EFFECTS OF DIRECT VERSUS VICARIOUS LEARNING UPON MOTOR RETENTION

by

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ABSTRACT

This thesis examined the question of whether vicarious learning could occur in a complex motor task on the two-hand coordinator. The hypotheses to be tested were as follows:

1. Initial observation of an expert model's performance would facilitate a subject's performance so that the vicarious observing group would perform at a higher level on the initial learning curve than would the direct, nonobserving group.

2. A short interpolated rest period would facilitate performance in both groups by allowing fatigue to dissipate. A longer rest period would benefit the direct group but not help the vicarious group.

3. Direct practice would contribute the greatest amount to performance and vicarious practice would add a smaller amount. Hence, the advantage of the vicarious group would be slight.

Hypotheses 1 and 3 were accepted, but hypothesis 2 was rejected. Subjects were 40 college age males and females. Twenty subjects watched an expert model demonstrate the task for 5 minutes before beginning 5 minutes practice themselves. Twenty other subjects began practice.
immediately without any observation. The vicarious group began performance at a higher level than the direct group and maintained a slight advantage most of the time.
CHAPTER 1

INTRODUCTION

This study was designed to evaluate the problem of how vicarious learning might influence the acquisition of a motor task. A number of people have studied the effects of vicarious learning upon verbal and social learning, but few have applied this method to motor learning.

The theory of vicarious learning through observation of a model states that a person can learn behaviors and emotional attitudes simply by watching a model perform a sequence of behavior and observing the consequences of that behavior. The observer need not immediately perform the behavior himself in order to learn it; there can be some lapse of time before he exhibits that behavior himself. This form of learning has been given many names over the years -- imitation, identification, matching behavior, vicarious or observational learning, modeling -- all refer to an observer reproducing the behavior of a model with more or less exactitude. This paper will use the term vicarious learning to describe this event.
Background Studies

Several different explanations have been offered of why vicarious learning takes place. Writers such as Allport (1924), Holt (1931), and Piaget (1952) explained it in terms of classical conditioning. This explanation depends on the model first imitating some response of the observer in a circular pattern of imitation so that each is producing the same behavior repeatedly. After he has thus become a significant stimulus for the observer, the model introduces a new behavior into the pattern and the observer reproduces that behavior. Simple contiguity between modeled and matching behavior was deemed sufficient to produce imitation. No reinforcement was specified.

Dollard and Miller (1941, 1950) believed that vicarious learning could occur only if the observer was reinforced for reproducing the behavior of the model. The observer's imitative response came initially from a series of random responses. As he produced the modeled behavior, he was reinforced for it, thereby increasing the probability of repeated imitative behavior. If the observer reproduced the behavior exactly, it was called copying. If the observer simply depended on the model for a cue as to which behavior to produce, it was called matched-dependent behavior.
Another reinforcement theory of imitation was given by Skinner (1953) who explained imitation in stimulus-response terms. Through differential reinforcement, matching behavior is strengthened and divergent behavior is decreased until the observer is able to duplicate the modeled behavior. The observer comes to attend more frequently to the behavior of others as a potential source of reinforcement. No mediating responses are postulated; only the observer's matching response gives evidence that vicarious learning has occurred.

Both of these theories can account very well for the observer producing a behavior already in his repertoire under model-cued circumstances. In such a case, the modeled behavior serves as a discriminative stimulus for the already learned response. The theories do not explain, however, how the observer first performed that behavior. Bandura has taken the lead in explaining this first step of acquiring an imitative response.

Bandura's explanation of vicarious learning (1969) states that mere contiguity with the stimulus of the modeled act is sufficient for the observer to learn that behavior. The vicarious learning is acquired through mediating symbolic processes which code and store information about the modeled behavior and its consequences. This stored information guides the observer's responses
so that he performs within the context of a plan rather than by random trial and error. Reinforcement is influen­
tial in that the consequences to the model will deter­
mine whether the observer forms a positive or negative valence toward the modeled behavior. Reinforcement also helps determine when the observer will display that behav­
ior in his own actions. Thus, reinforcement influences the probability of a modeled behavior being acquired and later reproduced in the observer's own behavior repertoire. It is not essential that the observer himself be rein­
forced by the model for reproducing the behavior nor that he be reinforced directly at the time of acquisition.

