of correct responses per training trial (i.e., on test trials following each training trial) for task 2 (assuming perfect performance on subsequent trials for subjects reaching criterion of two consecutive errorless test trials) was plotted for all groups, and is presented in Figures 2 and 3. These graphs support the findings presented in Table 6.

With reference to Table 6, it was observed that for groups trained under the P method on task 2, the net nonspecific transfer was greater for the groups that had the same training method on task 2 than for those that changed training method. This outcome was also exhibited by the task 2, C trained, experimental groups, but the changed method warm-up control group, PwC, had greater net nonspecific transfer than the same method warm-up control group, CwC. The significance of these observations was tested in further analysis.

Before carrying out these analyses of the net transfer data, a comparison was made between the P and C training methods on task 1, utilizing a component analysis (Winer, 1971, pp. 170-175). This resulted in a $F= .42$ for trials to criterion and a $F= .0009$ for correct

TABLE 6

Dunnett's t test of Total and Warm-up

Net Nonspecific Transfer by Group[a]

	Trials to Criterion Scores			Correct Responses Trials 1-5 Scores		
	Net Nonspecific Transfer (control-pretrained)			Net Nonspecific Transfer (pretrained-control)		
Group	Total	Warm-up	t	Total	Warm-up	t
PP	4.62		2.89*	8.63		2.84*
CP	2.75		1.72	6.63		2.18
PwP		1.00	.63		2.51	.83
CwP		0	0		.88	.29
CC	6.00		4.34***	8.83		3.55***
PC	5.75		4.16***	7.75		3.12**
CwC		.25	.18		-2.12	.85
PwC		3.87	2.80*		5.38	2.17

[a]The groups trained on task 2 by the P method were compared to the P control; the groups trained on task 2 by the C method were compared to the C control.

*$p < .05$
**$p < .02$
***$p < .01$

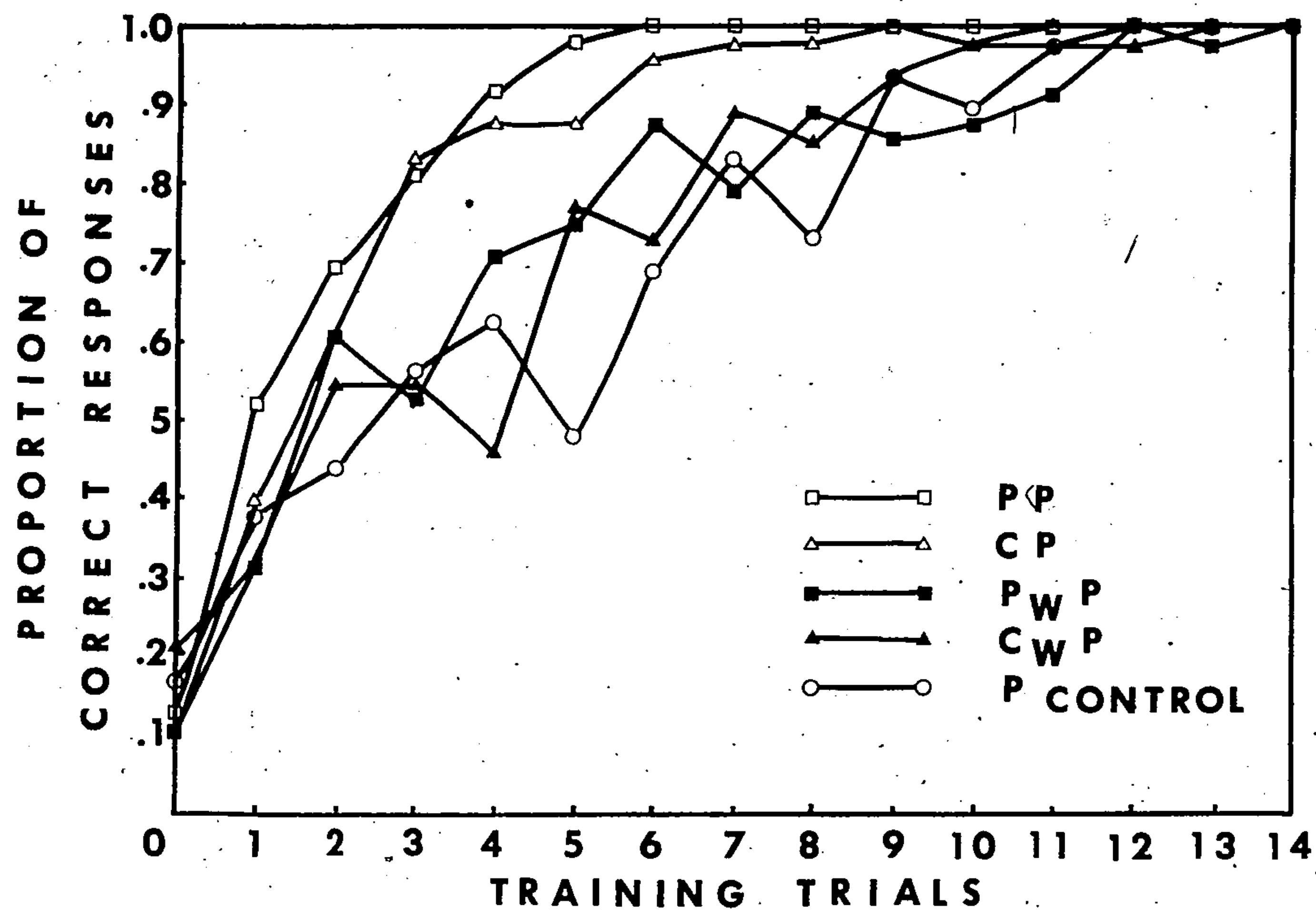


Figure 2. Mean proportion of correct responses per training trial on task 2 for task 2, P trained groups (tests were taken before training trial 1 and after each training trial).

