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The effects of pretraining on the learning of sequential cooperation on a serial task.

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The Effects of Pretraining on
the Learning of Sequential
Cooperation on a
Serial Task

by

John E. Hunter

B.A. (Hons.), York University, 1971

A Thesis
Submitted to the Faculty of Graduate Studies
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ABSTRACT

Using first-year female students from the University of Windsor to form dyadic teams, team performance was measured after differing amounts of individual pretraining were given: (a) no pretraining, (b) pretraining in a "social" skill, (c) pretraining in a "technical" skill, and (d) pretraining in both "social" and "technical" skills. A sub-experiment was conducted to test for an order effect when pretraining was given in both skills. There was a facilitative effect on team performance when pretraining in both skills was given in the order "technical" skill followed by "social" skill.

It was hypothesized that the amount of pretraining given would produce differentials in savings for the acquisition of the correct team response: greatest for pretraining in both skills, least for no pretraining. These hypotheses were confirmed. The differential saving between pretraining in the "technical" skill alone and pretraining in the "social" skill alone was not significant and close to zero. When total training trials were considered, no overall differences were found among the training conditions.

The speed with which individuals learned in the team training and individual training situations did not differ.

PREFACE

I wish to express my sincere gratitude to Dr. V.B. Cervin, under whose guidance this study was undertaken, for his helpful suggestions and encouragement offered throughout the course of the experiment; to my committee members, Dr. J.J. La Gaipa and Dr. A. Ragab, for their helpful contributions. The assistance given by Dr. A.A. Smith in the statistical analyses is also appreciated. I finally wish to extend my thanks to Jim Luetzgen and Isaac Srebro for their kindnesses.

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CHAPTER 1
INTRODUCTION

As noted by DeGreene (1970), both personnel selection and personnel training are inseparable and both interact with the complexity of the organizational system. The more complex the system, the more stringent are the selection and training requirements. Employees are often selected on technical skills and they are then trained on the integration of team role with perhaps some adjustments made to the technical skills, depending on the demands of the task. Frequently it is observed that many operators within modern systems must be trained as a team, or as groups of operators who must effectively coordinate their activities and work together if the system is to function efficiently. Often team training begins only after the individual operators have learned their specific skills in isolation, or in other words after individual pretraining. Thus, the notion of team training becomes a topic of relevance in social-industrial psychology. Any person who is responsible for providing team training is vitally concerned with the problem of how best to put teams together for the performance of a given task. This is the problem in this report.

Training, in a broad sense as proposed by Tiffin & McCormick (1965), is any planned and organized effort specifically designed to help individuals develop increasing capabili-

ties. In the industrial-oriented systems, many training programs are directed toward developing knowledge and skills that would be useful to employees performing their jobs. As Biel (1962) points out, whenever a number of employees interact with machines or with other employees in such a way as to constitute a distinguishable portion (i.e. sub-system) of a total operating system, individual training often becomes an inadequate means of improving team performance. Thus, training directed at the interactive procedures within the industrial sub-system is usually referred to as team training.

In this report, the distinction between individual training and team training is simply that the former involves the training of individuals in an independent setting while the latter involves the training of individuals in a group setting. This distinction between individual and team training appears compatible with the distinction made by Biel (1962).

Training frequently is carried out in an artificial situation which is a simulation of the real task situation. Where training takes place in a simulated environment, the assumption is made that the learning that occurs in the training situation will transfer to the real task situation. This being the case, then the real task is usually referred to as the transfer task. Simply stated, transfer of learning deals with the extent to which that which is learned in one situation can be carried over to, or be applicable to, another situation.

Usually, theorists interested in the area of transfer of learning (e.g. Osgood, 1949) think in terms of the degree of similarity for both the stimulus and response between the train-

ing situation and the transfer task. Transfer of learning is thought to be greatest (i.e. positive) when the stimulus and the response during training are highly similar to those in the transfer task. Where both the stimulus and response in the training are unrelated with the stimulus and response in the transfer task, no transfer of learning is expected. Where the stimulus is identical but the response is antagonistic between training and transfer situations, then the transfer of learning is expected to be negative (i.e. that which is learned in training is detrimental to the required performance on the transfer task).

Being a subset of the class of small groups, teams can be differentiated from this broader class by considering them as small groups of individuals that are both structured and task oriented; the task itself providing the justification for the existence of a team. Glaser & Klaus (1966) formally define a team as a collection of individuals which is usually well organized, highly structured, and has relatively formal operating procedures.

Implicit in the Glaser & Klaus (1966) definition of a team is the fact that teams depend on the cooperative participation of a number of specialized individuals whose activities contain little overlap, and who must each perform their task at least at some minimal level of proficiency if the team is to perform at a specified standard. In order for an individual to perform tasks at some minimal level of proficiency, it is necessary for the individual to receive training in the appropriate technical skills (i.e. to respond appropriately to cues

provided by the task itself). Likewise, in order for the cooperative participation of a number of specialized individuals to develop, training in the appropriate social skills is necessary (i.e. to respond suitably to cues provided by other members of the team). Biel (1962) indicates that it is useful to separate the training necessary to train persons in their individual skills from the skills used to train them as members of a team.¹

In his study of cooperative behavior in dyadic teams, Rosenberg (1960) offered a definition of cooperation in terms of the consequences to individuals (in the form of a feedback, reward, or payoff) after they had made their specified combined responses. A cooperative situation was defined as one where (a) there existed at least two outcomes for each individual following a response, (b) one of which was a rewarding state of affairs, (c) reward delivered to one person did not preclude its availability for the other, and (d) the outcomes to both persons were, in part or entirely, a function of the behavior of the other person. Underlying this definition of cooperation was the concept that the reinforcing events were considered as being critical components in the development and maintenance of cooperative action.

While both Bass & Vaughan (1966) and Tiffin & McCormick (1965) expressed the "generally accepted" notion that team training improves group performance, others have pointed to the fact that there is a lack of systematic research in the area of team training appropriate to performance improvement of typical working teams (see Boguslaw & Porter, 1962, p. 411; Howell &

¹ For convenience the expressions technical and social skills are used although both are the simplest of their kind.

Goldstein, 1971, p. 477). Fitts, Schipper, Kidd, Shelly, & Conrad (1964) suggested that one of the reasons for this research lag was due to the difficulty of creating a realistic team task in the laboratory where it can be subjected to controlled experimental study.

In psychological literature one notes that the performance of teams operating under different structures has been investigated (Klaus & Glaser, 1960; Kidd, 1961; Fitts et al, 1964; Naylor & Briggs, 1965; Briggs & Naylor, 1965; Glaser & Klaus, 1966; Egerman, 1966; Johnston & Briggs, 1968). Typically, these studies dealt with the performance of team operators on simulated radar-controlled aerial intercept tasks which often involved "timing responses". Usually the teams in these studies consisted of a monitor, a processor, and a controller whose activities were interconnected. The general purpose of these experiments was to investigate, in one form or another, the relationships between individual member performance and team performance. Some of the principal variables studied were: (a) the extent to which one could predict team performance on the basis of the constituent members' performance which was measured individually (Kidd, 1961), (b) the change in team membership when a substitute member possessed varying amounts of task experience (Naylor & Briggs, 1965), and (c) the inhibitory aspects of direct intermember communication (Johnston & Briggs, 1968). Of the studies cited above, a very small number were relevant to team training per se, and so, with the exception of one, they had no direct relevance to the present study.

