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Effects of Task Complexity on Mental Imagery & Work Decrement

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Effects of Task Complexity on

Mental Imagery and Work Decrement

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"But they that wait upon the Lord
shall renew their strength, they
shall mount up with wings as eagles,
they shall run and not be weary,
they shall walk and not be faint."

Isaiah 40:31

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The Effects of Task Complexity on Mental Imagery and Work Decrement

Mary Kathleen George June 30, 1982 34 Pages

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This study was conducted to determine the effects of task complexity on mental imagery and work decrement. A total of 180 right-handed undergraduates from Western Kentucky University were tested on the rotor pursuit apparatus. Task complexity was manipulated by eccentricity on the tracking target of the rotor pursuit (i.e., the more eccentric, the more complex). Three shapes of increasing eccentricity were used, and there were three practice conditions: rest, no-rest and control. Thus, nine treatment conditions existed. The rest group had a 5-min rest between practice and performance, the no-rest group went right from practice to performance without rest, and the control group received no practice. Performance was measured across nine trials which were averaged into three trial blocks for analysis.

An analysis of variance was used to determine significant differences between the groups on the performance measure (i.e., percent time-on-target). The results of the analysis revealed that effective mental imagery and work decrement did not occur. Previous research has demonstrated both of these phenomena. Therefore, the outcome of this study is deemed unreliable due to these findings. However, a significant difference between performance on the various

elliptical shapes was found. This information may be valuable in future research.

INTRODUCTION

Scientist have been intrigued by the process of learning for a number of years. One kind of learning recently studied in depth is motor learning. Motor learning is observed and evaluated mainly in terms of relatively permanent changes in motor ability resulting from practice and experience (Lockhart and Johnson, 1970).

Learning and performance of motor skills have become important areas of research in a variety of fields (e.g., physical education, psychology, physiology, etc.). The focus of this paper is to investigate motor learning via conditions that may enhance it (mental imagery) and conditions that may inhibit it (work decrement). A brief overview and description of relevant terms will follow.

Most often, people have studied skill learning by using physical practice (i.e., actual performance of the task). One effect of physical practice is an increase in performance with practice (Ammons, 1947; Oxedine, 1969). Another effect is that individuals will perform better if practice is distributed over time rather than massed together (Bell, 1942).

In addition to investigating motor skill learning and performance by use of physical practice, in recent years researchers have focused on mental practice. Mental practice involves a person mentally imagining himself engaged in a physical activity with no concomitant gross muscular movement. Most of the studies in the area have shown imagery to be a facilitative factor in motor learning. Research has also increased in the area of practice schedules (massed vs. distributed) and the function of work decrement (decrease in performance due to no rest between practice and performance) in acquisition and performance of a skill.

Most researchers investigating mental practice have employed simple tasks in their designs. For example, a person engages in mental practice by mentally rehearsing a motor skill on the rotor pursuit (a device commonly used in the study of motor behavior). The task often employed is the tracking of a circle. A point of theoretical, as well as practical, interest concerns the possible usefulness of mental imagery as a skill facilitator for more complex tasks. If the benefits of mental imagery are limited to simple tasks, then the theoretical importance of the phenomenon is minimized. The present research attempts to investigate mental imagery under more complex task conditions.

Whether increasing the complexity of the task will affect mental imagery and work decrement is the major concern of this thesis. It is hypothesized that by increasing the complexity of the task there will be a subsequent decrease in the ability to control the mental imagery. This lack of control may lead to lower levels of actual performance. Also, as complexity increases, the build up of work decrement may be decreased simply because with poor imagery control little skill acquisition may take place. A more thorough description of the logic behind these hypotheses will be presented later following a discussion and review of the relevant constructs and phenomena.

CHAPTER I

Literature Review

Physical and Mental Practice

When learning a new complex motor activity, high levels of achievement seldom result suddenly. Learning of this type usually involves a gradual process in which the learner progressively approximates his goals. This gradual process of coordinating and adapting movements happens during practice. Improvement in performance is the reason that athletic teams practice for hours before the actual contest or game.

The improvement in performance of a task with practice is intuitively obvious and consistent with our daily experience. This experience of the beneficial effects of practice is well documented in the research literature. The number of studies which demonstrate the effects of practice is quite large, and only a select few are reviewed here.

Physical practice of a rotor pursuit task (tracking of a light moving in a circular path at a fixed speed) has been shown to improve over the course of eight 6-min practice trials (Ammons, 1947). Similarly, Oxedine (1969) has shown improvement in performance on three motor skills with physical practice of these tasks: the rotor pursuit, a soccer kick, and a modified jumpshot. For each skill the subject went through a 7-day training period. For the rotor pursuit the subjects practiced eight trials a day. Each trial consisted of a 15-sec practice period followed by a 15-sec rest period. Subjects practiced the soccer kick or the modified jumpshot 12 times daily. The physical practice groups improved significantly on each of these tasks as a result of the overt rehearsal relative to the no-practice control. These examples are just a small sample of the numerous studies showing improvement with physical practice. Other studies are too numerous for the present discussion.