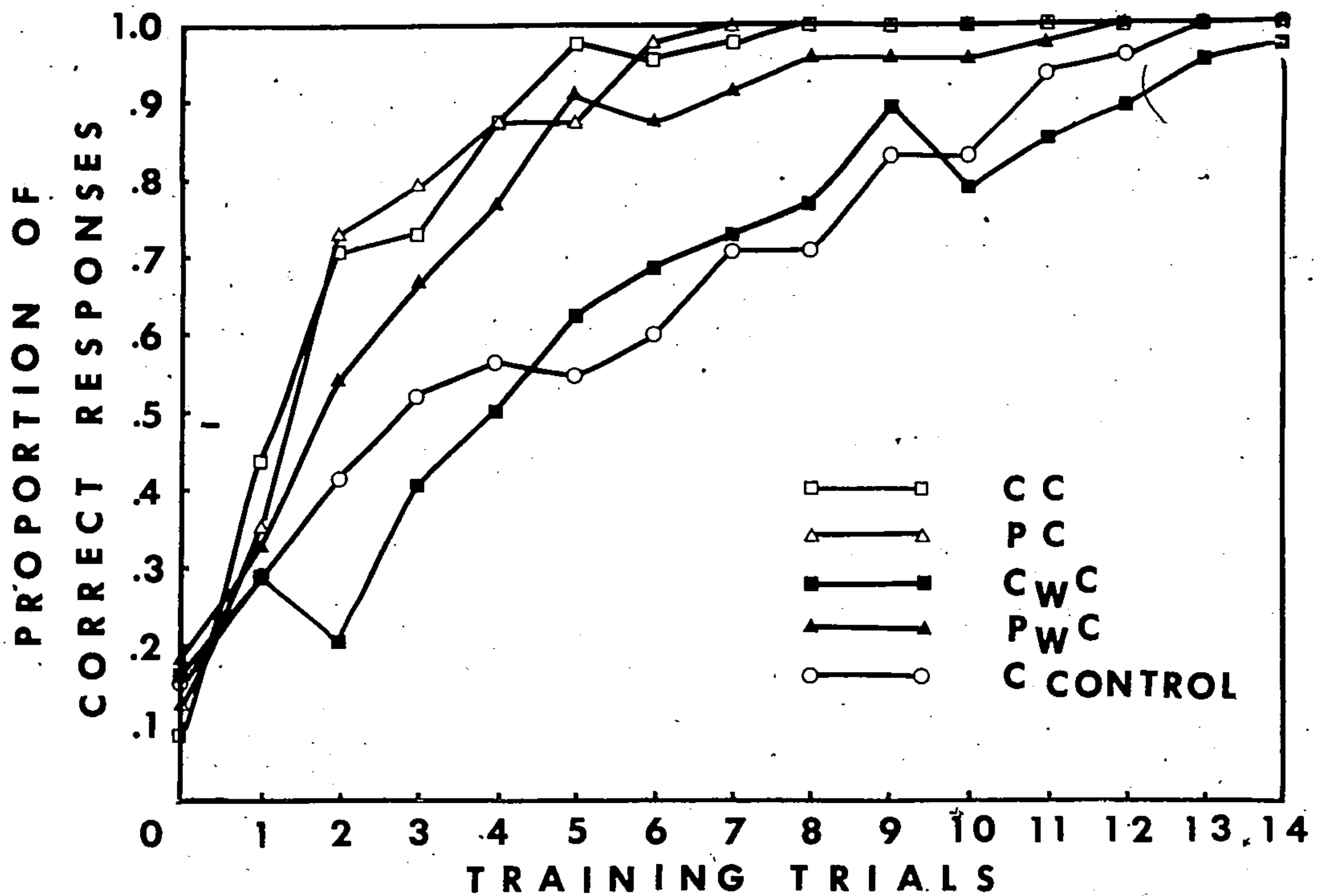


Figure 3. Mean proportion of correct response per training trial on task 2 for task 2, C trained groups. (tests were taken before the first training trial and after each training trial).

responses on trials 1 to 5. (see Appendix G, p. 77 for complete analysis). Thus there was no significant difference between the P and C training methods on the preliminary task.

The mean proportion of correct responses per training trial (as per Figures 2 and 3) for the experimental groups combined to represent the P and C training methods, are presented graphically in Figure 4. This graph indicates no clear superiority for either training method at any point during the training.

A component analysis was also performed in order to compare the two base line control groups. The results were a F = 1.12 for trials to criterion and a F = .10 for correct responses on trials 1 to 5; indicating no significant difference between these control groups which represent the two training methods.

Since the learning performance of the P and C training methods as well as the two base line control groups have been shown to be closely comparable, and the subtraction of, or subtraction from a constant does not affect a scores variance; it seemed equivalent[1] and more appropriate to perform the analysis of variance on the task 2 learning performance scores rather than the net transfer scores.

A 2 x 2 x 2 fixed factor analysis of variance was performed (Winer, 1971, pp. 452-456) with the following levels of the independent

---

[1]It would not be truly equivalent since there are two constants (9.25 for P and 11.12 for C), but since P and C have been shown to be very similar, this approach is statistically more conservative.