Briggs & Naylor (1965) investigated team versus individual training, training task "fidelity", and task organization effects on transfer performance. This study involved a three-man team performing an aerial-intercept control task via simulated radar displays. Experimenter assistants portrayed interceptor pilots and made heading and speed adjustments as directed to do so by two of the subjects who acted as radar controllers. The "interceptor pilots" received their directions by means of simulated radio communication channels. The third team subject occupied the role of a supervisor-coordinator.

The training task in this study was an abstraction of the transfer task: a checkerboard replica of the radar coverage with both interceptor and target aircraft represented by checkers. Training occurred at two levels. On one level, radar controllers directed the moves of the interceptor checkers over the simulated radio link to the experimenter assistants. Thus, in this training condition the radar controllers acquired the same communication skills as were required in the transfer task. On the other level of training the radar controllers moved their own interceptor checkers during training and; thus, they were given no opportunity to practice and develop the communication skills required for the transfer task.

Task organization occurred at two levels in both the training and transfer situations. One level was an independent condition in which each radar controller worked without coordination with the other controller. The other level was an interaction condition wherein the radar controllers traded off targets and interceptors thereby coordinating their operation.

One of the major conclusions reached by Briggs & Naylor (1965) was that "superior performance occurred after training on an independently organized task (as compared to that after training which required verbal interaction among the controllers)". Verbal communication in the interaction condition of training was superimposed on the normal demands of the task itself. This led to a "proportionate reduction of exclusively task-directed behavior". The investigators suggested that this finding supported earlier findings to the effect that individual training was superior to team training. They also found that the degree of similarity, of both the stimulus and response between the training task and the transfer task influenced performance on the transfer task. Superior performance followed a training situation which was highly similar to the transfer task in terms of stimuli and responses.

In this present report it is of importance to note that Briggs & Naylor (1965) suggested that the transfer task they employed actually involved some joint decision making but "little direct coordination in (the) behavior of the two operators". In other words, their study did not employ a task that approached the demand for cooperation among team operators as would be demanded for example in a sports team task (baseball, football), or in a task such as wiring and soldering television receiver parts.

Cervin, Bonner, Rae, & Kozeny (1971) investigated the learning of cooperation in "two-partner groups" under differing feedback and communication systems. In their study a modified verbal paired-associates learning task was employed. The

objective of the "groups" was to correctly learn six pairs of stimulus-response digits. Their main finding was that cooperation was learned significantly faster when the subjects saw their partner's response as opposed to not seeing their partner's response. While this study was only in part directly relevant to team training (i.e. in terms of the development of cooperation), it illustrated a characteristic which was applicable to other studies (Glaser & Klaus, 1966; Kidd, 1961). In the Cervin et al. (1971) study, the task was incidental to the learning of cooperation and it simply provided an occasion for the team performance.

A major point of interest that evolved from the previously cited studies (particularly Rosenberg, 1960; Egerman, 1966; Glaser & Klaus, 1966; and Cervin et al, 1971) was that these researchers considered the team as a learning unit which reacts to the presence or absence of reinforcement following a response. To illustrate the parallel between the team being regarded as the learning unit and the individual being regarded as the learning unit, the procedure used to produce a response acquisition for an individual will be considered.

Initially it is necessary to select a particular response class from the individual's repertoire. Following the occurrence of the particular response of interest, the experimenter provides a reinforcement or "reward" to the individual. Each successive reinforced instance of the response makes it increasingly likely that this same response will again be made. Gradually, the rate of the particular response increases as training proceeds until a fairly stable, high rate of perform-

ance is attained. Thus, an individual's performance is a function of the reinforcement contingencies he or she experiences. The reinforcement contingencies are usually established by the experimenter in the laboratory.

Viewing the team, rather than the individual, as a learning unit allows the experimenter to investigate the effect of a team reinforcement on the rate of proficiency of team and member responding. What is of interest here is that the team, and therefore all its members, receives or does not receive reinforcement. The reinforcement is contingent upon the team response at any particular time. The fact that the team response may be quite complex and consist of several separate actions, or that a number of individuals have cooperated in making the response possible, is of secondary interest at this point. Indeed, the properties of individual performance within the team may be manipulated, but even then the total team behavior usually is of primary interest. Thus, the adequacy of the total team performance is reported to all members equally. This knowledge of results, when it represents correct team performance, can be considered as a reinforcing contingency following team performance.

These previously mentioned studies which involved the application of reinforcement theory principles to team behavior, indicated that a learning theory model can provide a suitable framework for studying team performance (Berger & Lambert, 1968).

In those studies that were relevant to team training in one form or another, it was apparent that the experimenters

concerned did not separate or make distinctions between the training in technical skills and the training in social skills. These two types of skills, both independently and in combination, were viewed by the present investigator as being variables worthy of systematic study.

In complex man-machine systems, teams of operators can be arranged in series or in parallel. In series arrangement, all the operators must perform a correct response in order for the team to complete a specified task. In parallel arrangement, functional redundancy exists since the task completion depends on the integrated responding of some, but not all, of the operators on any one trial. Further, in both, the operators themselves can be organized so that they either respond simultaneously or sequentially. Also, the various sub-tasks comprising the overall team task can be either serial or simultaneous in their organization. Serial tasks require the operators not only to know the necessary skills to perform the particular sub-tasks, but also to know the order among such sub-tasks. These three basic variables of team and task organization and order provide a $2 \times 2 \times 2$ matrix.² One cell in this matrix is of interest in this study: a team of operators organized in series, the operators themselves organized so that they respond sequentially, and the sub-tasks organized in a serial order.

An explanation concerning the use of the term "sub-tasks" is in order. Any team task, whether it be wiring and soldering television receiver parts, receiving and filling orders in a mail order house, playing baseball, or participating as a member of a symphony orchestra, is composed of a series of related

² From personal communication with Dr. V.B. Cervin.

sub-tasks. One can separate these sub-tasks from the larger team task. The sub-tasks are the responsibility of, and are performed separately by, the individual members. Further, the individual member's sub-tasks can be broken into their components which must be performed by the individual members in an order appropriate for the completion of the sub-tasks. How well an individual is able to perform the components of the sub-tasks, and how well he is able to perform these sub-tasks in a definite order, are a function of training in the appropriate technical skills. How well the team task is performed collectively by the individual members is a function of their training in the appropriate social skills.

As implied at the outset of this report, training can be carried out within the context of a team, or it can be given to team operators on an individual basis followed by training in the team. Within the context of a team all operators receive the required amount of team training necessary to perform the team response at the specified level of proficiency. In this setting, the specific social skills are not separated from the specific technical skills: the operators receive training on both skills in combination. Training on an individual basis followed by training in a team involves individual operator pretraining on either one or the other, or on both of the social and technical skills. Following this, the operators as a team are trained to produce the team response at the specified level of proficiency.

Consider the situation in which the team operators have had no training on either the specific social skills or techni-

cal skills which would be relevant for a particular team task. Initially, the operators would likely be incapable of performing either of these skills at the required standard demanded by the team task. Only a minimal amount of positive transfer, if any, from their past experience would be possible. Training on both skills within the context of a team, or within an individual setting followed by training in a team setting would be required.

On the other hand, consider the situation where the operators have had, at one time or another, previous training on the appropriate technical skills required for performing the sub-task components. Here, the operators should be capable of exercising these technical skills at the required standard due to the opportunity for positive transfer of learning. However, these operators would likely be unable to meet the criterion demanded in terms of the appropriate social skills (i.e. little or no positive transfer of social skills). It would seem to be efficient to provide these operators with social skill training (i.e. further pretraining) followed by training in the team setting. In the team setting, their task would be to integrate the two skills. At the same time however, perhaps it would also be efficient to simply provide these operators with team training. In this case their task would be to learn the social skills and successfully integrate these skills with their previously learned technical skills in order to produce the correct team response. The question arises as to which of these possible training procedures is the most efficient: efficiency being thought of in terms of the "savings" in training

realized from the pretraining of team operators in either one or in both of the technical and social skills.

