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AN ABSTRACT OF THE THESIS OF Timothy K. Kelly for the Master of Science in Psychology presented April 20, 1983.

Title: Parameters of Mental Rehearsal

APPROVED BY MEMBERS OF THE THESIS COMMITTEE

[REDACTED]
Gerald D. Guthrie, Chair

[REDACTED]
Frank Wesley

[REDACTED]
Hugo Maynard

An extensive review of the literature of the phenomenon of mental rehearsal (MR), or the act of imagining oneself performing a behavior in anticipation of eventually doing so, indicated that MR could facilitate improved performance on varied motor skills. An experiment which drew from previous studies in MR, incorporated suggestions from the literature, and used a novel measurement task was conducted. The present study compared MR to physical practice (PP), no practice (NP), mental rehearsal/physical practice combined (MR/PP), and interference mental rehearsal (I). Five groups of twenty subjects (N=100) played a hand-held video computer game in a pre- and post-test design. The present study hypothesized that MR would improve performance scores in the video game task. A second hypothesis based on more recent trends in MR literature predicted that an MR/PP group might demonstrate more improvement

than the PP group. A final hypothesis was that should MR/PP not exceed PP in improved performance, the rank order outcome from greatest to least improvement would be: PP, MR/PP, MR, NP, and I.

The results of the present study were in conflict with reports in the literature and the pilot study, and did not support the three hypotheses. Subjects in all five treatment groups improved performance significantly between the pre- and post-test periods, however, none of the five treatment strategies demonstrated a statistically significant improvement in performance. The I group improved more based on mean percent improvement than either the MR/PP or PP groups. The rank order prediction was not supported in that the results of greatest to least mean percent improvement were as follows: I, MR/PP, MR, NP, and PP.

It is concluded that lack of significant improvement in performance using MR is most probably due to task related variables of complexity, unpredictability, difficulty, and the external pacing of performance that the video game task demands. The data are most consistent with literature reports which used complex and difficult tasks and ones which were paced by external task demands (i.e., the subject had to respond according to task demands rather than pacing his or her own performance). Further, the data are consistent with reports that suggest MR is less effective in unpredictable, difficult, and externally paced tasks than in ones which are predictable, less difficult, and self-paced.

PARAMETERS OF MENTAL REHEARSAL

by

TIMOTHY K. KELLY

A thesis submitted in partial fulfillment of the
requirements for the degree of

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1983

TO THE OFFICE OF GRADUATE STUDIES AND RESEARCH

The members of the committee approve the thesis of
Timothy K. Kelly presented April 20, 1983.

[REDACTED]
Gerald D. Guthrie, Chair

[REDACTED]
Frank Wesley

[REDACTED]
Hugo Maynard

APPROVED:

[REDACTED]
David Wrench, Head, Department of Psychology

[REDACTED]
Stanley E. Rauch, Dean of Graduate Studies and Research

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CHAPTER I

INTRODUCTION

The act of imagining oneself engaged in a situation and performing a behavior is a common one. Individuals perform this private act frequently and regularly. As with all mental actions this imagined performance process is individualized, subjective, and not immediately observable by others.

Mendoza and Wichman (1978) note that relating mental processes such as this imagined performance to observable behavior is a major challenge to psychology. Attempts have been made over the past fifty years to examine the phenomenon of imagining behavior and the effect on the eventual behavioral outcome (MacKay, 1981).

Many questions have arisen concerning this subject. Does imagining or rehearsing a behavior in anticipation of eventual performance have any effect on the behavior when it is actually emitted? Can use of this imagined rehearsal facilitate improved performance of a behavior when it occurs? These and other questions have been extensively researched.

The subject of imagined performance appears in the literature under a variety of names. Mental practice, imaginary practice, implicit practice, symbolic rehearsal, imagined rehearsal and mental rehearsal are all terms which have been applied to this phenomenon (Richardson, 1967a). For purposes of the present study the term mental rehearsal (MR) will be used.

The research findings in MR show mixed results. In his review of the first thirty years of literature on MR Richardson (1967a) concludes that on a variety of tasks subjects have improved

their physical performance after spending time thinking about or imagining themselves in the act of performing. It is assumed that MR, the cognitive, subjective, practice of a physical task in the absence of muscular movement can help facilitate learning and improve performance of actual tasks (Samuels, Note 1).