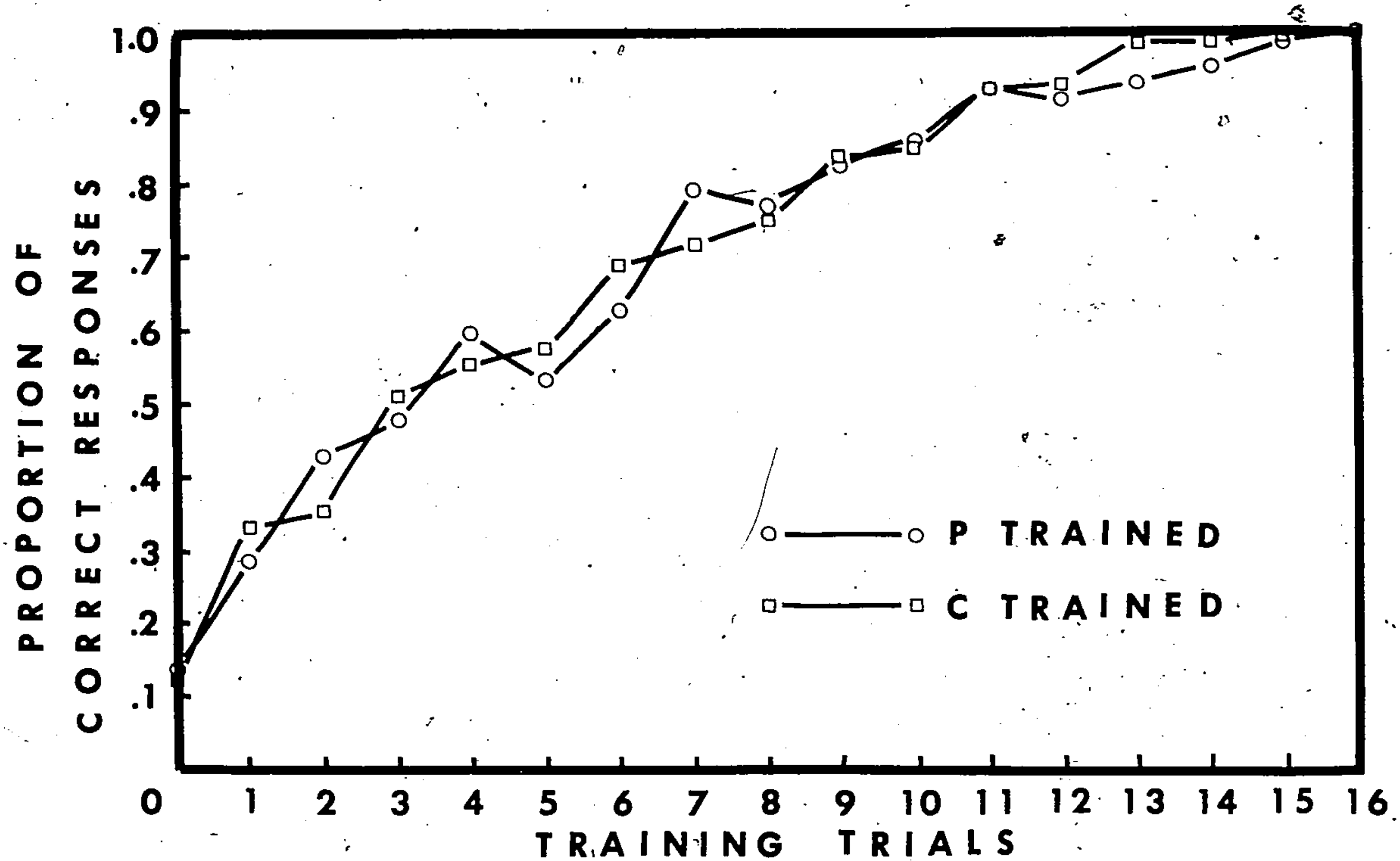


Figure 4. Mean proportion of correct responses per training trial for groups trained by confirmation correction and by prompting. (tests were taken before training trial 1 and after each training trial).

variables represented:

A_1 = same training method on both tasks

A_2 = changed training method on second task

B_1 = learned paired-associates on preliminary task

B_2 = warm-up only on preliminary task (i.e., random associations)

C_1 = learned second task under P method

C_2 = learned second task under C method

The results of this analysis are found in Table 7.

The significance of the B factor demonstrates that the groups that learned paired-associates on the preliminary task clearly out performed the warm-up groups on the second task; that is, there was a significant learning to learn effect. The AC interaction also proved to be significant for the dependent variable trials to criterion, and is presented in Figure 5. For the groups receiving their second task training under the P method, the same training method condition was superior, but for the groups receiving their training under the C method the changed training method condition lead to a greater transfer effect. Neither simple main effect of A at these two levels of C was significant. Between cells comparisons were also made for the A variable and it was found that the simple main effect of A at B_2C_2 was significant; that is, the PwC group's net nonspecific transfer was significantly better than the CwC group. This probably accounts for most of the AC interaction.

The simple main effects of A at both levels of B were also calculated and did not approach significance. Thus the hypothesis

TABLE 7

Analysis of Variance of Trials to Criterion and Correct Responses on Trials 1 to 5 for the Pretrained Groups on Task 2

Source	df	Trials to Criterion			Correct Responses		
		SS	MS	F	SS	MS	F
A (Same/changed method)	1	.25	.25	.03	10.56	10.56	.34
B (Learn/warm-up)	1	196.00	196.00	22.40***	612.56	612.56	19.88***
C (Task 2 method)	1	0	0	0	7.56	7.56	.24
AB	1	22.56	22.56	2.58	72.25	72.25	2.34
AC	1	39.06	39.06	4.46*	110.25	110.25	3.58
BC	1	1.56	1.56	.17	1.00	1.00	.03
ABC	1	9.00	9.00	1.02	60.06	60.06	1.95
A at B_1[a]	1	9.03	9.03	1.65	13.78	13.78	.71
A at B_2[b]	1	13.7[illegible]	13.78	1.10	69.03	69.03	1.57
A at C_1	1	16.53	16.53	1.89	26.28	26.28	.85
A at C_2	1	22.78	22.78	2.60	94.53	94.53	3.07
A at B_1C_1	1	14.06	14.06	1.61	16.00	16.00	.52
A at B_1C_2	1	4.00	4.00	.45	10.56	10.56	.34
A at B_2C_1	1	.25	.25	.03	1.56	1.56	.05
A at B_2C_2	1	52.56	52.56	6.01*	225.00	225.00	7.30**
Error	56	490.00	8.75		1725.50	30.81	

Note. The product-moment correlation between the two dependent variables is, $r = -.85$*** df = 62

[a]Since the variance at level B_1 was significantly different from the variance at B_2 ($p < .05$), the pooled MS_e was not used but calculated separately for B_1 as suggested by Winer (1971, p. 444). This resulted in a $MS_e = 5.49$ for trials to criterion and $MS_e = 19.42$ for correct responses.

[b]Similarly, the B_2 $MS_e = 12.50$ for trials to criterion and $MS_e = 44.06$ for correct responses.

* $p < .04$ ** $p < .01$ *** $p < .0001$

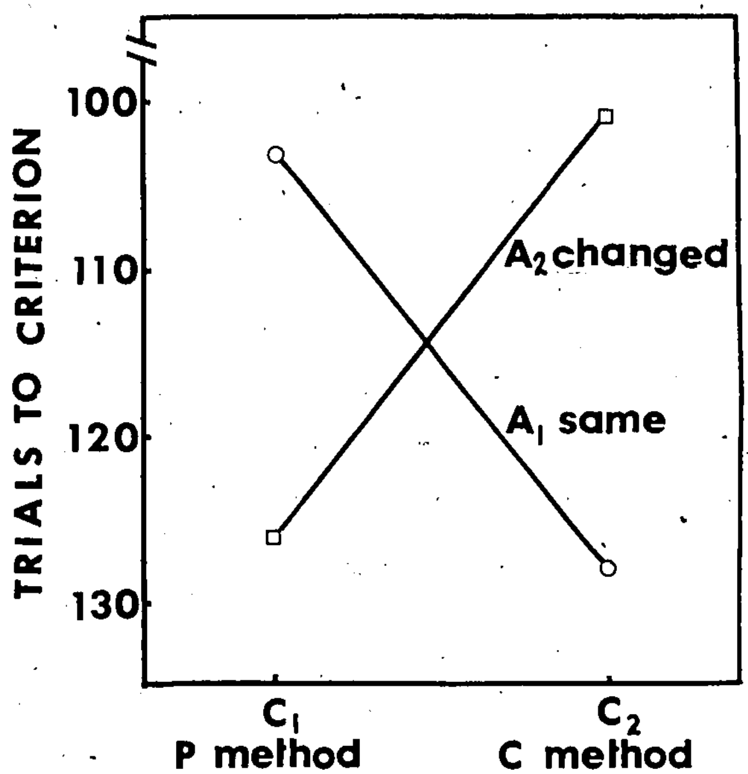


Figure 5. AC interaction for task 2 performance data. Trials to criterion are in terms of summary scores rather than means. A lower score on trials to criterion indicates a better performance.

that:

> The total nonspecific transfer will be greater when the training method stays the same than when it is changed

(tested by A at level B_1) was not supported, nor was the hypothesis that:

> The nonspecific transfer attributed to warm-up will be greater when the training method stays the same than when it is changed.