In a pilot study conducted by the present investigator it was found that the type of individual pretraining (i.e. pretraining on either the technical or social skills) had no apparent differential effect on team performance. However, there was a differential effect on team performance after providing the individual team members with varying amounts of pretraining: no pretraining was equated to "zero" pretraining, pretraining on either one of the social or technical skills was equated to "one-half" pretraining, and successive pretraining on both the social and technical skills was equated to "maximum" pretraining.

Based on the above observations from the pilot study, it was assumed in the present study that there would be no significant difference between the types of pretraining. Thus, the investigator's attention was directed toward determining the significant "savings" in team training produced by varying amounts of pretraining. Certain hypotheses derived from the theory of transfer of learning were formulated for the following pretraining conditions: (a) no pretraining, (b) pretraining on the technical skill, (c) pretraining on the social skill, and (d) pretraining on both the social and technical skills successively.

The teams consisted of two operators who were organized in series. The operators had to respond sequentially on the sub-tasks which were organized in a serial order. Thus, both of the operators had to learn to perform correct responses in

a definite order (i.e. they had to learn a technical skill). The operators also had to learn when it was their turn to respond (i.e. they had to learn a social skill). This team and task arrangement may be described as having a rigid structure and communication network. The arrangement required the coordinated participation of both individuals, and it also required from the individuals a maximum proficiency in the sub-task performance so that they could correctly produce the team response. Unlike the study of Cervin et al (1971) the task as a whole and its sub-tasks were not considered simply an occasion for team performance. Team and task training were given both separately and in combination. The well-defined assignments for each operator permitted an analysis of the contribution made by each operator to the team's response.

The "technical" skill involved in this study was a perceptual-motor coordination skill which formed an action sequence (AS). The technical skill involved depressing the correct response button on a panel in a particular serial order within a specified time period. The AS was learned as a result of technical skill training.

The social skill was characterized by the ordering of actions between the two operators forming the team. This skill gave an operator sequence (OS). The social skill required the operators to "fit into" the team by responding only when it was their turn. The OS was learned as a result of social skill training.

Throughout the study, both the AS and OS were of equal length in terms of the number of steps in each (eight steps).

The two sequences, AS and OS, were held at a constant level of complexity by randomly ordering the steps within each of the sequences.

The question asked was: In order to have a team perform a given task at a specified level of proficiency, which amount of pretraining (i.e. no pretraining, pretraining on AS or OS, or both) provided the greatest "saving"?

On the basis of the theory of transfer of learning, the investigator hypothesized that those teams in which the operators received pretraining on either AS or OS, or both, would learn to perform at the required level of proficiency faster (i.e. fewer trials) than would those teams in which the operators received no pretraining. A positive transfer of learning from the various amounts of pretraining to the team training condition was expected to occur for those operators who received pretraining. The transfer of learning was expected to be positive since the stimulus and the response in the pretraining condition were highly similar to those in the team training or transfer task condition. For those teams in which the operators received a zero amount of pretraining the opportunity to use a positive transfer of learning was probably non-existent.

The dependent variable was the number of trials required by the teams to reach the criterion of an error-free team response during team training. The "savings" were defined as the differences between the number of trials required by the teams to reach the criterion under the various training conditions.

In terms of savings, it was hypothesized that the minimum

(zero) savings would occur with zero pretraining. Greater savings were expected when pretraining was given in either the AS or OS. The maximum amount of savings was predicted to occur when pretraining in both AS and OS was given. The savings produced by pretraining in OS were expected to be comparable to the savings produced by pretraining in AS.

Another question asked was whether or not individual training is superior to team training. Briggs & Naylor (1965) found that verbal communication in their team training condition detracted from task-oriented behavior. Therefore, individual training was superior to team training.

In the present study, individual training (i.e. individual training in an independent setting) was given to some teams. Team training (individual training in a team setting) was given to all teams. However, unlike the Briggs & Naylor (1965) condition of team training, the team members in the present study could not verbally communicate with each other at any time. Thus, these teams did not experience the "inhibitory action" of verbal communication.

In the present study, the training condition in which the operators received zero pretraining was defined as the team training situation. The training condition in which the individual operators received pretraining on both AS and OS was defined as the individual training situation. The dependent variable in these respective situations was the number of trials required to reach criterion (an error-free response sequence) on both sequences by individuals working as members of teams and by individuals working independently.

In team training the operators had to divide their attention between the learning of AS and the learning of OS simultaneously. Thus, it was possible that the attention required for one task interfered with the attention necessary to learn the other on-going task. This simultaneous interference created a complex learning situation for operators working as members of a team.

In individual training the learning of the two tasks, AS and OS, was undertaken successively. Therefore, simultaneous interference was not experienced by these operators. The tasks of learning AS and OS were separated and therefore, this learning situation was not complex.

To the extent that the individual training situation was less complex than the team training situation, individual training was hypothesized to be superior to team training, in the sense that the operators would require fewer trials to learn AS and OS to criterion.

To test these hypotheses, a 2 X 2 fixed factorial design was employed. Two independent variables were manipulated at two levels: pretraining and no pretraining in AS, pretraining and no pretraining in OS. Data were collected for individuals working independently, for individuals working as members of teams, and for teams working as cooperative units.

Since some of the teams received pretraining on both AS and OS, it was possible that there would be some order effects. To test for this possibility a sub-experiment was conducted.

In summary, the purpose of the present study was to compare the savings in team training when individual operators

were given different amounts of pretraining on a relevant task. This task was a serial task requiring sequential cooperation.

The specific hypotheses tested were:

1. Different amounts of pretraining (i.e. pretraining in either AS or OS, or in both) as opposed to zero pretraining, will result in significant savings in the number of trials required to produce the correct team response.
2. The amount of savings realized by AS pretraining will be equal to the amount of savings realized by OS pretraining.
3. Independent-individual training will be superior to individual training in a team setting.

CHAPTER II

METHODOLOGY AND PROCEDURE

Subjects

A total of 88 female students from first-year classes at the University of Windsor were recruited according to the procedures and regulations as outlined by the Research and Resources Committee. The Ss were paired randomly into 44 pairs. Thirty of the 44 pairs were randomly assigned to one of five groups so that there were six pairs of Ss in each group. These 30 pairs formed the sample for the main experiment. For the sub-experiment, 12 of the remaining 14 pairs were randomly assigned to either one of two groups so that there were six pairs in each group. The two remaining pairs of Ss had to be discarded from the experiment due to the fact that one S in each pair was unable to comprehend the instructions (i.e. had a linguistic background other than English). The experimental session for each pair of Ss was approximately 50 minutes.

Apparatus

The General Learning Apparatus (GLA) of the University of Windsor (Cervin & Grewe, 1967) was used. This apparatus was programmed to present a series of numbers and to inform the Ss when the correct response had been given from the correct panel.