Richardson (1967a) notes that studies have focused on the utilization of MR to aid in skill acquisition, retention and improvement in performance. The present study will focus on the area of improved performance by the use of MR.

The acknowledgement that MR exists and can be investigated empirically, the numerous studies focusing on variables of the subject, and the conclusion by all researchers that MR merits further inquiry suggest that more investigation is warranted. Oxendine (1969) suggests that just by the nature of the phenomenon MR is difficult to observe and control. MacKay (1981) comments that recently interest in MR investigation has waned due to many difficulties in theoretical, conceptual, and methodological issues present in studying MR. Further, the highly varied and often conflicting reports on MR throughout the literature add to making MR a complex topic of study.

The purpose of this thesis is to investigate parameters of MR by reviewing the literature, identifying some critical conceptual issues, designing and implementing an experiment in MR which incorporates suggestions noted by previous researchers, and utilizing a novel measurement tool. The basic hypothesis of the present study is that MR can facilitate improved performance on a motor skill.

Theoretical considerations. It is suggested by MacKay (1981) that the existing examinations of MR in the literature have been atheoretical in nature. With the exceptions of Richardson (1967b), Mendoza and Wichman (1978), and MacKay (1981) the review of literature for the present study supports that observation. Investigators in MR have examined numerous variables within the subject rather than attempted to advance a theoretical position. A brief review of the statements by the few theoretically oriented researchers is in order.

Richardson (1967b) suggests what is called a psychoneuro-muscular explanation for MR. This explanation is based on the assumption that during practice of a task the visual feedback of the outcome is used to modify the muscular activity required to perform the task. Successive modifications of the physical activity improve the performance. For example, visual feedback provided to the subject on adjustments in body position, stance, arm movement, air, and release at a target may gradually improve dart throwing. Richardson (1967b) suggests the possibility that these processes may occur mentally without actual physical practice.(PP). This explanation relies on work by Jacobson (Cited in Richardson, 1967b) and Shaw (Cited in Richardson, 1967b) which notes that imagining a movement might serve to minimally innervate the muscles necessary to perform a task. Outcome feedback may not be needed if the kinesthetic feedback is tied to a well internalized model of successful performance. Richardson (1967b) notes that many more experiments are required before this explanation could be substantiated.

Mendoza and Wichman (1978) note that researchers have had to

extend and change conceptions about behavioral principles to include cognitive aspects of behavior. Explanations such as stimulus-response paradigms or successive approximations toward a target behavior have not been adequate to explain MR. Mendoza and Wichman (1978) suggest that what occurs in MR may in some way be likened to observational or vicarious learning and the effects of passive behavioral alteration as described by Bandura (Cited in Mendoza & Wichman, 1978). Mendoza and Wichman (1978) add that a possible theoretical explanation for MR facilitating motor learning might somehow relate to situations in which subjects are reinforced for imagining and then successfully performing a behavior which has been observed in a model. Mendoza and Wichman (1978) admit that this is probably a tenuous hypothesis.

MacKay (1981) approaches theoretical issues in MR from an opposite perspective. He suggests that investigators have used either behavioral or cybernetic frameworks in MR research, and that both are unhelpful or in conflict with MR effects.

According to MacKay (1981) the behavioral framework requires that learning is facilitated by strengthening stimulus-response connections and then practicing the behavior. Practice serves to further strengthen the stimulus-response connections and the behavior becomes skilled. To MacKay (1981) MR is a 'questionable phenomenon' since no behavior is actually performed, and therefore MR is irrelevant in a behavioral framework. Further, there is no emitted behavior in MR and there can be no strengthening or sensory feedback as a result of MR. It is for these reasons that MacKay (1981) thinks the behavioral framework is inadequate.

The cybernetic framework receives similar criticism. Neither

output or feedback, both of which are necessary requirements in a cybernetic framework are present in MR. Therefore, MacKay (1981) suggests the cybernetic framework is inadequate.