(tested by A at level B_2) supported.

Since the task 2 learning performance of the warm-up control groups was not comparable (i.e., PwC significantly superior to CwC), then conclusions concerning the net nonspecific transfer attributed to learning to learn could not be inferred from the second task learning scores directly, but rather tests had to be made on the learning to learn transfer data. Assuming that the warm-up of each warm-up control group was equivalent to the warm-up of its matched experimental group, then the difference in the performance on the second task between these matched groups would be the net nonspecific transfer attributed to learning to learn.

The learning to learn transfer effect, taken as a whole, has already been shown to be significant (i.e., B main effect Table 7). The learning to learn nonspecific transfer for each experimental group was tested for significance using Dunnett's t test (Winer, 1971, pp. 201-204). The results of this test are found in Table 8 (the preliminary analysis required to obtain the MS error required for Dunnett's t test are found in Appendix H). These results showed that for trials to criterion, only the same training methods conditions

TABLE 8

Dunnett's t test of Learning to Learn Net Nonspecific Transfer by Experimental Group

	Trials to Criterion		Correct Responses Trials 1-5	
	Net Nonspecific Transfer (warm-up control-experimental)		Net Nonspecific Transfer (experimental-warm-up control)	
Group	Learning to learn	t	Learning to learn	t
PP	3.62	2.38*	6.12	1.99
CP	2.75	1.74	5.75	2.05
CC	5.75	3.84**	10.95	3.68**
PC	1.88	1.51	2.37	1.11

*$p < .05$

**$p < .01$

produced significant nonspecific transfer attributed to learning to learn. For the number of correct responses on trials 1 to 5, only the CC group's learning to learn transfer effect was significant.

So that the hypothesis concerning nonspecific transfer attributed to learning to learn could be tested, a 2 x 2 fixed factor analysis of variance (Winer, 1971, pp. 431-440) was performed on the learning to learn data. Table 9 contains the results of this analysis. The levels of the variables represented were:

A_1 = same training method on both tasks.

A_2 = changed training method on second task

C_1 = learned second task under P method

C_2 = learned second task under C method

The significance of the A main effect implies that the experimental groups that had the same training method on both tasks had a significantly greater learning to learn effect than the groups that changed training methods. This conclusion supports the hypothesis that:

> the nonspecific transfer attributed to learning to learn will be greater when the training remains the same than when it is changed.

For the number of correct responses on trials 1 to 5, there was also a significant AC interaction. This interaction is illustrated in Figure 6. This illustration supports the results of the analysis of simple main effects of A at the two levels of C (Table 9) for both dependent variables. These results indicated that there was little differences between the PP and CP groups (i.e., level C_1, groups receiving task 2 training under the P method), but at level C_2 (groups receiving task 2 training under the C method), the same training method group, CC, had a significantly greater learning to learn effect than the

TABLE 9

Analysis of Variance of the Learning to Learn Net Nonspecific Transfer for The Experimental Groups

		Trials to Criterion			Correct Responses Trials 1-5		
Source	df	SS	MS	F	SS	MS	F
A (Same/change method)	1	45.03	45.03	7.95***	144.33	144.33	6.99**
C (Task 2 method)	1	3.10	3.10	.54	1.98	1.98	.10
AC	1	17.94	17.94	3.17	120.28	120.28	5.83*
A at C_1	1	3.06	3.06	.54	.55	.55	.03
A at C_2	1	59.91	59.91	10.57***	264.06	264.06	12.81***
Error	28	158.63	5.67		577.38	20.62	

Note. Product-moment correlation between dependent variables is r = .73**** df = 30. (Since for trials to criterion, experimental scores were subtracted from warm-up scores, while for correct responses trials 1-5 warm-up scores were subtracted from experimental scores, a positive r resulted).

*p < .05
**p < .02
***p < .01
****p < .0001

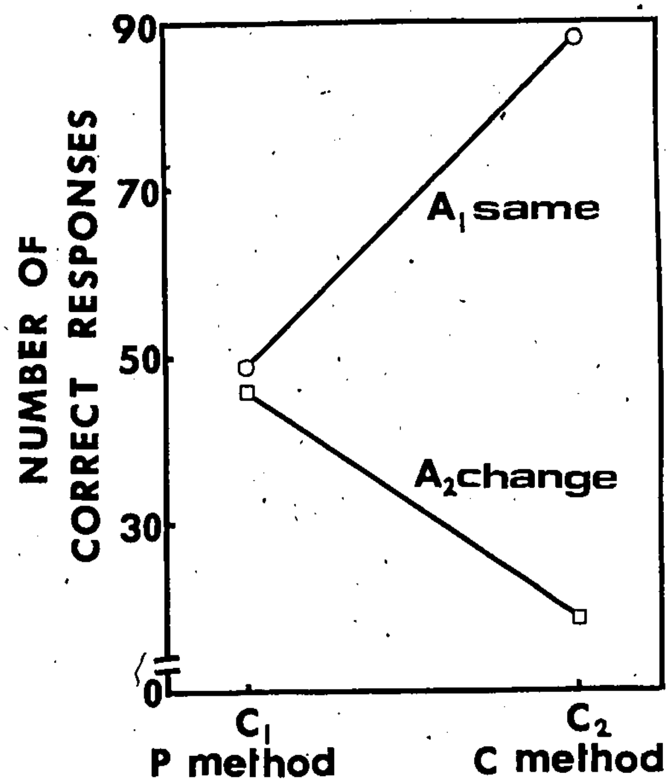


Figure 6. AC interaction for learning to learn data on task 2. Number of correct responses are in terms of summary scores rather than means.

changed training methods group, PC. This significant difference between the CC and PC groups for the net nonspecific transfer attributed to learning to learn can be ascribed to the significant difference between the CwC and the PwC groups' second task learning scores (Table 7). Evidence for this conclusion comes from the fact that before the warm-up controls score was subtracted, there was no significant difference between CC and PC (see A at B_1C_2, Table 7).