Two panels identified as panels "A" and "B", partitioned

from each other by a screen, were used for each pair of Ss. Each panel had at the bottom a row of response buttons numbered from 1 to 8, each button with a lamp inside. Above there was a single blue warning lamp in the centre of the panel and to the right and left there were two white lamps which served to indicate the onset of a new trial. Immediately left of the response buttons there was a green lamp marked "You Correct", and at the top left side of the panel there was a second green lamp marked "Partner Correct". The response button lights and the green lights provided cues to the Ss for the sequencing of actions in the performance of the task (AS) and the sequencing of operators (OS) respectively.

In another room there was a control panel which allowed E to present the Ss with button lights and green lights in the required programmed sequences and timing relations. An automatic event recorder for recording all the Ss' responses was contained in this room designated as E's room. Ss' and E's rooms were sound-insulated and E was able to see Ss through a window and talk to them on individual earphones. Ss' room was monitored for sound. The arrangement for two-way communication enabled E to ensure that certain experimental procedures (e.g. no talking among Ss) were followed throughout the course of the experiment.

Procedure

The GLA was programmed so that the response buttons were correct in the following random order: 3 8 5 7 4 1 2 6. This sequence of the response buttons formed the AS. The GLA was also programmed so that the panels were correct in the follow-

ing random order: B A A A B A B B. The random order in the panel sequence was formed under the restriction that each panel had four responses. The ordering between the panels formed the OS. Thus, the GLA was programmed overall so that the team task was:

B A A A B A B B. -(OS)

3 8 5 7 4 1 2 6. -(AS).

As a result, in order for the team response to be correct during team training, Panel B was required to begin the task by pressing button 3, followed by the operator at Panel A pressing button 8, and so forth.

It is to be noted that in a "pure" serial task organization, the AS in this study, no team operator should receive any feedback (i.e. reinforcement) about the accuracy of his or any other operator's performance until the entire AS is completed. However, in the present study, individual feedback to the team operators during team training about their own performance was given regardless of the correctness of AS. There were two reasons for programming the GLA for feedback in this manner. One reason was to minimize the difficulty in successfully completing the team task by those team operators who received no pretraining. With eight steps in both the AS and OS the number of permutations and combinations possible would have made their task of determining the correct team response most difficult without individual feedback. Another reason for providing feedback during the team training was to ease the adjustment by individuals into the team training situation from the pretraining situation. The GLA was programmed so that

individual feedback was given during pretraining to those operators who had pretraining. In this manner, the schedule of reinforcement to which an operator was introduced remained constant in both the pretraining and team training situations.

Pretraining was given in one or the other, or in both, or in neither of the AS and the OS prior to team training. The resulting four conditions of pretraining are graphically illustrated in Figure 1. Pretraining on the two different sequences (AS and OS) in Group 4 resulted in two possible orders: OS followed by AS and AS followed by OS. Thus, Group 4 was divided into two sub-groups. The teams that received pretraining on the sequences in the order OS - AS were identified as Group 4_a; the teams that received pretraining on the sequences in the order AS - OS were identified as Group 4_b. This sub-division within Group 4 created the fifth pretraining condition. As a result, there were five groups of teams: Group 1 consisted of those teams to which no pretraining was given; Group 2 contained those teams in which individual operators received pretraining in OS (i.e. one-half pretraining); Group 3 was formed by those teams in which the individual operators received pretraining in AS (i.e. one-half pretraining); Group 4_a consisted of those teams in which the individual operators received pretraining in both AS and OS successively and in the order OS - AS (i.e. maximum pretraining); and Group 4_b consisted of those teams in which the individual operators received pretraining in both AS and OS successively and in the order AS - OS (i.e. maximum pretraining).

The transfer task (i.e. team training) occurred after the

		OS (Operator Sequence)	
		No Pretraining	Pretraining
A S (A c t i o n S e q)	No Pretraining	----- ----- (Group 1)	B A A A B A B B ----- (Group 2)
	Pretraining	----- 3 8 5 7 4 1 2 6 (Group 3)	B A A A B A B B 3 8 5 7 4 1 2 6 (Group 4)

Figure 1. The four basic conditions of pretraining on OS and AS.

administration of the varying amounts of pretraining for those teams in Groups 2, 3, 4_a, and 4_b. Group 1 had zero pretraining and so, it experienced no transfer task; the teams in this group had team training only. The task of producing a correct team response was held constant across all groups.

Each pair of Ss was run separately. When the Ss arrived, they were seated in front of a panel labelled either "A" or "B", and they were instructed to fit on their earphones. They were not able to see each other's panel. A sheet of instructions was given to each S. The Ss were asked to silently read these instructions while E read them aloud to the Ss. Questions were answered by referring back to the appropriate passages of the printed instructions.

Since the teams in four of the five groups received a variety of pretraining before they were given team training, there were some instructional differences between groups. Different instructions were provided in order to accommodate the pretraining phases. However, the basic instructions for the teams in Group 1 were the basis of the instructions which were given in the other groups. The instructions in part for Group 1 were as follows:

You will be working as a team. Your task is to learn to push a sequence of eight buttons in a particular order between the two panels. On each step, only one button on one panel will be correct. (A printed example followed.)

The experiment will work as follows: This white light (E pointed to left white light) will be on for the first sequence. After the blue light goes off, you will have four seconds to push a button. Please push only one button and before the four seconds are up. If this green light appears (E pointed to lower left green light) you pressed the correct button on the correct panel at that step. Your success will be indicated to

your partner by this green light (E pointed to upper green light). If no green light appears, you either pushed the wrong button or pushed out of turn, or both. After the four second interval the button that should have been pushed on that step will light up on both panels regardless of whether it was pushed or not.

The complete instructions for Group 1 are given in Appendix A. The printed as well as the practice examples of the sequences were arranged so that they differed from the actual sequences used in the experiment.

For Group 2 (pretraining in OS) there were two phases to the experiment. Phase 1 was the pretraining phase. Phase 2 was the team task phase. The instructions, modified to accommodate the resulting two phases, are presented in Appendix B.

In the pretraining phase for Group 2 there was a time modification for the button light procedure which had to be accounted for in the instructions. In order to provide Ss with sufficient information as to the button they were to depress while learning the OS, a different button light lighted immediately after each blue light offset. The ideal of having one button light repeatedly could not be used due to apparatus limitations. In order to prevent the incidental learning of a particular serial order of buttons while learning the OS, a continuously random order of button lights was programmed in this phase.

Group 3 (pretraining on AS) had two phases. Phase 1 was the pretraining phase. Phase 2 was the team task. The instructions for this group are presented in Appendix C.

Three procedural phases were used in both Group 4_a and Group 4_b (pretraining on both AS and OS successively). For

the phase involving pretraining in OS E used that portion of the instructions relevant to pretraining for Group 2. Likewise, for the phase involving pretraining in AS E used the appropriate section of the instructions relevant to pretraining in Group 3. For the third phase with Groups 4_a and 4_b , the Ss were informed that, "... as a team you are to combine the two tasks learned earlier." The instructions reviewed the basic procedures of responding to the lights and buttons (see Appendix D).

The confirmation-correction method of learning (Cervin, Ladd, & Scheich, 1970) was used. The order of buttons (AS) and panels (OS), as well as the basic timing relations, remained constant for each of the five groups. The timing relations for the lights and the response interval are presented in Figure 2.

The sub-experiment

As noted earlier, there could have been significant order effects in pretraining individual operators in both AS and OS successively. Pretraining in both the AS and the OS was characteristic of Group 4_a and of Group 4_b . After running six pairs of Ss in both Group 4_a and Group 4_b , a t test for possible order effects in pretraining was conducted. The low power in this test indicated that more replications were required before any conclusive statements could be made about order effects.