It must be noted that in the theoretical criticisms of MR noted by MacKay (1981) he specifies purely mental practice, or MR in the absence of any preceeding PP to familiarize the subject with the task to be mentally rehearsed. Numerous investigators have stressed the necessity of pairing MR with PP of the task for MR to be most effective. Whether the criticisms of behavioral and cybernetic frameworks are made with MacKay's (1981) acknowledgement or ignorance of the necessity of paired MR and PP is beside the point, however, MacKay (1981) notes in the conclusion of his report that paired MR and PP constitute the most efficient use of MR.

MacKay (1981) advances his own rather complex theoretical explanation for MR based on an earlier investigation (MacKay & Bowman, 1969) involving use of MR in a sentence production task.

This physiologically oriented theory suggests the presence of 'nodes' or collections of one or more interconnected neurons arranged into heirarchical sequences which are activated by a particular action be it mental or muscular. The mental nodes (atop the heirarchy and few in number) are activated during MR whereas the muscular nodes (lower in the heirarchy and many in number) are not engaged until a behavior is performed. This 'priming' (activating the sequences of nodes) occurs when MR is done. Skilled performance of a behavior results from repeated performance of an action, and the speeding up of activation occurs with PP.

The results of the MacKay and Bowman (1969) study support MacKay's (1981) theoretical position. In the sentence production

tasks used, subjects performed equally well whether in a MR or PP group. MacKay (1981) suggests that similar activation sequences occur in MR and PP, and therefore, MR will be most effective if paired with PP.

It must be noted that MacKay (1981) confines his theory to sentence production, and supports his position with references from speech and hearing tasks. In MacKay and Bowman, (1969) the task was sentence production translating German phrases to English. These phrases were performed in a MR condition and a PP condition. This task is a considerable variation from virtually all MR tasks in the literature, as speech production is not a similar motor skill to such things as free-throw shooting (Vandell, Davis, & Clugston, 1943) or pursuit rotor (Oxendine, 1969). MacKay's (1981) task is an atypical measurement device and does not seem related to other tasks reported in the MR literature. It is questionable if a speech production task and its qualities are generalizable to other MR tasks.

While the present study does not attempt to advance a theoretical position, some considerations of the ideas of Mendoza and Wichman, (1978) and MacKay (1981) are in order. Richardson (1967b) offers a tentative explanation, not a theoretical position, and suggests that more research is necessary before that explanation could be supported.

MacKay (1981) appears to be criticizing the behavioral framework as if it were still enmeshed in the radical behavioral tradition of years passed. Limiting MR to a 'questionable phenomenon' (MacKay, 1981) narrows the scope of Behavioral Theory to the radical past. This immediately eliminates advances in more contemporary

Cognitive-Behavioral Theory which includes such concepts as mediating cognitive and symbolic factors which effect emitted behavior, and the notion that thinking is behaving (Bandura, 1977; Meichenbaum, 1977).

Mendoza and Wichman (1978) suggest a view that is more compatible with Cognitive Behavioral Theory, considering MR to be a process which facilitates skilled behavior. Watson and Tharp (1981) note that MR is an established mediational process recognized in behavior analysis, behavior therapy, and self-directed behavior change. Further, Wolpe's (Cited in Martin & Pear, 1978) use of MR as part of his systematic desensitization imagery process, MR as used in many sports (Mahoney, 1979; Suinn, 1972, 1977) to improve athletic performance, and MR as preparation for behaviors-in-situation in self-management (Williams & Long, 1975) attest to MR as a recognized part of Cognitive Behavioral Theory. All of these uses of MR can be understood within that theoretical framework.

The present study suggests that many of the theoretical issues in MR can be treated from a Cognitive Behavioral perspective.

Empirical findings. A highly significant and important contribution to the literature was made by Richardson's (1967a, b) review of the first thirty years on MR research. He reviewed twenty-one experiments and in his conclusion noted that eleven had shown positive results in improving performance by use of MR. Richardson (1967a) cited seven studies showing positive trends that indicated MR was effective in acquisition, retention, and improved performance of motor tasks. Only three studies reported negative findings.