The post learning questionnaire was used to determine whether the subjects used the stimulus and response labels provided by the experimenter. Of the 64 subjects completing the questionnaire, 28 were categorized as numerical; that is, they used the numerical labels provided by the experimenter, 30 were categorized as positional; that is, they used positional labels such as renumbering the stimuli from left to right as lights 1 to 6, and 6 could not be categorized. Because of the missing data, and the distribution of categories in the groups (e.g., PP had 1 numerical, CC had 5, and PwP had 7), this label variable could not be included in the analyses of variance.

Instead, the mean trials to criterion and the mean number of correct responses on trials 1 to 5 of numerical categorized subjects was compared to that of the positional categorized subjects, for the experimental groups on task 1 and task 2, the warm-up control groups on task 2, and all the pretrained groups combined on task 2. A t test was used to make these comparisons (Tables 10 and 11). In most cases there was no significant difference between the two labelling methods. Only for the experimental groups on number of correct responses on trials

TABLE 10

t Test of Trials to Criterion for

Categories of Labelling

Data Source	Numerical n	Numerical M	Positional n	Positional M	Standard Error	df	t
Experimental Groups Task 1	13	11.38	17	10.18	1.17	28	1.09
Experimental Groups Task 2	13	6.23	17	5.00	.90	28	1.36
Warm-up Groups Task 2	15	9.73	13	8.69	1.40	26	.74
Pretrained Groups Task 2	28	8.10	30	6.60	.92	56	1.63

TABLE II

t Test of Correct Responses on Trials 1 to 5

for Categories of Labelling

	Numerical		Positional				
Data Source	n	M	n	M	Standard Error	df	t
Experimental Groups Task 1	13	11.31	17	15.35	.83	28	4.87**
Experimental Groups Task 2	13	20.69	17	22.88	.74	28	2.96*
Warm-up Groups Task 2	15	16.20	13	15.54	2.68	26	.25
Pretrained Groups Task 2	28	18.29	30	19.70	1.67	56	.84

*$p < .01$
**$p < .001$

1 to 5 (task 1 and task 2) were there significant differences. This implies that the labelling methods were comparable except that the positional labelling was more efficient at the early stages of training.

1 Note. refers to average number of trials.

CHAPTER IV

DISCUSSION

The purpose of this study was to determine whether a change in training methods would affect nonspecific transfer. It was found that when the training method remained the same, nonspecific transfer attributed to learning to learn was significantly greater than when the training method was changed. The hypotheses that total and nonspecific transfer attributed to warm-up would be greater when the training method stayed the same than when it was changed were not supported.

The positive finding depends on the assumption that the warm-up of an experimental group is equivalent to the warm-up of its matched warm-up control group. This assumption is a consequence of the methodological problem of separating nonspecific transfer into its two components of learning to learn and warm-up. There have been two approaches to this problem. One solution assumes that "the habits constituting learning to learn are not forgotten" (Postman, 1971, p. 1037), whereas, the effects of warm-up dissipate rapidly. Then the within-session nonspecific transfer is attributed to warm-up while the between sessions (usually a minimum of one day) nonspecific transfer is attributed to learn to learn (Thune, 1951). This solution has been criticized (Postman, 1971, p. 1037) mainly on the grounds that the first assumption is open to question; that is, why should learning to learn unlike other forms of learning be immune to forgetting.

The second approach, the one used in this study, requires the use of naive subjects (so that there is an opportunity for learning to learn in early stages of practice), and warm-up control groups that are under conditions simulating as closely as possible the experimental arrangements of the experimental groups, but not afforded the opportunity of learning (i.e., pairings are random, Schwenn & Postman, 1967). As mentioned before, this solution assumes the equivalency of the warm-up of the experimental and warm-up control groups. This assumption has been questioned by Postman (1971, p. 1038), who points out that in list learning, time is spent in rehearsal and searching for mnemonic devices, while time demands would not be the same in a "pure" warm-up task. Thus distribution of attention and rhythm of responding may not be identical for the two types of task.

This equivalence of warm-up assumption has not been tested so there is no empirical evidence for or against it. Suffice it to say that "the problem of separating out the relative contribution of warm-up and learning to learn...has not been fully solved" (Postman, 1971, p. 1040).

Accepting the assumption that the warm-up is equivalent, then the findings of this study support the contention that once a person learns a mode of attack (learning to learn) inherent in a training method, that person will do better in a subsequent learning task if the training method stays the same. That is, learning to learn is training method specific.

It should be pointed out that the greater significant nonspecific transfer effect of the experimental groups compared to the warm-up control groups, and the generally nonsignificant transfer effects of the warm-up control groups is very similar to the results obtained by Schwenn and Postman (1967). These results uphold their argument that for naive subjects in a rote learning task, learning to learn is relatively more important than warm-up.

The fact that the PwC group was significantly superior on the second task to the CwC group indicates that warm-up is also training method specific, but not in the direction predicted. That is, the changed training method condition produced more warm-up effect than the same training method condition. The training under P warm-up, with no guessing required but simply responding in a given time frame, probably placed the least attentional demands on the subject, of any of the training conditions. On the other hand, the C training method which required guessing (or testing) as well as learning during training trials, probably placed the greatest attentional demands on the subject. Accepting this argument plus the change of training methods, the PwC sequence would have been the most disruptive and thus caused the greatest amount of arousal. Assuming that the greater arousal was more optimal for learning than the lesser amounts produced by other sequences of warm-up and learning methods, it follows that the PwC sequence would produce the greatest warm-up effect. This reasoning also supports the CwC and PwP minimum warm-up results since there was no disruptive training method change. Even though in the CwP situation the training method is changed, the attentional demand of guessing in the C warm-up condition could be equated to the attentional demand of learning in the P condition, and again a small warm-up effect would be explained by this argument.

The total nonspecific transfer was not significantly affected by the independent variable, change in training method. This can be explained by the fact that the two components of total nonspecific transfer, learning to learn and warm-up, acted in opposite directions (i.e., greater learning to learn for same methods, and greater warm-up for changed methods), and virtually cancelled each others effect in relation to the independent variable.

The findings concerning the independent variable are based very heavily on the significant difference between only two groups, CwC and PwC. A replication would increase the confidence that the significant difference between CwC and PwC was not artifact.

The significant difference between two warm-up control groups has implications for other learning studies. That warm-up has been shown to be specific for a manipulated variable such as training method should caution against the assumption that warm-up is not specific for other independent variables (other than amount of training) and that experimental groups are equated for warm-up simply because they have had equivalent amounts of training (e.g., Postman & Schwartz, 1964).

The almost identical learning performance produced by the P and C methods on the preliminary task replicates the findings of Cervin et al. (1970). This result supp[illegible]e argument that if the P and C methods are differentiated solely [illegible] bases of the order of the ST, RT, and

R elements, then these two training methods are equated for efficiency in the second stage of paired-associate learning (the hook up of specific stimuli and responses).