Research has demonstrated that mental practice of a task will also improve performance on motor skill (Richardson, 1967). Mental practice refers to the imaginary rehearsal of a physical activity without any gross muscular movements. A football player who imagines himself kicking the ball is using mental practice.

Rawlings (1972) performed two experiments to test the benefits of mental rehearsal in the learning of a rotor putsuit tracking task. In the first experiment 24 female undergraduates were randomly assigned to three groups. The first group physically practiced the tracking task, and the second group mentally practiced the task. Both groups practiced for 25 trials with 30-sec practices and 30-sec rest intervals. The target speed was set at 60 rpm. The third group (control) was given 25 trials, each consisting of 30-sec color naming followed by 30-sec rest intervals. After 10 days, all groups were tested on the rotor pursuit task for 25 trials using the same arm. Results indicated that the performance of the mental practice group was equal to the physical practice group, and both were superior to the control group. From these results one concludes that mental practice does improve performance.

The second experiment examined the combined effects of physical and mental practice. The experiment used 20 male freshmen randomly assigned to two groups. All subjects practiced for 25 trials, each trial consisting of a 30-sec practice and a 30-sec rest period. The performance task was the same as in the first experiment (i.e., 25 trials using the same limb). The subjects in the first group were to physically practice for the first 30 sec and then mentally rehearse during the rest period (30 sec). The subjects in the second group were to physically practice for the first 30 sec and then name colors during the 30-sec rest period. The results showed that the group which mentally practiced during the break after physical practice performed better than the group which just physically practiced. The results of this study, therefore, confirm the hypothesis that mental practice can aid in the acquisition of rotor pursuit tracking.

Similar results have been reported by Williams (1969). Williams studied 160 male and female physical education majors divided into four groups: mental practice, physical practice, placebo control, and strict control. A polar pursuit tracker was used in which the target could be changed to designs other than a conventional circle. The shape used in this study was generally round with five curved identations. The physical practice group overtly practiced the task for three consecutive 3-min trials separated by a 1-min rest period each day for 16 days. The mental practice group imagined the task, and the placebo was actively involved in unrelated tasks for the same time period daily. The strict control did not participate until the post-test, which was the polar pursuit tracking task for three trials (3-min practices and 1-min rest) with the same limb. Tests for treatment effects indicated that the mental practice and physical practice groups were significantly better in performance than either of the control groups. Differences between the two control groups were not significant.

Powell (1973) also demonstrated the benefits of mental practice in a study involving a comparison between positive and negative mental practice (MP). The positive MP group was to imagine throwing darts and hitting around the center of the board. The negative MP group was to imagine very poor throwing, just hitting the edge of the board. The procedure consisted of five blocks of throwing 24 darts with blocks 1, 3, 5 being actual physical practice and 2, 4 being mental practice. During physical practice both the positive and the negative MP groups tried to hit the center of the board. The rate of improvement from trial 1 to trial 5 was used as the measure of performance. The outcome was that subjects in the positive MP group performed significantly better than those in the negative MP group. Thus, irrelevant mental practice (negative MP) was not as beneficial as relevant mental practice (positive MP).

These studies represent only a small sample of the studies which demonstrate that mental practice facilitates subsequent motor performance. Even though they represent a small sample, they are reflective of how mental practice has been studied. Other functional aspects of mental practice that have been investigated only recently are work decrement and reminiscence.

Work Decrement and Reminiscence

A phenomenon which occurs as a result of either physical or mental practice is work decrement. Work decrement is a lowered quality of performance which occurs after practice trials are massed together with inappropriate time for rest (Bell, 1942). There are two ways in which work decrement can be measured: in a unilateral design and in a bilateral design. In a unilateral design, the subject practices with one limb with short intertrial rest periods and then performs with the same limb following either a rest or no-rest period. In a bilateral design, the subject practices with one limb on massed practice trials and then performs on the contralateral limb after either a rest or no rest. In either design the difference in performance between rest and no-rest conditions is taken as evidence for the dissipation of work decrement.

Reminiscence is the term used to describe the increase in performance after a rest period of no practice compared to a no-rest group. In other words, reminiscence is the measure of the dissipation of work decrement. Unilateral reminiscence refers to the dissipation of work decrement in the same limb when practice is followed by a rest period. Bilateral reminiscence refers to the gain in performance attained when a task is practiced with one limb but performed after a rest with the opposite limb (Eynsyck and Frith, 1977). When measuring either unilateral and bilateral reminiscence, a comparison is made relative to the no-rest group.