Richardson (1967a) examined variables influencing individual differences in performance noted throughout the literature. Such factors as abstract and mechanical reasoning ability, intelligence, kinesthesia, and selective attention were found to be unrelated to the effectiveness of MR by correlational studies. Imagery ability, games ability, and motor ability were factors which Richardson (1967a) suggested could benefit from further experimental attention. The overall conclusions from this literature review suggest that despite many method inadequacies in research design, MR could significantly improve performance on motor tasks. Further and more specific suggestions that the degree of task familiarity, the effects of paired MR and PP, alternated MR/PP trials, the duration of MR utilized, and the addition of an Interference (I) group which mentally rehearses a behavior unrelated to the task were noted by Richardson (1967a).

Some investigators have indicated less effective results with MR than have other investigators. These studies (Richardson, 1967a) did not report any consistent conclusions as to the failure of MR to be effective, nor did they illustrate any trends in MR failure.

The MR studies up to Richardson's (1967a, b) review followed a usual method of randomly assigning subjects to one of three experimental groups: MR, PP, and No Practice (NP). Subjects participated in a pre- and post-test design. PP subjects continued to practice the task to be performed during the treatment condition phase. MR subjects mentally rehearsed the task to be performed, and NP subjects did nothing during the treatment condition phase.

Upon completion of the post-test, the performance scores of

the subjects were compared. In some cases the score consisted of a successful or unsuccessful completion of the task, while in others a numerical score was obtained. Virtually all studies demonstrated that PP showed the greatest improvement in performance. MR followed with improved performance, but less so than PP, while NP showed little or no improvement in performance (Richardson, 1967a).

As noted by Richardson (1967a) the latest trend in MR research is to examine combinations of MR and PP. These experiments investigated pairing MR and PP, and generally compared performance on varied tasks to purely MR groups, PP alone groups, NP groups, and in some cases, varied proportions of MR/PP combined. Results indicated a positive trend for pairing MR and PP, suggesting that MR would be most effectively utilized if combined with actual PP (Corbin, 1967; Johnson, Note 2; Oxendine, 1969; Stebbins, 1968).

Other investigators since Richardson (1967a, b) have utilized the earlier PP, MR, and NP designs, and have confirmed previous reports that MR is more effective than NP, but less effective than PP in improving performance (Kohl & Roenker, 1980; Mendoza & Wichman, 1978; McBride & Rothstein, 1979; Samuels, Note 1).

While a major focus in MR research has been as noted, experimenters have examined a multitude of variables within MR, and a variety of conclusions have been suggested in the literature. Some conceptual issues involving these variables are significant.

Conceptual considerations. For purposes of the present study it is assumed that the variables examined by researchers in MR can fall into one of three categories: cognitive response variables, motor response variables, and cognitive-motor response variables.

It is within these categories that particular variables relevant to the present study will be placed. Cognitive response variables are ones which involve the mental, cognitive, and symbolic rehearsal itself. Motor response variables are ones which involve the task used to measure the effectiveness of the MR. Cognitive-motor response variables are ones which involve the overall process of MR, or the learning of a task, mentally rehearsing the task, and performing the behavior.

Cognitive response variables. Some conclusions relative to cognitive response variables have been reported in the literature. Powell (1973) examined the effects of positive MR (subjects imagine themselves successfully performing the target behavior) versus negative MR (subjects imagine themselves unsuccessfully performing the target behavior) on a dart throwing task. Results indicated that what a subject imagines has a great deal to do with the effectiveness of later performance. Subjects experiencing positive MR performed significantly better than subjects experiencing the negative MR (Powell, 1973).

Oxendine (1969) reports that varied IQ levels do not effect either ability to imagine nor the outcome of behavior when using MR.

Samuels (Note 1) incorporated Richardson's (1967b) suggestion to include an Interference MR (I) group in his study, however, results of that group when compared to NP, MR, and PP are not reported.

Clark (1960) reported that MR was not as successful if used purely, that is, without any PP to familiarize the subject with the task to be completed.

Johnson (Note 2) suggests that for MR to be effective subjects should be able to symbolize the desired performance outcome, and be properly instructed in the MR technique to be used.