It may seem difficult to reconcile Bandura's theory of vicarious learning, based on complex cognitive, social and verbal interactions, with the simpler tasks of a motor-learning problem. Fitts (1964) provides a view­
point which bridges this gap and permits the application of vicarious learning approaches to motor learning tasks. Social or verbal learning and motor learning have tradi­tionally been treated as separate activities with differ­
ent methodologies and approaches. Fitts has suggested that the division between verbal and motor learning is artificial and exaggerated. He views both tasks as part of an overall category of skilled responses which involve the same basic learning problem of processing information
about the task and organizing responses. The cognitive sphere is as influential in motor learning as it is in verbal learning. Vicarious learning could begin to take place before the subject had even started to practice the motor responses of the task. Observation would provide information about the environment, the direction and timing of the model's motions, and numerous other variables of the task. In terms of Fitts' information processing theory, observation of a model would permit the subject to select a general executive program from past learning, to try imaginarily the model's task in terms of already existing patterns of behavior in his repertoire, and to note pertinent items of information such as sequencing and pacing in the model's behavior. People concerned with training athletes and dancers have often made use of demonstrations or modeling to assist the teaching process, but no one has examined when and how much the modeling affects the learning.

Though no one seems to have systematically studied the exact effect of vicarious practice upon motor learning several people have studied the effect of direct pre-practice upon later learning. These studies are relevant to the problem of vicarious motor learning in so far as they shed light upon the effects of a related activity taking place shortly before the motor learning task.
Ammons (1951) used 202 college women subjects who practiced for 2 - 12 minute periods on the pursuit rotor with a 17 minute rest period in between. The experimental groups were given 2 minutes of pre-practice immediately before the first practice session and/or before the second practice session. The pre-practice was designed to emphasize some components of the rotor pursuit task. The occular pre-practice groups stood and observed the target rotate with no manual practice. The blindfolded manual practice group followed the target with their hand while blindfolded. He also included one group that only imagined the rotary pursuit activity for 2 minutes before the second practice period. Ammon's hypotheses were that pre-practice would increase performance in the initial period and, if done also before the second practice period, would decrease the warm-up decrement of that period. An analysis of variance showed that none of the groups did significantly better than the controls, except during the first minute of practice in the first period when the F test was at the .05 level. Ammons rejected this result as chance. One questions his decision because the first minute F seemed to be at a much higher level and quite distinct from the cluster of later F scores. Also, the first minute of performance is exactly where one would
expect to see the advantage of brief pre-practice of task components in terms of warm-up and acquisition of set.

One other study of pre-practice of task components was conducted by Hammerton and Tickner (1969). The task was to track a target through use of a thumb-controlled joystick. After acquiring that skill, one-half of the subjects exercised their whole hand on a hand-grip ergometer during an intertrial rest. The other one-half of the subjects exercised only their thumb. The latter group showed a definite decrease in performance level which lasted over 3 trials. The less task-specific exercise of the whole hand produced no decrement. To be beneficial, pre-practice must not tire the specific muscles involved in the task.

Several other studies presented pre-practice rehearsal during a rest period after some initial practice had taken place. Most of these studies did not use models, but they do offer further information of the effect of visual activity upon later performance, particularly upon work decrement and warm-up effects which occur after a rest period away from the task.

Humphries and McIntyre carried out two related studies designed to test whether the locus of temporary work decrement in the rotary pursuit task was in the peripheral or central system. Their first study (1963a)
presented 4 experimental groups with the interpolated activity of watching a turntable rotate or stand still. They observed either monocularly or binocularly for 5 minutes, pressing a switch with the non-preferred hand each time they sighted a moving stimulus light beneath the turntable. A control group simply rested during this interval. The results showed no significant difference between any of the groups. All showed an equal amount of reminiscence. The interpolated activity did not block dissipation of the temporary work decrement.