The occurrence of unilateral reminiscence has been demonstrated in practicing physical tasks. Bell (1942) investigated the effects of rest periods at two points in the learning process. One study was concerned with early learning when rises in learning are expected and the other dealt with late learning when losses following rest may be expected due to fatigue, boredom, or inattention. The study involved 457 undergraduate students divided into 10 experimental groups and one control group. All subjects completed 20 1-min trials on the rotor pursuit, with the trials separated by 1-min rest periods except for a single longer rest. This single longer rest was either 10 min, 1, 6, 24, or 30 hrs and occurred after either the 5th or the 15th trial. The control group performed only the 20 1-min trials. The results indicated an improved performance by all five rest groups when the rest period occurred early (after trial 5).

In the late rest condition there was improved performance by only one group after the 15th trial and improvement by three more groups after the 17th trial (i.e., improvement was evident two trials after the rest period). Besides demonstrating the dissipation of work decrement after interpolated rest (reminiscence) the experiment also showed that it makes a difference when rest occurs and for how long, being most beneficial in the early stages of learning.

Ammons (1949), utilizing a unilateral design, studied reminiscence with 500 subjects divided into 35 groups. The apparatus was a rotor pursuit tracker. The 35 conditions used were various pre-test continuous work periods (1/3, 1, 3, 17 min) and various rest periods (1/3, 2, 5, 10, 20, 60, 360 min). All subjects continually worked for 8 min following the rest period, and these data served as the basis for comparison. The results showed that reminiscence increased as the amount of pre-test practice increased up until 8 min of practice and then slightly dcreased. The experiment demonstrates that reminiscence is dependent upon the duration of practice before rest, as well as the duration of the rest period.

Other studies have demonstrated the occurrence of unilateral reminiscence in mental practice. Rawlings and Rawlings (1974) gave 47 female college students concentrated physical practice (50 sec of work alternated with 10 sec of rest) for 5 min on the rotor pursuit task. Following a 10-min rest period subjects were given 5 min of post-rest practice with the same limb (i.e., a single limb design). Twelve control subjects performed an irrelevant task during the rest period, while 35 subjects mentally rehearsed the rotor pursuit task. Imagery subjects exhibited more work decrement in the post-rest performance, indicating that mental rehearsal of the task during the rest period prevented the dissipation of work decrement.

A second way to measure work decrement is in a bilateral design in which reminiscence is the performance gain made when a task is practiced with one limb but performed after rest by the contralateral limb relative to a no-rest group. Bilateral reminiscence has been studied in the practicing of physical tasks. Irion and Gustafson (1952) demonstrated bilateral reminiscence in a rotor pursuit study involving two groups which practiced for 10 trials with the left hand. The trials were 25 sec long with 5 sec between trials (i.e., massed practice). For one group there was 30 sec to switch hands after 10 trials and for the other group there was a 5-min rest period. The data revealed that the group with the longer rest period had significantly higher gains in post-rest performance. This demonstrated a dissipation of work decrement.

In another study done by Rockaway (1953), similar results were obtained. The investigation involved 12 groups of 25 subjects who received either 1, 2, 3, or 5 min of first-hand (FH) practice with preferred hand followed by rest of 0, 2, or 5 min. Then, all subjects performed continuously for 5 min with second hand (SH). The results showed that SH performance increased with increasing practice and rest. Therefore, bilateral reminiscence was increased according to the amount of FH practice and the length of rest between FH and SH practice.

Bilateral reminiscence also occurs as a function of mental practice. Three experiments done by Kohl and Roenker (1980) investigated bilateral transfer on a rotor pursuit after mental practice. In the first experiment 60 right-handed subjects were divided into three groups (mental, physical, and control). Each experimental group practiced alternating 25 30-sec rehearsal trials with 25 30-sec rest intervals using the right hand. Performance was measured using the left hand. Results provided evidence that mental imagery and physical practice facilitate bilateral transfer. The second experiment was similar to the first except that the rest period was extended and there were fewer practice trials. The changes were made so that the physical practice group would build up and transfer less work decrement. That is, the increased rest interval would allow for the dissipation of any accumulated work decrement in the physical practice group. The results revealed a significant difference between the control group and the physical and mental practice groups. No difference was found between the mental and physical practice groups. The interpretation offered was that both groups accumulated and recovered from work decrement.