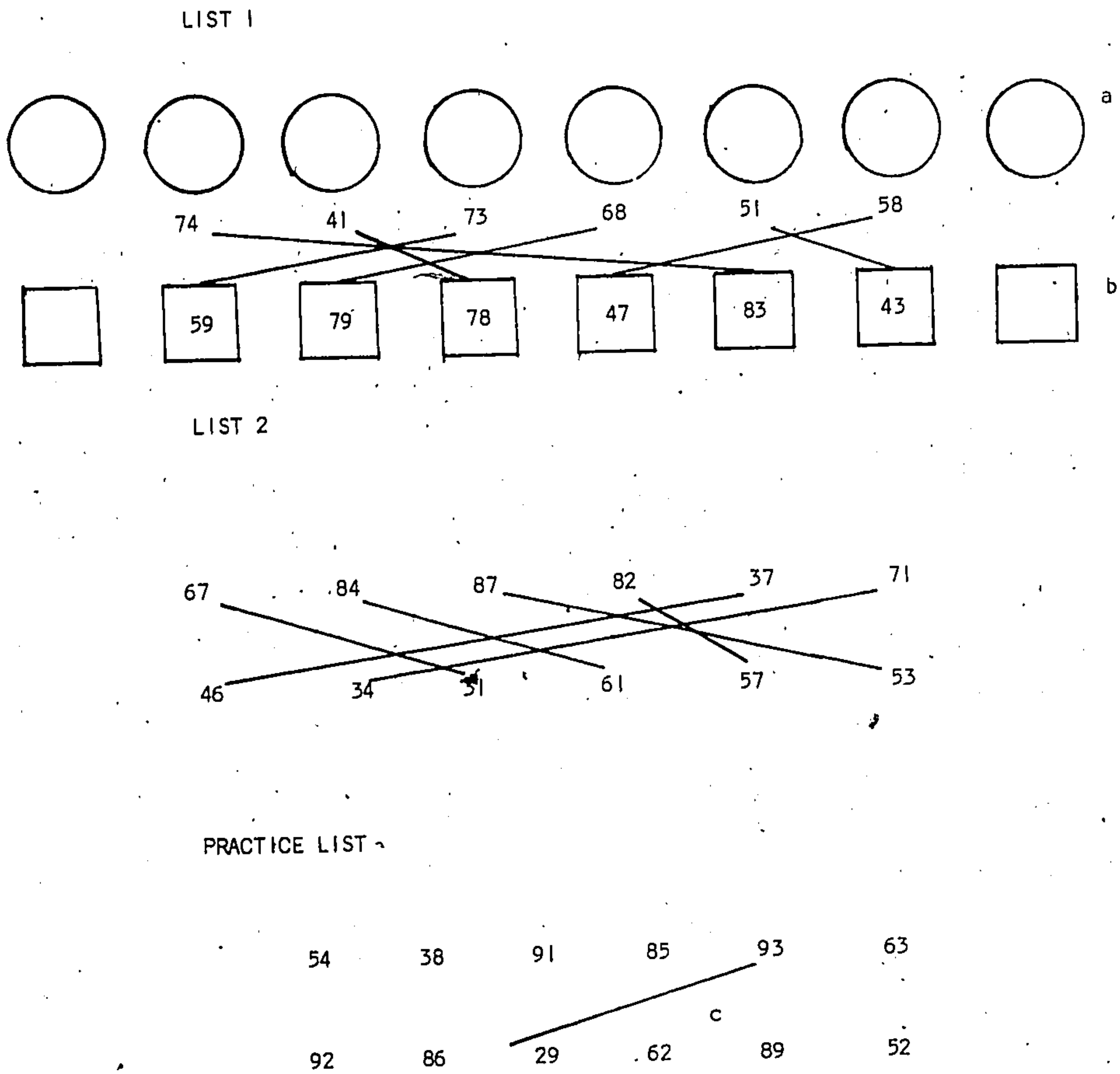
Since the P and C training methods are equated for efficiency and are very similar from an informational point of view, one would not expect a dramatic effect from a change from one method to the other. Thus interference effects caused by a change in training methods, not expected to be excessive in the first place, may have been dissipated by explaining and practicing the new training method just prior to its utilization on the second task. Instructions can have a strong influence on paired-associate learning (D'Amato, 1970, p. 551). Thus a greater change of training methods effect might have been realized if all instructions and practice had been given at the beginning of the experiment.

Another methodological problem of this experiment was the attempt to control for specific transfer. Approximately 50 percent of the subjects used positional labels for stimuli and responses. Assuming that the labels reported for the second task were the same type used for the first task (i.e., assuming the worst possible case), the experimental group subjects using positional labelling should have experienced specific transfer relating to the A - B, A - Br paradigm (Figure 1) rather than the A - B, C - D paradigm. According to Martin (1965) and others, this should have resulted in negative specific transfer. There is no evidence that those using positional labelling were inferior in their learning performance to those using numerical labelling. In fact, the experimental group positional labellers were significantly better on number of correct responses in trials 1 to 5 for both the preliminary and second tasks. Thus if there was negative specific transfer associated with positional labelling, it was compensated for by the greater efficiency of this labelling method early in practice. Also since the assignment of subjects was random and the choice of labelling methods is thought to be a subject specific variable, the labelling method should not have influenced the other results.

In previous studies nonspecific transfer, especially its component of learning to learn has been tested for its specificity to a number of variables (e.g., class of materials and task type). This study is a very small way, augmented this area of research by demonstrating that learning to learn and warm-up the two components of nonspecific transfer, are training method specific.

APPENDIX A

PAIRED ASSOCIATE LISTS



Paired-associate lists and positions, with white lights and buttons shown (not to scale) for LIST 1.

[a] white lights

[b] response buttons

[c] connection

Order of Presentation of ST for LIST 1 and LIST 2

LIST 1

	74	41	73	68	51	58
1st Order	5	2	3	1	6	4
2nd Order	1	3	6	2	4	5
3rd Order	4	2	1	3	6	5
4th Order	3	2	1	6	5	4
5th Order	2	5	3	1	4	6

LIST 2

	67	84	87	82	37	71
1st Order	1	5	4	3	2	6
2nd Order	1	6	2	3	5	4
3rd Order	3	5	4	6	1	2
4th Order	6	1	4	3	5	2
5th Order	4	2	6	3	5	1

Order of Presentation of ST and RT for

Warm-up LIST I and Warm-up LIST 2

Warm-up LIST I ST's	74	41	73	68	51	58
Warm-Up LIST 2 ST's	67	84	87	82	37	71
Ist Order	3	5	4	6	I	2
2nd Order	5	4	I	6	3	2
3rd Order	4	I	2	3	5	6
4th Order	6	2	5	4	I	3
5th Order	6	4	I	5	2	3
Warm-Up LIST I RT's	59	79	78	47	83	43
Warm-UP LIST 2 RT's	47	34	31	61	57	53
Ist Order	I,2			3,5	6	4
2nd Order	2	3,4,6		5	I	
3rd Order			2,4,5	3	I	6
4th Order		4,6	I,2	3,5		
5th Order	4,5	6		I,2		3

APPENDIX B

C METHOD INSTRUCTIONS

1. Each number under a white light is connected to a different number on a button. Your task is to find out and learn which button number is connected to which white light number. I'll repeat that.