In their second study, Humphries and McIntyre (1963b) gave subjects 2 sessions of massed practice on the pursuit rotor. During the rest period between these sessions, 3 groups did 3 different types of interpolated activity. Group 1 carried out a visual pursuit of the rotor target in the same manner as the first study. Group 2 was blindfolded and performed a rotary arm motion with the hand riding around on the rotor target. Group 3 rested with no rotary activity. They found no significant difference among the groups. All showed an equal amount of reminiscence and recovery from temporary work decrement. They concluded that the locus of work decrement could not be in the peripheral motor or visual system.

The Humphries and McIntyre studies supported the earlier findings of the Ammons study which also found
that manual or visual rehearsal had no significant effect on initial performance or on reminiscence.

Other studies on the same problem have presented contradictory evidence, however. Humphries and McIntyre (1963b) were attempting to replicate an earlier study done by E. Feitler in 1958 in which the interpolated activity did block recovery from temporary work decrement. Feitler's study used the same interpolated activities except that the timing of the stimulus light presentation was done manually by Feitler and electronically by Humphries and McIntyre. It is possible that some irregularity in the presentation of the stimulus could have led to this difference in results.

Adams (1955) did a study in which components of the rotary pursuit task were practiced during the rest period. After 10–1 minute trials of practice, the experimental subject watched another subject practice on the rotor for 12 more trials. Whenever he judged the model to be on target, he pressed a small button with his non-preferred hand. By this means, Adams hoped to isolate the visual response of pursuit and discrimination. One-half of this group proceeded directly on to further practice while the other one-half rested for 10 minutes. He included other control groups that did not observe but merely rested, stood at their desks, or pushed the
button in response to an auditory cue. These groups were to control for any fatigue effects. Adams found that the interpolated observing activity did prevent dissipation of the temporary work decrement and led to significantly lower scores for that group in the second practice session. The temporary work decrement disappeared for the group that rested 10 minutes after observing; their performance was at the same level as the group that had rested throughout the interval. The two other control groups that did not perform visual tracking showed some decrement effect from fatigue, but the effect was not statistically significant.

These results differed from Ammons (1951) study in which observation of a rotating target's route did not affect later performance. Adams explained this difference in terms of the degree of active observation and judgement required. Ammons' observation was passive with no model performing the task, while Adams required active visual judging and responding to a model's performance on the task. The lack of positive influence from such observation might be attributed to the model's lack of skill and his fatigue from massed practice for 26 minutes, as well as the fatigue built up in the observer from attending to the model.
Rosenquist (1965) used a version of Adams' procedure in a study of bilateral transfer on the rotary pursuit. Adams had predicted that active observation would interfere with bilateral transfer because the visual component was equally involved in both responses. Rosenquist found this prediction to be accurate. The amount of decrement was functionally related to the length of observing and resting. His procedure varied from Adams in that he provided varying lengths of observation and rest intervals of 0, 3, 6, or 9 minutes, singly or in combination. Subjects observed a skilled model who performed at a level of 50% time on target. The results showed that all observing groups' scores were lower than the resting groups' scores in the second performance period. The greatest decrement from watching occurred after 9 minutes of observing compared with 9 minutes of rest; the decrement equalled a loss of 9% of possible time on target. The groups which rested after observing showed an increase in time on target after 3 minutes of rest. Their performance did not improve significantly with further rest beyond 3 minutes.

None of these studies used a procedure in which the subject observed a skilled model before beginning practice himself. One early report on Army Air Force testing by Melton (1947) had the instructor briefly
demonstrate rotary pursuit practice for 10 revolutions before the subjects began to practice. This demonstration was very brief and no comparison was made between model and no-model conditions, so no conclusions can be drawn. Modeling in all other studies occurred after some initial practice. These other studies gave evidence that observing and judging a model's performance after some practice of one's own might actually interfere with later performance because of interference with recovery from temporary work decrement. When the observation was less active and did not require judging or motor activity, it did not interfere with performance but neither did it help. Thus, observation evidently produces two effects, learning and fatigue. Adams and Rosenquist showed that the fatigue or work decrement could interfere with learning and performance so that observing groups actually did worse. This fatigue dissipated after 3 minutes rest and longer rest periods such as Adams used did not produce any further improvement. For less active observing such as Ammons or Humphries and McIntyre used, the performance deficit was not evident in the no rest groups because the work decrement was less. The effects of learning and fatigue from observation were confounded in these studies so that one cannot identify how much learning actually took place.
Hypotheses

The present study was designed to investigate whether expert modeling before practice would have a positive influence upon learning a complex motor task. The confounding of fatigue and learning effects was eliminated by permitting enough rest (3 minutes) for all groups to dissipate fatigue. The learning effect could then be more accurately measured. It is assumed that the amount of learning which did occur would not dissipate much over so brief a rest period, particularly since this is a motor learning task. The experiment was designed to measure these variables by presenting a modeling versus no-modeling condition and a short versus a long rest period. The design is described more fully in the following chapter on method. The following hypotheses were tested.