The final experiment attempted to determine if mental practice shows a bilateral transfer of work decrement corresponding to work decrement demonstrated in physical practice. Six groups (mental imagery rest and no-rest, physical practice rest and no-rest, and control rest and no-rest) were utilized in the experiment. The mental imagery rest group performed nine 30-sec right-handed imagery trials with alternate 8-sec color reading rest intervals, rested for 9 min and then performed nine 30-sec left-handed physical trials. The mental no-rest group did the same except that the 9-min rest was reduced to 8 sec. The physical practice rest and no-rest group followed the same procedures as mental practice groups, only with overt physical rehearsal. The control groups did multiplication tables under the same conditions instead of either physical or mental practice. The data showed a significant difference between the rest and no-rest groups in the experimental conditions (physical practice and mental imagery). The rest groups were superior in performance indicating the presence of work decrement. However, there was not an interaction between the mental and physical practice groups. This serves as evidence for the existence of bilateral transfer of work decrement when either physical or mental practice is used. All three experiments clearly show that bilateral transfer does occur under mental imagery conditions. They also demonstrate that work decrement occurs under conditions of mental or physical practice.

In summary, it has been demonstrated that both physical and mental practice can improve skill performance. Research has also indicated that continuous mental and physical practice of a skill can build up work decrement, which is measured by its dissipation after rest (i.e., reminiscence). Reminiscence can be measured in either a unilateral or a bilateral design. This indicates that just as learning transfers from one limb to the other so does work decrement.

Most of the research done concerning mental imagery and work decrement has utilized relatively simple tasks. The results then can only be generalized in a very limited degree to other simple tasks. Very few studies have looked at the effectiveness of mental practice on more complex tasks.

One study was executed by Phipps (1969) on the acquisition of motor skills of varied difficulty. He employed 80 male subjects assigned to either a control or a mental practice group for the learning of three motor skills: the hock-swing to horizontal bar, a jump-foot, and soccer-hitch kick. To perform the hock-swing, the subject grasped the horizontal bar, which was at shoulder height, with his palms forward. He then brought both legs to the bar pressing one leg between his trunk and the bar, hooking it over the bar at the knee. The subject hung from the bar by one knee and both arms, with the opposite leg extended to a horizontal position. The free leg was then lifted from its horizontal position to one nearly perpendicular to the floor. He then thrust the free leg toward the floor while tucking his head toward the bar. These movements enabled the subject to rotate around the bar with his hooked knee and come to an upright perpendicular position on top of the bar, if done correctly. The position had to be held for three seconds in order to pass the criterion.

The jump-foot was executed by the subject holding the toes of one foot in the opposite hand in front of the body. He then jumped upward so that the free foot could be passed through the loop formed by the foot being held in the opposite hand. A jump-foot was considered successful if the task was executed without losing contact between the hand and foot and maintaining the completed position for three seconds.

To perform the soccer-hitch kick, the body was lifted from the ground with a half kick on one foot, and then the ball was contacted with the opposite foot while the first foot was still off the ground. The ball was rolled down a track and had to be kicked before dropping to the floor. The passing criterion was the ball passing above a one foot horizontal line and between two vertical lines 14 ft apart. Each subject was given 10 attempts on all three tasks, with the passing criterion being successful completion of two successive attempts on each.

A pilot study was done previous to the experiment to determine which skills were more complex. It revealed a smaller percentage of subjects were able to successfully perform the soccer-hitch than the jump-foot, and lastly, the hock-swing. The assumption was made from this pilot study that the skills ranged from simple to complex.

The subjects in the control group attended regular physical education classes and were given demonstrations of the three skills with the subsequent ten performance attempts. The mental imagery group met for mental practice sessions in which the procedures for the skills were read to them while they mentally imagined themselves performing them. The directed mental practice was repeated 10 times during each of the sessions.

The results indicated that those who mentally practiced the hock-swing performed significantly better than the control group. However, there were no significant differences between the mental practice and the control group on the other two motor tasks. It was hypothesized that the value of mental practice depends not only on the difficulty of the skill, but is specific to the simpler skills.

Most research dealing with the effects of mental imagery and work decrement utilized the rotor pursuit apparatus. The criterion task on this apparatus is usually following one particular design (i.e.,circle). The next logical step is to find out if the same effects occur when the task is made more complex on the rotor pursuit. Complexity can be manipulated by changing the eccentricity of the target path. As the track becomes more eccentric (elliptical) the task of following the light can be assumed to be more complex, the reason being that all points on the track are not equidistant from the center of revolution (i.e., as would be with a circle). Thus, the target changes speed, moving fastest along those parts of the track furthest from the center. In order to track the light successfully, the movements of the arm must be constantly changed with the speed of the target, making the task more complex.