A replication consisting of six teams in both Group 4_a and Group 4_b was run. The same procedures as outlined for these two groups in the main experiment were applicable to the replication (i.e. the sub-experiment).

The data for the teams working as cooperative units in

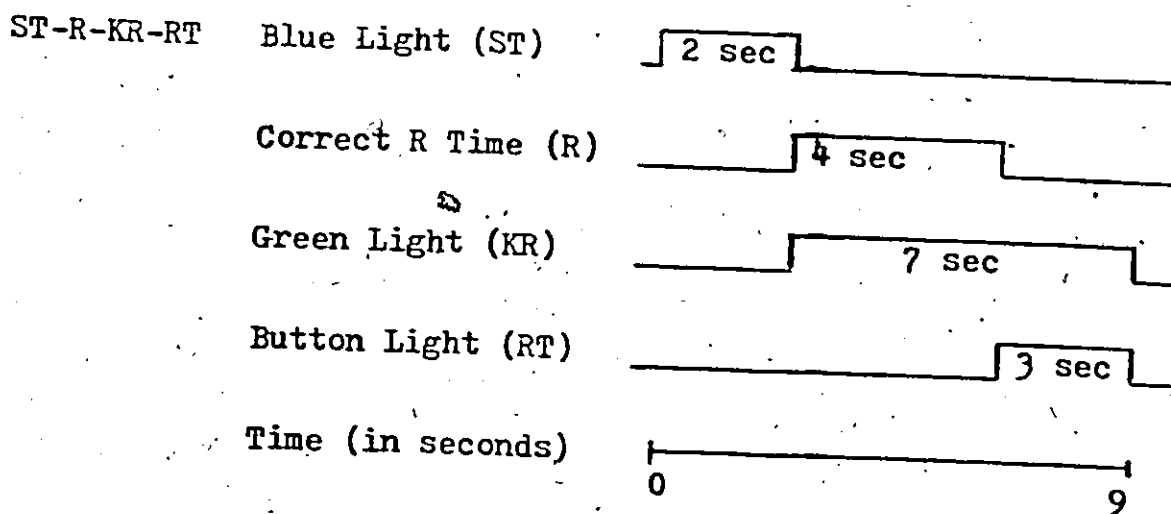



Figure 2. The chart of the timing relations for the GLA used in the confirmation-correction method of learning.

the replication were combined with the appropriate data from Groups 4_a and 4_b in the main experiment. The test for possible order effects was made before the analysis of the main experiment.



CHAPTER III

PRESENTATION AND ANALYSES OF RESULTS

The data were first tested for homogeneity of variance according to a Winer model (Winer, 1971, p. 443) before any tests were made. In all instances, the hypothesis of homogeneity of variance was not supported. The preliminary inspection of the data further revealed that the cell variances generally were functions of the group means: the smaller the mean, the smaller the variance. Thus, a square-root transformation (Winer, 1971, p. 399) was used in order to attain homogeneity of variance. All the analyses that follow were performed on the transformed data. The original data is presented in Appendix E.

Order Effects of AS and OS Pretraining: (Sub-experiment)

The mean number of trials to criterion on the transfer task after pretraining in the order OS - AS was 3.89 trials as compared to 2.92 trials after pretraining in the AS - OS order. A t test (Winer, 1971, p. 37) indicated a significant difference between the two means ($t = 2.43$, $df = 22$, $p < .05$). Thus, a significantly greater saving for the transfer task was realized when pretraining was given in the order AS - OS.

Savings in Team Training Following Different Amounts of Pretraining

In view of the significant order effect when pretraining was given in both AS and OS, five training conditions were

obtained for the statistical analyses. The mean numbers of trials required by the teams to reach criterion on the transfer task for each group are given in Table 1. For Groups 1, 2, 3, 4_a, and 4_b, the mean numbers of trials to criterion were 7.08, 5.73, 5.46, 3.89, and 2.87 trials respectively. The greater the mean, the less is the saving from the pretraining condition. Thus, the greatest amount of savings was realized when pretraining was given in both AS and OS in the order AS - OS (i.e. Group 4_b),

Since the joint effect of pretraining in both AS and OS depends in part on the order in which it was given, two separate two-way analyses of variance were performed on the transfer task scores: one analysis of variance for Groups 1, 2, 3, and 4_a; and one analysis for Groups 1, 2, 3, and 4_b.

The results of the analysis of variance on the transfer task scores for Groups 1, 2, 3, and 4_a are presented in summary form in Table 2. The main effects are significant ($p < .05$) which supports the hypothesis that different amounts of pretraining produce significant differentials in savings on the transfer task performance. The interaction effect was not significant and close to zero.

The near zero interaction implies independence in the sense of equal savings produced by adding pretraining in either AS or OS. Thus, the second hypothesis is supported. The type of pretraining given (AS versus OS) produces no significant differential in savings.

In view of the above independence, the comparisons between Groups 1 and 2, and between Groups 3 and 4_a, are two independent

TABLE 1

The Mean Numbers of Trials Required by the Teams
to Reach Criterion on the Transfer Task for each
of the Five Groups

GROUP	MEAN
1. No Pretraining	7.08
2. Pretraining in OS	5.73
3. Pretraining in AS	5.46
4 _a . Pretraining in both AS & OS in the order OS - AS	3.89
4 _b . Pretraining in both AS & OS in the order AS - OS	2.87

TABLE 2

Summary of Analysis of Variance on Transfer Task
Scores for Groups 1, 2, 3, & 4_a

SOURCE	SS	df	MS	F
AS effect	17.94	1	17.94	6.87*
OS effect	12.68	1	12.68	4.86*
AS X OS	0.08	1	0.08	0.03
Within Cell	52.28	20	2.61	
Total	89.98	23		

* $p < .05$

cases in which a group without OS pretraining is compared with a group with OS pretraining. Since the interaction is near zero and the main effect is significant, the simple main effects will go in the same direction but may not be significant. Moreover, they also should be equal. On these grounds it was not felt necessary to determine whether or not the simple main effects were significant. From the significant main OS effect, one can conclude that the effect of OS pretraining on saving in team training is the same at either level of AS pretraining. Mutatis mutandis, the same statement applies to the significant main AS effect.

It was of interest to determine which amount of pretraining produced the significant saving. Therefore, an individual comparison was made between Groups 1 and 4_a (i.e. minimum and maximum pretraining). The difference between Groups 1 and 4_a was significant ($F = 11.65$, $df = 1, 20$ $p < .01$). An individual comparison was then made between Groups 1 and 3. Group 3, rather than Group 2, was selected for this comparison since the difference between Groups 1 and 3 was greater than the difference between Groups 1 and 2. The difference between Groups 1 and 3, and so the difference between Groups 1 and 2, were not significant. Therefore, the significant saving in the transfer task was realized when pretraining was given in both AS and OS in the order OS - AS. Pretraining in OS or AS alone produced no significant amount of savings in the transfer task.

The results of the analysis of variance for Groups 1, 2, 3, and 4_b are presented in summary form in Table 3. The main effects are significant ($p < .01$). The interaction, though

TABLE 3

Summary of Analysis of Variance on Transfer Task
Scores for Groups 1, 2, 3, & 4_b

SOURCE	SS	df	MS	F
AS effect	30.06	1	30.06	13.30**
OS effect	23.13	1	23.13	10.23**
AS X OS	2.30	1	2.30	1.02
Within Cell	45.24	20	2.26	
Total	100.73	23		

** p < .01

larger than in the analysis of variance for Groups 1, 2, 3, and 4_a, is not significant. The greater interaction variance in this analysis is attributed to the facilitative effect of the AS - OS pretraining order in Group 4_b. This point of view is supported by the significant difference in savings between Group 4_a and 4_b. Similarly, the higher level of significance for the main effects can be accounted for in the second analysis of variance.