1. Initial observation of an expert model's performance would facilitate a subject's performance on the two-hand coordinator. It was expected that the vicarious practice group's performance would begin at a higher level on the initial learning curve and show the most advantage early in the practice period.

2. A short rest period would facilitate performance in both groups by permitting dissipation of the temporary work decrement from either direct or vicarious
practice. A longer rest period would further benefit the
direct practice group which should have accumulated more
fatigue than the vicarious group. The longer rest would
not give further benefit to the vicarious group but might
actually permit more forgetting of the observed informa-
tion. One would expect to see a differential effect in
favor of the direct group over the long rest period.

3. It was expected that direct practice would
contribute the greatest amount to performance and that
vicarious practice would add a smaller amount. Hence,
the advantage of the vicarious group over the direct
group would be fairly slight. Predicted rank order for
the final scores of the groups would be Vicarious Prac-
tice II and Direct Practice II at approximately the same
level followed by Vicarious Practice I and then Direct
Practice I. (Direct Practice I would be the first 5
minute practice session for all direct groups. Direct
Practice II would cover the second 5 minute practice.
Vicarious Practice I would be the first 5 minute practice
for all vicarious groups, and Vicarious Practice II would
include the second 5 minute practice.)
CHAPTER 2

METHOD

Subjects
Subjects were 40 adults, 20 men and 20 women, who volunteered from psychology classes at The University of Arizona. The only requirements were that they be in reasonably good physical condition and have no prior experience with tracking types of apparatus. Subjects were assigned to the four treatment groups in alternating sequence according to the order in which they volunteered. 5 men and 5 women were assigned to each treatment group. One adult female, the experimenter, served as the expert model for the motor task.

Apparatus
A two-hand coordinator, Model CM 101B, similar to that described by Melton (1947) was used for the motor task. It was equipped with a standard electric timer which automatically recorded the subject's time on target. The two-hand coordinator was modified so that it could be turned on and off manually by the experimenter and did not automatically shut itself off after 1 minute of rotation. This adaptation permitted continuous practice sessions to
be given. Several current news and pictorial magazines were provided for the subjects to read during the rest intervals.

**Procedure**

A 2 x 2 x 2 factorial design was used to test any interaction between the variable of practice conditions and the variable of length of rest interval. In addition, the design controlled for sex differences by placing an equal number of men and women in each treatment group.

![Experimental Design](image)

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**Figure 1. Experimental Design**
There were two practice conditions. The direct practice group simply practiced on the two-hand coordinator by themselves without observing the model. The vicarious practice group first observed the model demonstrate the two-hand coordinator for 5 minutes before beginning actual practice themselves.

The rest period variable was divided into two levels. The short rest groups practiced or observed for 5 minutes, rested 3 minutes, and then resumed practice for 5 minutes. The long rest group followed the same observation and practice schedule but rested for 8 minutes between sessions. The time sequence for all groups followed this diagram.

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*Figure 2. Time Sequence for Practice and Rest*
Each subject was tested individually. The procedure for each group was as follows:

Direct Practice Group

Standardized instructions (See Appendix A) were given by the experimenter on the use of the machine. No practice was given except to allow the subject to turn the handles so as to move the pointer off target 1 inch in each direction, thus testing his comprehension of the instructions. All subjects were able to do this. Each subject then practiced for 5 minutes. Practice was continuous for all groups and scores were recorded cumulatively every 15 seconds. One-half of the group then rested for 3 minutes. The other half of the group rested for 8 minutes. Interpolated rest activity was passive reading. Each subject resumed practice for another 5 minutes. The experimental session was concluded by allowing the subject to ask questions and get any feedback he desired.