It is predicted that as task complexity increases, the effects of mental imagery will decrease. This is because as the task becomes more complex accurate mental imagery will become more difficult. Furthermore, it is hypothesized that less work decrement will build up as the task becomes more complex. The hypothesis is based on the same reasoning as the first, being that effective mental imagery will become more difficult on more complex tasks. If there is little or poor mental imagery, work decrement should not build up.

CHAPTER II

Method

Subjects

A sample of 180 right-handed subjects drawn from psychology classes at Western Kentucky University were randomly assigned to one of nine groups. Thus, there were 20 subjects in a group. Nievete and right-hand dominance were established during recruitment (self-report from the subjects was the criterion for dominance and nievete).

Apparatus

The principal apparatus were two Lafayette photoelectric pursuit rotors (model 30014). Three templates were used for each rotor. The templates were ellipses with varying degrees of eccentricity, ranging from .91 to .657 to .158. Note that the smaller the eccentricity value for the ellipse, the more oval the ellipse. Thus, ellipse A (eccentricity = .91) was assumed to be less complex than ellipse B (eccentricity = .657), than ellipse C (eccentricity = .158). The formula for determining eccentricity can be found in Appendix A. The speed of the rotor pursuits was set at 45 rpm and checked after each subject. The rotor pursuits were connected to Lafayette universal timers (model 6010-BF), which programmed the rotor pursuits for alternating 30-sec practice and 8-sec rest periods. Other Lafayette timers (model 58007) recorded the subject's total time-on-target for each trial.

Procedure

All subjects practiced and were tested in pairs. The subjects were isolated from each other by a screen so they could not view each other. Subjects were randomly assigned to one of the nine groups. The nine groups represented all combinations of task eccentricity and type of practice.

Three practice conditions were employed: mental practice rest, mental practice no-rest, and no-practice (control). Practice conditions for each group consisted of nine 30-sec mental rehearsal trials alternated with nine 8-sec rest intervals. The practice conditions were preceded by an introduction to the rotor pursuit (see Appendix B). Performance appraisal for each group consisted of nine 30-sec trials alternated with nine 8-sec rest periods. The three rest groups received a 9-min rest period between the practice and the performance conditions, during which time the subjects read magazines. The three no-rest groups received only the regular 8-sec rest period following the 9th practice trial and preceding performance appraisal. The control group performed nine 30-sec trials with 8-sec rest. All subjects practiced and performed with the right hand.

Design

The experiment represented a three (task eccentricity) by three (practice conditions) by nine (trials) mixed factorial design with repeated measures on the last variable. Task complexity levels were determined by eccentricity of the shapes utilized on the rotor pursuit. The practice conditions included practice trials followed by a rest (5 min rest between practice and performance), no-rest (no rest between practice and performance), and a control group which received no practice before performance.

CHAPTER III

Results

Each subject's performance was measured by recording the total time-on-target for each of the nine 30-sec trials. A subject's score on one trial could have ranged from 0 to 30 sec (time was measured to the hundreth of a second). These scores were converted to percent time-on-target. For each subject the first three performance trials formed the 1st trial block, the second three trials formed the 2nd trial block, and the remaining three formed the 3rd trial block. This was done in order to stabalize the dependent variable. This resulted in a three (eccentricity of ellipse) by three (practice conditions) by three (trial blocks) mixed factorial design with repeated measures on the last variable (see Appendix C for source table).

Mean percent time-on-target as a function of ellipse eccentricity, practice condition, and trial block is presented in Table 1. The analysis of these data revealed a significant effect of eccentricity, $\underline{F}(2,480) = 14.47$, $\underline{p} < .05$, a significant difference across trial blocks, $\underline{F}(2,462) = 171.49$, $\underline{p} < .05$, and a significant interaction between trial blocks and eccentricity, $\underline{F}(4,462) = 6.91$, $\underline{p} < .05$. There was

Table 1

Mean Percent Time-On-Target and Standard Deviations as a Function of Treatment Conditions and Trial Blocks

Treatments	Trial Block 1 Mean (SD)	Trial Block 2 Mean (SD)	Trial Block 3 Mean (SD)	Means
Ellipse A Imagery Rest	11.01 (3.63)	13.98 (4.17)	13.76 (4.11)	12.92 (4.10)
Ellipse A Imagery No-Rest	11.79 (3.89)	14.07 (4.13)	13.83 (3.90)	13.23 (4.01)
Ellipse A Control	10.07 (3.40)	12.25 (4.17)	11.36 (3.81)	11.23 (3.83)
Ellipse B Imagery Rest	7.67 (3.61)	9.42 (3.64)	9.81 (3.21)	8.97 (3.54)
Ellipse B Imagery No-Rest	9.46 (4.41)	10.97 (4.30)	11.38 (3.85)	10.60 (4.21)
Ellipse B Control	7.97 (2.97)	9.35 (3.10)	9.65 (2.85)	8.99 (3.01)
Ellipse C Imagery Rest	5.38 (2.25	6.71 (2.10)	6.92 (2.09)	6.34 (2.16)
Ellipse C Imagery No-Rest	5.35 (2.43)	6.64 (2.27)	6.98 (2.14)	6.32 (2.33)
Ellipse C Control	5.26 (1.84)	6.08 (2.87)	6.75 (1.49)	6.03 (1.75)
Means	8.23 (3.84)	9.94 (4.26)	10.05 (3.91)	