2. During the experiment there will be training phases and testing phases. The light will come on above the word "TRAIN" for the training phases and above the word "TEST" for the testing phases.

3. The training phase will work like this: A white light over a number will come on. You are to firmly push the button number you think is connected to this white light number. You will have 3 seconds to make your response. Please respond whenever a white light over a number comes on. Then a Light will come on under the button number that is connected to this white light number. For example, if white light 93 was connected to button 29, light 93 would come on, you would firmly push one of the numbers on the buttons, and then the light under button 29 would come on.

4. The testing phase will work like this: A white light over a number will come on. You are to firmly push the button number you think is connected to this white light number. You will have 6 seconds to make your response. Please respond to each white light number.

5. To acquaint you with the operation of the machine you will now have some practice. In the actual experiment the white light numbers that are connected to the button numbers will not be

the same as in the practice.

6. First an example of testing. Don't forget when the white light over a number comes on, firmly push the button number you think is connected to this white light number (PRACTICE). In the actual experiment you will be tested on all 6 white light numbers one at a time, but the white light numbers will not be presented in any special order. Then there will be a 12 second break before the training phase begins.

7. Now an example of training. Don't forget you will have 3 seconds to push the button number when the white light over a number comes on. (PRACTICE). In the actual experiment you will be trained on all 6 white light numbers but the white light numbers will not be presented in any special order. Then there will be a 12 second break before the next testing phase begins.

8. Raise your hand if you have any questions. If you have any questions ask them now because once started the sequence cannot be interrupted.

APPENDIX C

P METHOD INSTRUCTIONS

1. Each number under a white light is connected to a different number on a button. <u>Your task is to find out and learn which button number is connected to which white light number.</u>

I'll repeat that.

2. During the experiment there will be training phases and testing phases. The light will come on above the word "TRAIN" for the training phases and above the word "TEST" for the testing phases.

3. The training phase will work like this: A white light over a number and a light under the button number that is connected to this white light number will come on at the same time. When the light under the button number goes off, you are to firmly push this button number. You will have 3 seconds to make your response. Please respond whenever a white light over a number comes on. For example, if white light 93 were connected to response button 29, light 93 would come on as well as the light under button 29. Then when the light under button 29 went off, you would firmly push response button 29.

4. The testing phase will work like this: A white light over a number will come on. You are to firmly push the button number you think is connected to this white light number. You will have 6 seconds to make your response. Please respond to each white light number.

5. To acquaint you with the operation of the machine you will now have some practice. In the actual experiment the white light numbers that are connected to the button numbers will not be the same as in the practice.

6. First an example of testing. Don't forget when the white light over a number comes on, firmly push the button number you think is connected to this white light number. (PRACTICE). In the actual experiment you will be tested on all 6 white light numbers, one at a time, but the white light numbers will not be presented in any special order. Then there will be a 12 second break before the training phase begins.

7. Now an example of training. Don't forget you will have 3 seconds to push the button number after the light under this button number goes off. (PRACTICE). In the actual experiment you will be trained on all 6 white light numbers, but the white light numbers will not be presented in any special order. Then there will be a 12 second break before the next testing phase begins.

8. Raise your hand if you have any questions. If you have any questions ask them now because once started the sequence cannot be interrupted.

APPENDIX D

Cw METHOD INSTRUCTIONS

1. There is no connection between the numbers under the white lights and the numbers on the buttons. Your task is to push the button numbers at the proper time according to the instructions. I'll repeat that.

2. During the experiment there will be training phases and testing phases. The light will come on above the word "TRAIN" for the training phases, and above the word "TEST" for the testing phases.

3. The training phase will work like this: A white light over a number will come on. You are to guess which light under a button will come on next by firmly pushing the number on the button of your choice. You will have 3 seconds to make your response. Please respond whenever a white light over a number comes on. Then a light will come on under a button number. The button number light that comes on has nothing to do with which white light number came on. For example, if white light 93 came on, you would push the button number you think will come on next, then the light under button 62 might come on. White light 93 is not connected to button 62; the next time white light 93 came on, any other button number light, including button 62, might come on.

4. The testing phase will work like this: A white light over a number will come on. You are to firmly push one of the button

numbers. You will have 6 seconds to make your response. You are being tested on whether you will respond to each white light number within 6 seconds.

5. To acquaint you with the operation of the machine you will now have some practice.

6. First an example of testing. Don't forget when the white light comes on over a number, firmly push one of the button numbers. (PRACTICE). In the actual experiment you will be tested on all 6 white light numbers, one at a time, but the white light numbers will not be presented in any special order. Then there will be a 12 second break before the training phase begins.

7. Now an example of training. Don't forget you will have 3 seconds to push the button number of your choice, when the white light over a number comes on. (PRACTICE). In the actual experiment during each training phase you will be presented with all 6 white light numbers, one at a time, but the white light numbers will not be presented in any special order. Then there will be a 12 second break before the next testing phase begins.

8. Raise your hand if you have any questions. If you have any questions ask them now because once started the sequence cannot be interrupted.

APPENDIX E

Pw METHOD INSTRUCTIONS

1. There is no connection between the numbers under the white lights and the numbers on the response buttons. Your task is to push the button numbers at the proper time according to the instructions. I'll repeat that.

2. During the experiment there will be training phases and testing phases. The light will come on above the word "TRAIN" for the training phases, and above the word "TEST" for the testing phases.

3. The training phase will work like this: A white light over a number and a light under a button number will come on at the same time. When the light under the button number goes off, you are to firmly push this button number. You will have 3 seconds to make your response. Please respond whenever a white light over a number comes on. The button number light that comes on has nothing to do with which white light number came on. For example, if white light 93 and button light 62 came on at the same time when button light 62 went off, you would push button 62. White light 93 is not connected to button 62; the next time white light 93 came on any other numbered response button light, including button 62, might come on.