Vicarious Practice Group

This group was instructed in the same words as the direct practice group and given the same brief opportunity to handle the machine controls. At that point, instead of beginning practice themselves, they were instructed to observe the model practice for 5 minutes and see what they could learn. At the end of the observation
period, one-half of the subjects rested for 3 minutes; the other half rested for 8 minutes. Each subject then practiced himself for 5 minutes, rested for 3 minutes, and had a final 5 minutes practice that permitted him to have the same amount of direct practice as the other group.
CHAPTER 3

RESULTS

A Chi Square test was performed on each variable at the first and fifth minute of each practice session. The Chi Square for long versus short rest periods did not approach significance at any point, so the long and short rest groups were combined for further analyses. There was no significant sex difference during the first minute of session I, but a significant difference had developed by the fifth minute of the trial and continued to appear during the second trial.

A 2 x 2 analysis of variance was performed on the scores from the first and fifth minutes of Trial I and Trial II. The averaged scores of all male and all female subjects were compared with the averaged scores of all direct and all vicarious practice groups.

Statistical Analyses

The results of the analysis indicate that sex differences were highly significant throughout both sessions. The training effect and its interaction with the sex variable did not quite reach significance at the .05 level. However, the first minute of Session I differed so greatly from later minutes that it deserves further
comment. The training effect reached the .10 level of significance during the first minute, and its interaction with sex differences approached the .05 level. The F tests for the remaining minutes were not significant and seemed to be quite separated from the trend of the first minute. Based on the distribution of scores, the author feels that the scores of the first minute represent a probable treatment effect in favor of the vicarious group which averaged 5 seconds time on target better than the direct group during the first minute. This difference between groups was not so large at any other point in the practice period.

Figure 3 presents a graph of the mean score differences between the vicarious and direct groups, showing the vicarious group to be superior in all minutes except the third and fifth of Session I and the first minute of Session II. The direct group's advantage during those minutes was very slight compared to the advantage of the vicarious group at all other times. This graphic evidence lends further support to the superiority of the vicarious group's performance.

**Hypotheses Results**

On the basis of this accumulated evidence, the first hypothesis was accepted. The vicarious practice group did begin performance at a higher level than the
Figure 3. Mean Score Differences Between Each Minute
direct practice group, showing the most advantage in the first minute of practice. The second hypothesis was rejected; length of rest period did not affect performance significantly, and the longer rest period did not give greater advantage to the direct practice group. The third hypothesis, which predicted a final rank order of Vicarious Practice II followed closely by Direct Practice II and Vicarious Practice I followed by Direct Practice I, was accepted with the exception that Direct Practice I finished slightly higher than Vicarious Practice I, though the difference was not significant.
CHAPTER 4

DISCUSSION

The results indicated that observation of a skilled model did produce superior performance for the vicarious groups. The vicarious effect was not at as high a level of significance as had been expected, but it did occur in the predicted early period of practice. The significance level ranged between .05 and .10. Such findings seem appropriate to a preliminary study such as this one which presented a procedure that had not been tried before. The results did closely follow the hypothesized direction.

Suggestions For Further Studies

It would be fruitful to test some variations in the treatment and see if they led to more pronounced effects. Specifically, it would be useful to try a more active form of observation. This might take Adams' and Rosenquist's method of discriminating the model's time on target, or it might be provided with a stronger incentive set such as a cash reward for the best performance. One might also provide more directive instructions which emphasized specific details to observe.
One might compare the effects of longer or shorter periods of observation. Would more time produce better vicarious learning? Rosenquist suggested that prolonged observation built up an inhibition effect which could offset the learning benefits of observation. This problem could be examined by providing various lengths of observation with various rest intervals after the observation. In particular, it would be good to compare the short rest offered in this study with no rest at all to see whether forgetting or consolidation may have taken place during the rest interval.

The failure to find a difference between long and short rest intervals may be due to several factors. The practice period of 5 minutes was short and may not have built up very much fatigue. The contrast between long and short rests may not have been great enough. Rosenquist's data suggests that a large amount of work decrement has already dissipated after 3 minutes rest.