not a significant main effect of the practice conditions (i.e., rest, no-rest, control), nor of it's interaction with either eccentricity or trial blocks, F's < 1.

The overall effects of eccentricity and trial blocks by eccentricity were further analyzed by a Newman-Keuls Analysis. The results of the analysis of the eccentricity of the ellipse revealed that all three ellipses were significantly different from each other. The results of this procedure on the trial blocks by eccentricity interaction showed that all trial blocks were different within each eccentricity except for trial blocks 2 and 3 on ellipse C. Figure 1 is a graphic illustration of the eccentricity by trial blocks interaction. Performance on all three ellipses (A, B, C) increased from trial block 1 to trial block 2. However, performance decreased on ellipse A in trial block 3; whereas performance increased significantly on ellipse C and numerically on ellipse B from trial block 2 to trial block 3.

The expected results of a statistical difference in practice conditions (rest, no-rest, and control) were not in evidence. If the rest and no-rest groups would have demonstrated superior performance over the control group, then the indication would have been that effective mental imagery had occurred. Also, if the rest group would have performed better than the no-rest group, it would point to the build-up of work decrement on the no-rest group. An orthogonal comparison was to be done on the effects of elliptical

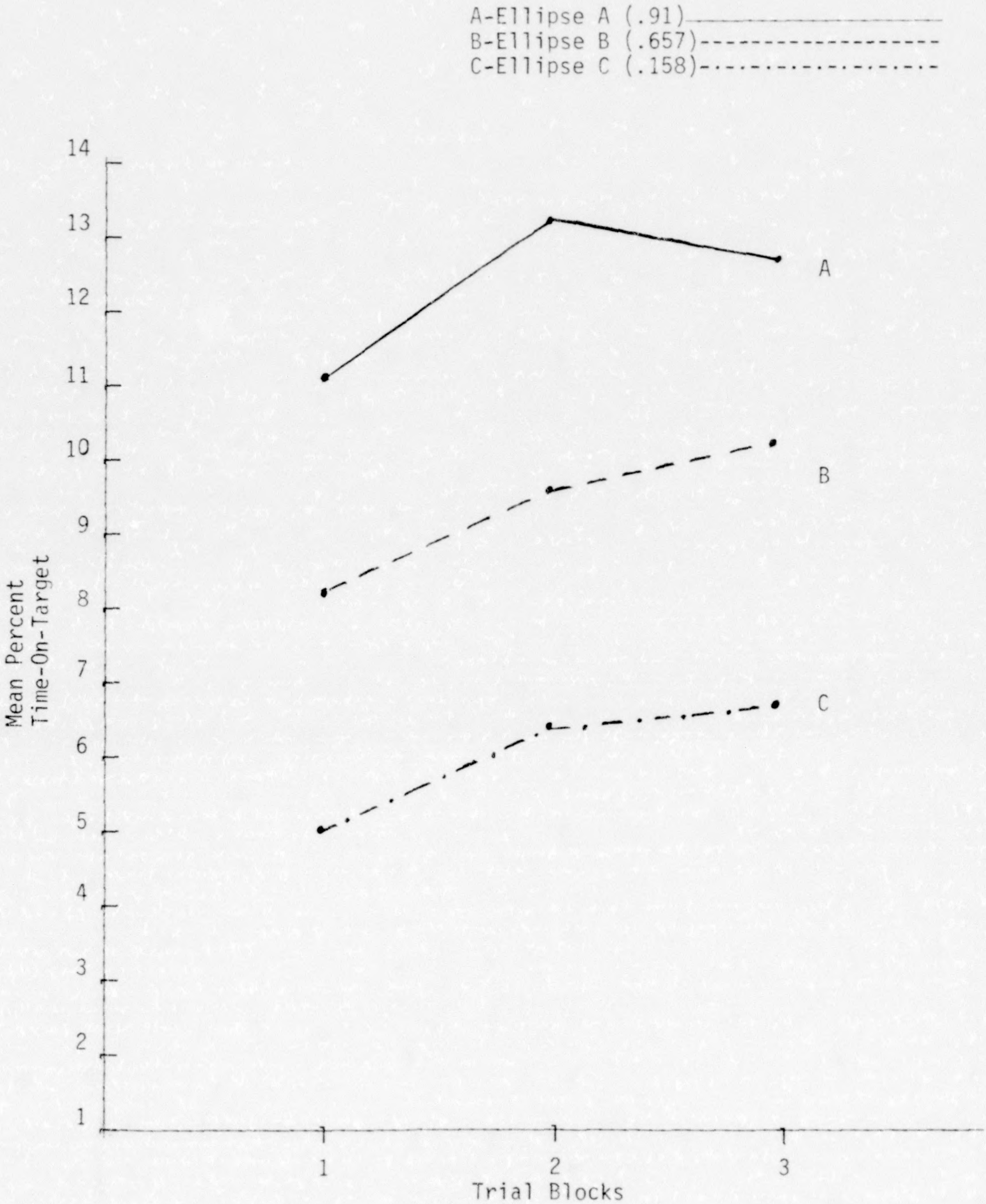

Figure 1. Mean percent time-on-target pooled across practice conditions (rest, no-rest, control) as a function of elliptical eccentricity and trial blocks.

eccentricity. These comparisons were to involve each rest group compared to the no-rest group, each rest and no-rest group compared to the control, and each ellipse (A, B, C) compared to the other. However, this procedure was deemed unnecessary since an analysis of variance revealed no significant main effect of practice conditions. The failure of the difference between these groups, as well as the lack of a practice conditions by eccentricity interaction, to reach statistical significance suggests that effective mental imagery and work decrement did not occur in any of the treatment conditions.

In summary, the results indicate a significant difference in performance as a function of elliptical eccentricity. As eccentricity increased, performance decreased.

There was a significant difference in performance across trial blocks, and a significant interaction between eccentricity of ellipse and trial blocks. Subject performed better from trial block 1 to trial block 2 on all three ellipses. On trial block 3 there was a slight decrease in performance on ellipse A with statistically significant increase on ellipse C and a numerical increase on ellipse B. Effective mental imagery and work decrement were not demonstrated.

CHAPTER IV