4. The testing phase will work like this: A white light over a number will come on. You are to firmly push one of the button numbers. You will have 6 seconds to make your response. You

are being tested on whether you will respond to each white light number within 6 seconds.

5. To acquaint you with the operation of the machine you will now have some practice.

6. First, an example of testing. Don't forget when the white light comes on over a number, firmly <u>push</u> one of the button numbers. (PRACTICE). In the actual experiment you will be tested on all 6 white light numbers, one at a time, but the white light numbers will not be presented in any special order. Then, there will be a 12 second break before the training phase begins.

7. Now, an example of training. Don't forget you will have 3 seconds to <u>push</u> the button number after the light under this button number goes off. (PRACTICE). In the actual experiment you will be trained on all 6 white light numbers, but the white light numbers will not be presented in any special order. Then there will be a 12 second break before the next testing phase begins.

8. Raise your hand if you have any questions. If you have any questions ask them now because once started the sequence cannot be interrupted.

APPENDIX F

QUESTIONNAIRE

PLEASE COMPLETE THIS FORM AND LEAVE IT ON THE DESK WHEN YOU ARE FINISHED.

NAME ______________________________

Using the space below, indicate the connections you learned on the second part of the experiment.

APPENDIX G

ANALYSES OF CONTROL VARIABLES

Analysis of Variance for Experimental Groups and

Paired-Associate Lists on Task I

		Trials to Criterion			Correct Responses Trials 1-5		
Source	df	SS	MS	F	SS	MS	F
Groups	3	15.84	5.28	.38	16.09	5.36	.15
Lists	1	.03	.03	.002	11.28	11.28	.32
Group X Lists	3	13.09	4.36	.31	40.09	13.36	.38
Error	24	336.71	14.03		835.25	34.80	

Analysis of Variance for Pretrained Groups and

Paired-Associate Lists on Task 2

Source	df	Trials to Criterion SS	MS	F	Correct Responses Trials 1-5 SS	MS	F
A (Same/changed method)	1	.25	.25	.03	10.56	10.56	.36
B (Learn/warm-up)	1	196.00	196.00	22.81**	612.56	612.56	20.79**
C (Task 2 method)	1	0	0	0	7.56	7.56	.26
D (Lists)	1	18.06	18.06	2.10	118.62	118.62	4.02
AB	1	22.56	22.56	2.62	72.25	72.25	2.45
AC	1	39.06	39.06	4.55*	110.25	110.25	3.74
AD	1	9.00	9.00	1.05	5.06	5.06	.17
BC	1	1.56	1.56	.18	1.00	1.00	.03
BD	1	20.25	20.25	2.35	33.06	33.06	1.12
CD	1	1.00	1.00	.12	45.56	45.56	1.54
ABC	1	9.00	9.00	1.05	60.06	60.06	2.04
ABD	1	3.06	3.06	.36	36.00	36.00	1.22
BCD	1	1.56	1.56	.18	36.00	36.00	1.22
ABCD	1	16.00	16.00	1.86	5.06	5.06	.17
Error	49	421.06	8.59		1446.75	29.46	

$*p < .04$
$**p < .0001$

Analysis of Variance of the Learning to Learn Data

for Experimental Groups and Paired-Associate Lists

		Trials to Criterion			Correct Responses Trials 1-5		
Source	df	SS	MS	F	SS	MS	F
A (Same/change method)	1	45.03	45.03	6.96**	144.33	144.23	6.45**
C (Task 2 method)	1	3.10	3.10	.48	1.98	1.98	.09
D (Lists)	1	.03	.03	.005	13.78	13.78	.61
AC	1	17.94	17.94	2.77	120.28	120.28	5.38*
AD	1	.78	.78	.12	7.03	7.03	.31
CD	1	.03	.03	.005	.28	.28	.01
ACD	1	2.53	2.53	.39	19.53	19.53	.87
Error	24	155.25	155.25		536.75	22.36	

*$p < .03$
**$p < .02$

Component Analysis of Prompting Versus Confirmation

Correction on Task I for Experimental Groups

		Trials to Criterion			Correct Responses Trials 1-5		
Source	df	SS	MS	F	SS	MS	F
(PP+PC)-(CC+CP)	1	5.28	5.28	.42	.03	.03	.0009
Error	28	349.88	12.50		886.62	31.67	

Component Analysis of P control Versus C control

		Trials to Criterion			Correct Responses Trials 1-5		
Source	df	SS	MS	F	SS	MS	F
P control-C control	1	14.06	14.06	1.12	3.06	3.06	.10
Error	28	349.88	12.50		886.62	31.67	

APPENDIX H

PRELIMINARY ANALYSIS REQUIRED FOR

DUNNETT'S t TEST

Analysis of Variance of Task 2 Scores

for Task 2 P Trained Groups

		Trials to Criterion			Correct Responses Trials 1-5		
Source	df	SS	MS	F	SS	MS	F
P Groups	4	127.40	31.85	3.13*	447.35	111.84	3.03*
Error	35	356.38	10.18		1290.25	36.86	

$*p < .03$

Analysis of Variance of Task 2 Scores

for Task 2 C Trained Groups

		Trials to Criterion			Correct Responses Trials 1-5		
Source	df	SS	MS	F	SS	MS	F
C Groups	4	269.90	67.48	8.81**	708.25	177.06	7.17*
Error	35	268.00	7.56		864.13	24.69	

$*p < .0004$
$**p < .0001$

Analysis of Variance of Task 2 Scores for Each Experimental Group and Its Warm-up Control Group

		Trials to Criterion			Correct Responses Trials 1-5		
Source	df	SS	MS	F	SS	MS	F
PP/PwP	1	52.56	52.56	5.69*	150.06	150.06	3.95
Error	14	129.38	9.24		531.88	37.99	
CP/CwP	1	30.25	30.25	3.04	132.25	132.25	4.19
Error	14	139.50	9.95		441.50	31.54	
CC/CwC	1	132.75	132.75	14.72**	441.00	441.00	12.43**
Error	14	125.75	8.98		496.75	35.48	
PC/PwC	1	14.06	14.06	2.06	22.56	22.56	1.24
Error	14	95.38	6.81		255.38	18.24	

*$p < .03$
**$p < .004$

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VITA AUCTORIS

Richard A. Zuliani was born on May 25, 1944 in Coniston, Ontario. In June, 1964 he graduated from Michael Power High School, Islington, Ontario. In September, 1964 he enrolled at the University of Windsor. He graduated with the Bachelor of Arts degree in Honours Psychology and Science in June, 1968. Since September, 1974 he has been enrolled in the Master's programme in Experimental Psychology at the University of Windsor.

Richard A. Zuliani is married to the former Margaret Bald.