**Comparisons With Earlier Studies**

It is difficult to compare this study with the earlier ones cited in Chapter 1 because the presentation of variables is quite different. The only studies which used models were Adams (1955) and Rosenquist (1965). Only Rosenquist used a skilled model. No directions were given to try to learn anything from the modeling. Instead
emphasis was placed upon monitoring the model's performance. Also, the modeling took place after some temporary work decrement had built up from direct practice. Given these differences, it is not so surprising that Adams and Rosenquist found that observing a model, which itself builds up some temporary work decrement, led to a decrease rather than an improvement in later performance. In the present study observation had a helpful effect rather than an interfering one. This difference may be ascribed to the directions, which gave some emphasis to learning from the model, and to the fact that no practice with accompanying fatigue had yet occurred. Also, a model using the two-hand coordinator exhibits a greater variety of motions for the observer to learn; there is more obvious information to be gained from observing the two-hand coordinator than from the pursuit rotor used by other studies.

The results of this study can be accepted tentatively, and they open many avenues for further investigation. It seems that vicarious motor learning can take place. The effect of demonstrations and instructions can be enhanced by greater emphasis on learning specific things from modeling. What is needed now is more detailed investigation of the variables which can most facilitate vicarious motor learning.
APPENDIX A

INSTRUCTIONS TO SUBJECTS

Upon entering the room, the subject (S) is brought over to the two-hand coordinator. The experimenter (E) stands in front of it; the S stands to the left of it in a position to see clearly. E says,

This is a two-hand coordinator which we use to study muscular coordination. It was originally used to test pilot trainees. You will be assisting us in a study to find the best way of instructing people in its use. This black disc will turn very slowly in a clockwise direction. The small brass target E points to it will move with the disc E moves hand in clockwise motion from the target. It will also move back and forth in an irregular manner within the curved slot move hand back and forth over the slot. Your task will be to keep this small button point to it anywhere on top of the brass target.

You move the button by turning these two handles at the same time. Place right hand on front handle, then left hand on side handle. The front handle moves the button toward and away from you move button forward off target and then back on. The side handle moves the button from side to side turn handle to move button to left off target and then back on. Both handles used together move it diagonally.

Now you can try it. Put your right hand on the front handle and move the button about an inch off the target and back on. Wait until S has button back on target before proceeding. Let go of the front handle and put your left hand on the side handle. Move the button about an inch off the target and back on. Wait until S is back on. Now let go of the side handle.
Direct Practice Group

Your task will be to keep the button on top of the target during a 5 minute period. When you get off target, get back on as quickly as possible but never release the handles in order to spin them. Your score will be the total amount of time you stay on the target during this period. When I tell you to, grasp the handles, and when the target moves, try to keep the button on top of it. Do you have any questions? [Set timing mechanism]. Take hold of the handles. Begin.

[At end of first session] Make sure the button is back on target. Now release the handles. You may take a short rest break now, then I want you to take one more try. There are some magazines over here for you to read while I work on my records. [Seat S over in corner of lab with current magazines]

Let's start again now. I want you to follow the same procedure as before. [Set timer]. Take hold of the handles. Begin. [After second session]. Thank you very much for your help. It's a pretty hard task, as you can see, and you really performed quite satisfactorily. Do you have any other questions about it?

Vicarious Practice Group

I'll demonstrate the procedure for you now so you'll have a better idea of how it all fits together. Watch closely and see what you can learn. [E demonstrates for 5 minutes]. Now you may take a short rest break, then I want you to try the task. There are some magazines for you to read over there while I work on my records.

[After rest break] Your task will be to keep the button on top of the target during a 5 minute period. When you get off target, get back on as quickly as possible but never release the handles in order to spin them. Your score will be the total amount of time you stay on the target during this period. When I tell you to, grasp the handles, and when the target moves, try to keep the button on top of it. Do you have any questions? Take hold of the handles. Begin.
At end of trial Make sure the button is back on target. Now release the handles. You may take a short rest break now, then I want you to take one more try. Seat S over by magazines for rest break. Let's start again now. I want you to follow the same procedure as before.

Set timer. Take hold of the handles. Begin.

After second session Thank you very much for your help. It's a pretty hard task, as you can see, and you really performed quite satisfactorily. Do you have any other questions about it?
REFERENCES CITED