Discussion

This study attempted to investigate the effects of task complexity on mental imagery and work decrement. The procedure involved varying the complexity of the rotor pursuit task by increasing the eccentricity of the three elliptical shapes used for tracking. It was assumed that the greater the eccentricity of the ellipse the more complex the tracking task. Three practice conditions were employed to include rest, no-rest, and control. The difference between these groups was to indicate the effects of mental imagery and work decrement.

It was hypothesized that, as task complexity increased, the effects of mental imagery would decrease. This would mean that mental imagery would be very beneficial on ellipse A (least complex) but steadily decrease in effectiveness across ellipses B and C.

The failure of the control group to differ from the other groups (rest and no-rest) makes it impossible to draw conclusions about the effects of mental imagery and work decrement. The rest and no-rest groups should have performed better than the control group (mental imagery), and the rest group should have performed better than the no-rest group (work decrement) as numerous previous studies have demonstrated (e.g., Ammons, 1947; Kohl and Roenker, 1980; Rawlings and Rawlings, 1974; White, 1981).

The shape of ellipse A used in this study was very close to the shape of a circle, which has been used in previous research. The failure to produce a significant difference in performance between practice conditions (rest, no-rest, control) on ellipse A makes the data concerning this treatment condition suspect. Thus, it is reasonable to assume that something in the procedure of the experiment (e.g., rate or wording of instructions) was faulty and resulted in poor mental imagery. Based on experimenter observation, the subjects exhibited some behaviors which indicated they did not understand the instructions even though they reported that they did.

However, the results of this study did demonstrate a decrease in rotor pursuit performance with increased eccentricity regardless of the practice conditions. The results also revealed an increase in performance across trial blocks on ellipses B and C (greater eccentricity), but a peak in performance on ellipse A on the 2nd trial block. This seems to indicate that subjects learned task A quickly, peaked out, and decreased--whereas subjects performing on ellipses B and C were still learning the task at the completion of the 3rd trial block. However, this conclusion must be taken cautiously since the other expected results of practice conditions were not demonstrated.

It is recommended that a study be conducted implementing the same design as used in this study but altering the instructions given to the subjects in order to ensure a thorough understanding. The information yielded from such research would add useful information to the study of motor learning.