Essentially, the same conclusions are reached for the second analysis of variance as for the first when comparisons between Groups 1 and 2, and between Groups 3 and 4_b are entertained. Since there is still a nonsignificant interaction, tests for simple main effects are not warranted.

An individual comparison between Groups 1 and 4_b indicated a highly significant difference in savings ($F = 23.43$, $df = 1, 20$ $p < .01$). Thus, a significant amount of savings on team training was realized when pretraining was given successively on AS and OS in the order AS - OS.

In brief, different amounts of pretraining did produce differential amounts of savings on the number of trials needed to reach criterion in the transfer task. A significant amount of savings was realized when pretraining was given in both AS and OS. Further, there was an additional facilitative effect produced when pretraining in both the AS and OS was given in the order AS - OS. The differential saving between pretraining in OS and pretraining in AS was not significant and close to zero.

Individual versus Team Training

The mean number of trials required by the individual operators working independently (i.e. individual training) to learn both AS and OS in the order OS - AS was 3.27 trials; in the AS - OS order the mean was 3.16 trials. For individuals working as members of a team (i.e. team training), the mean number of trials to criterion was 3.20 trials.

It is readily apparent that neither one of the two comparisons (i.e. team training compared with AS - OS order individual training, and with OS - AS order individual training) would produce any significant differences. Thus, the third hypothesis was not supported and it was concluded that in learning the two sequences, AS and OS, individual training in a team setting is comparable to independent-individual training.

CHAPTER IV

DISCUSSION

One aspect of the problem of how best to put teams together for the performance of a given task is to consider pretraining and its possible facilitative effects. Two skills, technical and social, can be separated from the overall team task for the purpose of providing pretraining. The technical skill refers to that skill which is necessary for the performance of the sub-tasks at some minimal level of proficiency. The social skill refers to that skill which is necessary for the development of cooperative participation among the team members. The research in this paper provides evidence for the existence of lawful relationships between pretraining in these two skills and the subsequent performance on the transfer task.

The transfer task of concern in this study was the situation of two people sequentially performing a serial task. A real-life example of such a situation would be the processing of an order by two co-workers where the first records the receipt of the order and passes the order to the second worker. The second worker then checks to see if the product is available and then retrieves it from stock. The order then goes back to the first worker who invoices and mails a bill. Each step in this process must be performed in a definite sequence by a specified person. The completion of the task depends on

each worker performing their assigned sub-tasks in a particular sequential order.

Such a task was simulated in the University of Windsor's laboratory. In this sense, the present experiment was regarded as an "applied" social-industrial study. In terms of generalizations from the sample to a particular existing population, it is not an applied study. All the generalizations in this paper are to a hypothetical population of teams defined by the properties of the sample.

The problem of putting teams together in the most efficient way was viewed from the perspective of providing different amounts of pretraining (i.e. no pretraining, pretraining in either the technical skill or social skill, or in both). When pretraining was given on both skills a statistically significant order effect was found. The greatest amount of savings in the transfer task performance was realized when pretraining was given in the order of technical skill (AS) followed by social skill (OS).

The significant order effect implied that when pretraining was given in the order OS - AS, there was some significant interference occurring in the overall training. An inspection of the data revealed that in a great majority of the teams for which pretraining was given in the order OS - AS, individual operators experienced initial difficulty in performing the transfer task. In some instances the team operators' ability to recall the skill for the OS performance had been weakened by the subsequent learning of the skill for the AS performance (i.e. retroactive inhibition). In one instance it appeared that

the retention of the AS skill had been interfered with by the earlier learning and retention of the OS skill (i.e. proactive inhibition). In some instances the investigator could not determine the form of interference since too few overt responses were made. When pretraining was given in the order AS - OS, there was a smaller number of teams in which the individual operators experienced either form of inhibition on the transfer task. This asymmetry in the occurrence of interference (primarily the retroactive inhibition) for the two groups is a possible explanation for the order effect.

It was hypothesized that different amounts of pretraining would produce different amounts of savings in the performance on the transfer task. Because of the significant order effect, two separate analyses of variance were performed. In the first analysis with the OS - AS order this hypothesis was supported at the .05 level of confidence. In the second analysis with the AS - OS order the hypothesis was supported at the .01 level of confidence. The pretraining of individuals in either the technical skill alone or the social skill alone produced no significant amount of savings in the performance of the transfer task.

An assumption in this study was that the savings produced by the two types of pretraining (AS versus OS) would be of equal amount. This assumption was upheld. It is not surprising since the two sequences were arranged so that they would be comparable in terms of length and complexity (i.e. the random ordering of the eight steps within each).

To compare the rates in which the individual team members

learned each sequence, the following data were examined. The individual operator scores in pretraining on OS (Groups 2 and 4_a) were compared with the individual operator scores in pretraining on AS (Groups 3 and 4_b). The mean number of trials required to learn OS to criterion was 2.11 trials and to learn AS the mean was 2.18 trials. The difference between the two means was obviously nonsignificant. It was concluded that the two sequences were comparable in terms of difficulty. Thus, the facilitative effect produced by pretraining in either of these two skills was comparable when the transfer was made to the team task.

It was also hypothesized that individual training (i.e. individual training in an independent setting) would be superior to team training (i.e. individual training in a team setting). In terms of the number of trials required to learn both the technical and social skills in either setting, there was no significant difference between the individual training and the team training conditions. This was true for both the orders (i.e. AS - OS and OS - AS orders) in individual training.

The conclusion that individual training is comparable to team training goes counter to the Briggs & Naylor (1965) finding. They found that individual training was superior to team training. However, it is noted that in the context of the Briggs & Naylor (1965) study, team training and individual training were defined as a "verbal interaction" and a "no verbal interaction" condition respectively. In the present study verbal communication was a controlled variable in that it was not present at any time. Thus, the two studies are not directly comparable.

It may be recalled that in the individual training condition of the present study, the technical and social skills were separated for individual training. In team training the two skills were presented simultaneously to the individuals for learning. An inspection of the data in the team training condition revealed that at the outset of team training, most individuals separated the two skills for themselves and concentrated on learning the AS skill first. Those individuals who did attempt to learn the two skills simultaneously, eventually separated the two and learned them successively in the order AS - OS. Therefore, in effect the individuals converted the team training situation into one which was comparable with the individual training situation. This is offered as an explanation for the nonsignificant differences between the individual training and team training situations.

As noted in the inspection of the data in team training, individuals in most cases "voluntarily" chose to learn the sequences in the AS - OS order. It is of interest to also note that when individuals were pretrained in both skills successively, the most efficient order was the AS - OS order. This interesting juxtaposition between the "voluntarily" selected order and the imposed order raises the question: Why did most individuals of their own volition select the most efficient order AS - OS? One could tenuously speculate that the individuals were primarily concerned with their ability to master the technical skill. Their concern as to whether or not they could "fit into" the team as a contributing member was secondary in importance. The order selected to learn the sequences is a

matter of individual preference and it is likely to vary from individual to individual, and from task to task.

On-the-job training virtually eliminates the problem of transfer of learning (see Tiffin & McCormick, 1965, p. 285). In this study, the teams in the zero pretraining condition had only team training. As a result, these teams experienced no problems of transfer. Thus, Group 1 can be considered analogous to an on-the-job training situation.