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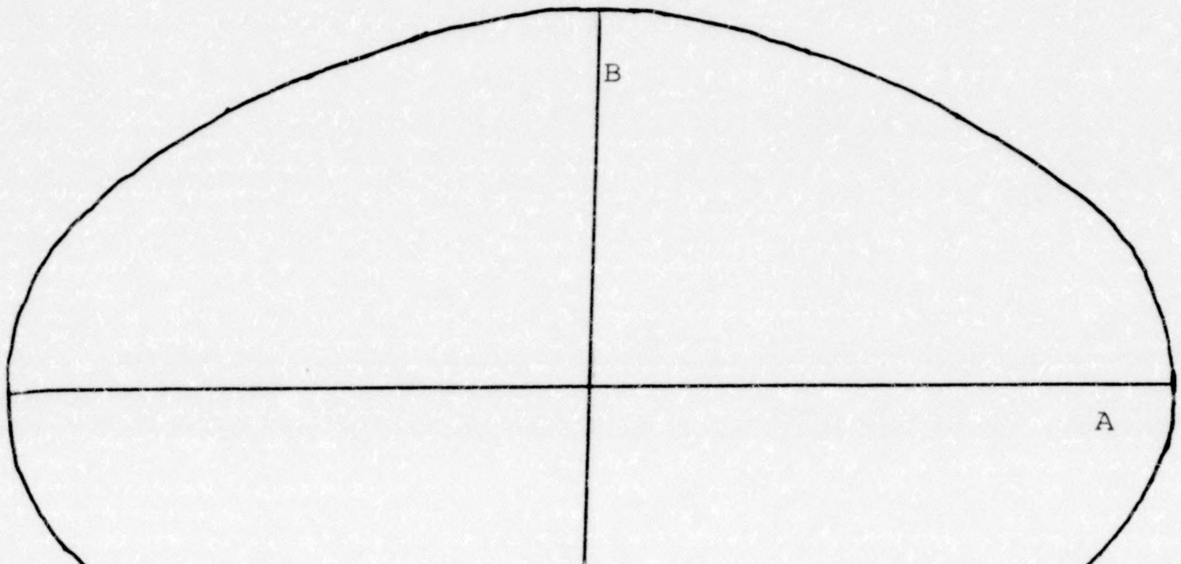
APPENDIX A

Formula for calculating the eccentricity of an ellipse:

E = Eccentricity
A = Length of the major axis
B = Length of the minor axis

$$E = \frac{\sqrt{A^2 - B^2}}{A}$$



APPENDIX B

Introduction to experiment

Fill in your name, age, and birthdate on this form. Please pay close attention; it is essential that you have a clear understanding of the task I am to explain.

This is a rotor pursuit apparatus. It is used to measure eye-hand coordination. (Experimenter picks up stylus with right hand). One needs to grasp the stylus with the right hand, then assume a comfortable position facing the apparatus. (Experimenter demonstrates position). The object of the task is to keep the tip of the stylus on the rotating light. While following the light, avoid any discrete and jerky movements but rather make one continuous movement. (Experimenter demonstrates for 30-sec). Do you understand the task?

Instructions for practice trials

Now sit on the stool. Take the stylus in your right hand. When I tell you to begin, you are to mentally rehearse the rotor pursuit task. Mental rehearsal refers to imagining the task without making any overt or physical movements. You must close your eyes. Conceptualize and create a mental picture of yourself performing the task. For the duration of each practice trial imagine yourself making a continuous and fluid movement with the stylus. Try to get the feel of executing the task by imagining yourself performing the task as precisely as possible. Can you explain back to me what you are to do? I will give you nine 30-sec imagery trials with 8-sec rest in between. Are there any questions?

Instructions for interim rest period

Now you will have some time to read through these magazines. I will let you know when we will proceed. It is important that you respond quickly to instructions that I will give you at that time.

Instructions for performance trials

Stand up. Put the stylus on the center of the glass--not the target. When the target starts moving, perform the task just like I demonstrated and just like you imagined (the last five words are eliminated for the control groups). (Experimenter starts performance trials from the control board). As soon as the target stops, Experimenter says) Keep the stylus away from the light whenever the target is not rotating. Get ready to begin again.

APPENDIX C

ANALYSIS OF VARIANCE
SUMMARY TABLE

Source	SS	DF	MS	F	P
Total	8932.39	539			
Between Subjects	8172.14	59			
Eccentricity	2834.23	2	1417.12	14.47	$< .05$
Practice Conditions	123.68	2	61.84	< 1	NS
Eccentricity by Practice Conditions	77.51	4	19.38	< 1	NS
Error (b)	5136.72	51	100.72		
Within Subjects	760.25	480			
Trials	308.26	2	154.13	171.49	$< .05$
Trials x Eccentricity	24.87	4	6.22	6.91	$< .05$
Trials x Practice Conditions	6.24	4	1.56	1.73	NS
Trials x Eccentricity x Practice Conditions	5.66	8	.71	< 1	NS
Error (w)	414.22	462	.90		