Consider a hypothetical yet practical situation in which a sequential two-member team is to be selected for performing a serial task during which the two members are not to verbally communicate. To perform the task, the team members are required to exercise a technical skill and a social skill which are of equal complexity. From a managerial point of view the problem of how best to put such a team together becomes: To efficiently form this team, does one select people who have had pretraining in either one or in both of the technical and social skills appropriate to the task? The findings presented in this study would imply that this team can be most efficiently formed by selecting people who have had pretraining in both the technical and social skills. Teams would realize significant savings in learning the specific team task by the transfer of skills acquired by members in their pretraining experiences. Management would financially benefit from these savings if pretraining costs are borne by outside organizations. Also, job applicants who have been pretrained in the skills in the order AS - OS would be preferable to those who had been pretrained in the skills in the OS - AS order.

Another question might be: Will it be of any advantage to select individuals on the basis of whether or not they possess either one of the appropriate technical or social skills? The results of this study indicate that it does not matter.

A person who is responsible for training individuals already in his employ to perform a team task (i.e. the hypothetical one above) which is unfamiliar to them might ask: Will individual pretraining in the required social and technical skills provide any significant savings when the transfer is made to team training? The present study's results imply that if any pretraining is undertaken, it must be in both the social and technical skills; and preferably in the order technical skill pretraining followed by social skill pretraining. Otherwise, on-the-job training would be just as efficient as individual pretraining in only one of the two appropriate skills.

The additional question may be asked: Were there any overall differences in total training among the five conditions?

At first glance, one would predict that providing pretraining in the order AS - OS would lead to more efficient training than would training in the order OS - AS. Theoretically, these operators could produce the correct team response on the first trial in team training since they had been pre-trained in both sequences to the point of maximum efficiency. However, to the extent that the transfer situation differed from the pretraining situation, there could have occurred a loss in the learning transferred for both groups. In addition, the teams in these groups could have experienced interference

(i.e. retroactive and proactive interference) during the pre-training itself. The teams without pretraining also could have had interference resulting from the simultaneous presentation of two stimuli during their team training, but no possible loss of learning in pretraining or transfer task since there was none. The other groups could have experienced a loss of learning in the transfer from pretraining to team training. Thus, it was hypothesized that those teams which received pretraining in both AS and OS could be the most subject to interference.

So, grosso modo, this training condition, and especially the OS - AS order, could be less efficient than the others. It was further hypothesized that the other three groups could have experienced equal amounts of interference but of different kinds.

By adding the number of pretraining trials (where given) to the number of trials required to learn the correct team response in team training, the data were compiled for each team in each of the five groups. The data were first tested for homogeneity of variance (Winer, 1971, p. 443) and it was found that they were homogeneous. The mean overall numbers of trials required to achieve the correct team response for Groups 1, 2, 3, 4_a, and 4_b were 13.17, 12.67, 14.17, 16.67, and 13.50 respectively. A single factor analysis (Winer, 1971, p. 153) yielded no significant differences. However, teams with OS - AS pretraining were somewhat slower in their learning as expected. It is to be pointed out that there were only six teams under each of the five training conditions. Before any conclusive statements can be made regarding the overall differences in

total training, it would be advisable to run further replications of the experiment. Thereby, the power of the single factor test would be increased.

It is to be noted that all the inferences presented in this study are applicable to only a population of dyadic teams in which the members are sequentially performing a serial task during which no verbal communication is allowed. Further, the inferences apply to situations in which the technical and social skills are comparable in complexity. The social skill required the members to respond only when it was their turn; it was not concerned with other social variables such as antagonism between the team members. The technical skill was a simple perceptual-motor coordination skill which involved the depressing of the correct response button on a panel.

Interference seems to have been an influential variable in the formation of the lawful relationships between pretraining and transfer task performance. Inspection of the data revealed that retroactive inhibition was present in many instances. A systematic study would be advisable whereby the existence of this type of interference, and others, could be investigated.

Using the same team and task arrangement as given in this study, it would be worthwhile to investigate the additional effects produced by increasing the team membership to three or more persons, or by allowing verbal communication among the team members. Possible sex differences in this arrangement also should be studied.

Other variables which should be further investigated in terms of pretraining effects on team performance are the number,

coordination and sequencing of actions in the performance of a task and the number, coordination and sequencing of operators. For example, one should determine the effects of pretraining on transfer task performance when the team is organized in a parallel arrangement so that the operators respond sequentially in a task that is serial in nature. Such a real-life situation is exemplified by an assembly-line system in which there are redundant members or stand-bys'.

In brief, the main purpose of this study was to compare the savings in team training when individual operators were given different amounts of pretraining. It was found that there were savings from different amounts of pretraining. This is an important point for the employer since in some instances he does not bear the cost of pretraining. Even if the total training conditions employed in this study indicated no significant overall differences, it may still be worthwhile for the employer to know what kind of pretraining his employees have had. Employees who have been pretrained in the technical skill followed by the social skill are preferred to all other employees.

This study has hopefully laid the groundwork for many future investigations in the area of team training and its effects on team performance. The investigator appreciates the fact that the presented findings represent only a small portion of the knowledge that is to be gained by studying human behavior in complex systems.

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APPENDIX A

INSTRUCTIONS USED FOR GROUP 1

You will be working as a team. Your task is to learn to push a sequence of eight buttons in a particular order between the two panels. On each step, only one button on one panel will be correct. An example would be: Button 1 on Panel A, Button 2 on Panel B, Button 3 on Panel A, Button 4 on Panel B, and so on.

The experiment will work as follows: This white light (E points to left white light) will be on for the first sequence. The appearance of this blue light (point) for two seconds will indicate the beginning of each step in the sequence. After the blue light goes off, you will have four seconds to push a button. Please push only ONE button and before the four seconds are up. If this green light appears (point to lower left), you pressed the correct button on the correct panel at that step. Your success will be indicated to your partner by this green light (point to upper green light). If no green light appears, you either pushed the wrong button or pushed out of turn, or both. After the four second interval the button which should have been pushed on that step will light up on both panels regardless of whether it was pushed or not.

After the button light and a short interval the blue light will appear again, indicating the beginning of the next step. This step will be identical with the preceding step except that a different button will be correct on the same or the other panel. After eight such steps the sequence will be complete. The left white light will go off and the right white light will go on to indicate the beginning of the next sequence of eight steps. The sequence, in the same order of buttons and panels, will be repeated again and again while these two white lights (point) will be alternating at the end of each eight-step sequence. Please continue pushing buttons even after you have learned the sequences until I ask you to stop.

At the beginning of the experiment, both of you are free to push any one button on any step, but your task eventually is to learn to push a button only when it is your turn. All your responses will be recorded. Please do not talk to each other. The only communication should be via the panel lights.

Do you have any questions?

Now we will have a practice session so that you understand the procedure perfectly. The buttons and panels will be correct in the following order: Button 1 on Panel A (i.e. Panel A pushes Button 1), Button 2 on Panel B, Button 3 on Panel A, Button 4 on Panel B, Button 5 on Panel A, Button 6 on Panel B, Button 7 on Panel A, and Button 8 on Panel B.

In the practice session please push the buttons in this order on the appropriate panels; one person one button at each step, so that you get used to the procedure of the lights and buttons.

APPENDIX B

INSTRUCTIONS USED FOR GROUP 2

This experiment will be in two parts. In this part, your task is to learn to push the lighted button in a particular order between the two panels. On each step only one panel will be correct.

This part of the experiment will work as follows: This white light (point) will be on for the first sequence of eight steps. The appearance of this blue light (point) for two seconds will indicate the beginning of each step in the panel order. Immediately after the blue light goes off, a button light will appear for four seconds. Push this button while it is lighted. If this green light appears (point), you are the correct panel to respond on that step. Your success will be indicated to your partner by this green light (point to upper green light).

After the button light goes off and a short interval, the blue light will appear again, indicating the next step in which the same or a different panel will be correct for the lighted button. After eight such steps, the order in alternation of the panels will be complete. The left white light will go off and the right white light will go on to indicate the beginning of the next repetition of order in the panel alternation. The order of alternation of the panels will remain the same for each sequence of eight steps. Pay no attention to the continuously random order in which the buttons light up.

At the beginning of the experiment, both of you are free to push the lighted button on any step, but your task eventually is to learn to push the lighted button only when it is your turn. Please continue pushing the lighted buttons even after you have learned the order of panel alternation. All your responses will be recorded. Please do not talk to each other. The only communication should be via the panel lights.

Do you have any questions?

Now we will have a practice session so that you understand the procedure perfectly. For the practice session, the panels will be correct in the following order: A B A B A B A B. Please push the lighted buttons in this order (i.e. Panel A pushes the first lighted button; Panel B pushes the second; Panel A pushes the third; and so on) and note the meaning of the green lights.

Part Two

In this part of the experiment you will be working as a team. Your task is to learn to push a particular sequence of eight buttons between your panels using the order of panel alternation learned earlier. On each step, only one button on one of the two panels will be correct. An example would be: Button 1 on Panel B, Button 2 on Panel A, Button 3 on Panel A, Button 4 on Panel A, Button 5 on Panel B, Button 6 on Panel A, and so on.

APPENDIX B CONTINUED

That is, both in this example and in the experiment, the order of panel alternation is the order you have just learned.

As in the first part of the experiment, the blue light procedure indicates the beginning of each step. However, in this part of the experiment, after the blue light goes off, there will be no immediately lighted button. Thus, after the blue light goes off, you will have four seconds to push a button. Please push only one button on your turn and before the four seconds are up. The green light procedure will indicate the same as before with one added feature. If no green light appears, but you pushed a button since it was your turn to push, then you pushed the wrong button. After the four second interval, the button which should have been pushed will light up on both panels.

The sequence in the same order of buttons and panels will be repeated again and again while these two white lights will be alternating at the end of each eight-step sequence. Please continue pushing buttons even after you have learned the sequence until I ask you to stop. All your responses will be recorded. Please do not talk to each other.

Do you have any questions?

APPENDIX C

INSTRUCTIONS USED FOR GROUP 3

This experiment will be in two parts. In this part your task is to learn to push a sequence of eight buttons in a particular order on your panel. On each of the eight steps, only one button will be correct.

This part of the experiment will work as follows: This white light (point) will be on for the first sequence of eight steps. The appearance of this blue light (point) for two seconds will indicate the beginning of each step in the sequence. After the blue light goes off, you will have four seconds to push a button. Please push only ONE button. If this green light (point) appears, you pressed the correct button. After the four second interval, the button that should have been pushed on that step will light up on your panel regardless of whether it was pushed or not.

After the button light and a short interval, the blue light will appear again, indicating the beginning of the next step in which a different button will be correct. After eight such steps, the sequence will be complete. The left white light will go off and the right white light will appear indicating the beginning of the next sequence of eight steps. The sequence of the eight steps will remain the same throughout the experiment. Please continue pushing buttons even after you have learned the sequence until I ask you to stop. All your responses will be recorded. Please do not talk to each other. The only communication should be via the panel lights. Do you have any questions?

Now we will have a practice session so that you understand the procedure perfectly. The buttons will be correct in the following order: 1 2 3 4 5 6 7 8. Both of you are asked to push the buttons in this order after the blue light goes off and before the button light appears.

Part Two

Now you will be working as a team. Your task is to learn to push the sequence of eight buttons in the order learned earlier between the two panels. On each step, only one button on one of the two panels will be correct. An example would be: Button 3 on Panel A, Button 8 on Panel B, Button 5 on Panel A, Button 7 on Panel B, and so on.

The procedure and the sequence of lights will be the same as for the first part of the experiment. The only difference will be in the sequence of the panels which will be correct on each step. If this green light appears (point to lower left), you pressed the correct button on the correct panel at that step. Your success will be indicated to your partner by this green light (point to upper green light). If no green light appears, but you pushed the correct button, then you pushed out of turn. The sequence in the same order of buttons and panels will

APPENDIX C CONTINUED

be repeated again and again while these two white lights will be alternating at the end of each eight-step sequence. Please continue pushing buttons even after you have learned the sequence until I ask you to stop.

At the beginning of this part of the experiment, both of you are free to push the button sequence that you have learned, but your task eventually is to learn to push the correct button only when it is your turn. All your responses will be recorded. Please do not talk to each other.

Do you have any questions?

APPENDIX D

INSTRUCTIONS (PART THREE) USED FOR GROUPS 4_a & 4_b

You have learned in what order to respond between your panels and you have also learned a particular button sequence. In this, the third part of the experiment, your task is to press the buttons in the sequence you have learned between your panels in the order that you have also learned. In effect, as a team, you are to combine the two tasks learned earlier.

The procedure of lights will be the same regarding the alternating white lights and the blue light. Remember to respond after the blue light goes off and before the four seconds are up. If this green light (lower left) appears, you pressed the correct button on that step. Your success will be indicated to your partner by the upper green light. If no green light appears, you either pushed out of turn or pushed the wrong button, or both. After the four second interval, the button which should have been pushed on that step will light up on both panels.

The sequence in the same order of buttons and panels will be repeated again and again until you have successfully combined the two tasks. Once you have combined the two tasks correctly, please continue until I ask you to stop. All your responses will be recorded. Please do not talk to each other.

APPENDIX E
ORIGINAL DATA

The Variances and the Mean Numbers of Trials, as Ex-
pressed by the Original Data, Required by the Teams
to Reach Criterion on the Transfer Task for each of
the Five Groups

GROUP	MEAN	VARIANCE
1. No Pretraining	13.17	68.57
2. Pretraining in OS	8.33	26.27
3. Pretraining in AS	7.00	2.40
4 _a . Pretraining in both AS & OS in the order OS - AS	3.67	7.47
4 _b . Pretraining in both AS & OS in the order AS - OS	1.67	0.67

APPENDIX E CONTINUED

ORIGINAL DATA

The Variances and the Mean Numbers of Trials, as Expressed by the Original Data, Required by Individuals in Two Different Settings to learn both AS and OS to Criterion

GROUP	MEAN	VARIANCE
1. Individuals in Team Setting	11.17	48.15
4 _a . Individuals in Independent Setting (OS - AS order)	11.00	15.45
4 _b . Individuals in Independent Setting (AS - OS order)	10.33	15.33

VITA AUCTORIS

- 1937 - Born in Gooderham, Ontario to John and Grace Hunter.
- 1943-1956 - Educated at Gooderham Consolidated Public School, Lindsay Collegiate Institute, and Haliburton County District High School.
- 1958-1959 - Educated at Peterborough Teachers' College, Peterborough, Ontario.
- 1963-1969 - Educated at Atkinson College, York University (Extension Program), Toronto, Ontario.
- 1970 - Graduated with the degree of B.A. (Psychology), York University.
- 1971 - Graduated with the degree of B.A. (Hons.), York University.
- 1971-1973 - Registered as a full-time graduate student at the University of Windsor.