A final cognitive response variable comes from the literature of psychotherapy and sports psychology. This is the use of relaxation to enhance MR. Meichenbaum (1977) notes several varied types of relaxation training used by psychotherapists to further imagery in MR. It is thought that relaxation prepared the subject to be more receptive to imagining (Rachman, cited in Meichenbaum, 1977). Although Wolpe (Cited in Martin & Pear, 1978) used relaxation as part of creating an incompatible response to anxiety in systematic desensitization, it is possible that the imagery may have been facilitated as well. Mahoney (1979), Singer (Cited in Mahoney, 1979), and Suinn (1972; 1977) suggest that the effectiveness of MR might be enhanced if the subject is trained in relaxation. Studies with athletic performance have utilized relaxation in this manner (Mahoney, 1979).

Cognitive response variables being used in the present study are that of PP to help the subject build task familiarity, instructed MR to help the subject symbolize the desired task outcome, an Interference MR (I) group to balance the MR group, and a brief relaxation period prior to MR to help the subject enhance imagery.

Motor response variables. These variables are ones which pertain to the task used to measure the effectiveness of MR. They are the behaviors that are required to successfully perform the action which is facilitated by MR.

There are several conceptual areas regarding motor response variables which the present study views as problematic. It is

suggested that these conceptual problems have contributed to some of the difficulty in interpreting the MR literature.

Richardson (1967b) notes that researchers have failed to report any information regarding the reliability or appropriateness of the tasks selected to measure MR. Still many investigators draw conclusions about the effectiveness of MR based on aspects of the task. The literature review for the present study supports this observation by Richardson (1967b), and suggests that a lack of operational definitions in four conceptual areas make drawing conclusions about the effectiveness of MR based on tasks problematic.

Simple versus complex tasks. This is the first area of conceptual difficulty. Phipps and Morehouse (1969) used a gymnastics hock swing to a parallel bar, a jump-foot (subject holds right foot with left hand and jumps through the ring made with the left foot), and a soccer hitch kick rated respectively from simple to complex tasks. Phipps and Morehouse (1969) report that MR is more effective when used with a simple skill, and therefore, MR effectiveness is dependant upon the complexity of the task.

Corbin (1967) suggests that MR and PP may be equally effective relative to the subjects' skill levels and the complexity of the task.

Mendoza and Wichman (1978) questioned whether MR would be as effective with complex tasks as it was with their simple dart throw.

Smyth (1975) used mirror drawing and pursuit rotor tasks to measure the effectiveness of MR, and concluded that a well-thought-out, complex task should be used as a measurement device in future MR research.

In all of these studies investigators address simplicity or

complexity of tasks, commented on the effectiveness of MR, and related this effectiveness to task difficulty. However, none of these investigators attempted or advanced an operational definition for the concepts of simple or complex. It appears as if simple or complex is implied by virtue of the task itself; but is mirror drawing more complex than dart throwing? Without an operational definition, simplicity or complexity of a task is problematic.

For purposes of the present study it is suggested that rather than differentiate a task as simple or complex by implication, without a definition, and as separate and distinct categories, simple and complex can be placed at opposite ends of a continuum. Tasks can be placed along the continuum based on the number, kind, range, of movement, and rate of responses to stimuli required to successfully complete the task. The task to be used can be compared to other tasks used in MR research as to simple or complex.

For example, a basketball free-throw (Clark, 1960) consists of five easily identified response clusters: positioning the ball in the hands, aiming at the basket, drawing the arms up and back to prepare to shoot, propelling the ball forward, and releasing it. Mirror drawing (Smyth, 1975) requires looking into the mirror, placing the pencil to paper, and by moving the pencil, attempting to draw the modelled object. Juggling balls (Corbin, 1967) consists of constant movement of the head, arms, and hands which occurs for the duration of the task or until an error is made by dropping the object. Assigning simple or complex as labels to the above tasks is obviously problematic.

Juggling as compared to free-throw shooting is more complex because it requires many more responses to stimuli based on the

number and kind, the continuous movement, and the faster rate of movement required to successfully perform the task. To draw conclusions about task complexity or simplicity and to evaluate the effectiveness of MR in the absence of some way to place the task relative to difficulty and to other tasks could be avoided by use of an operational definition such as the above, and by placing the tasks on a continuum.

Operational definitions and placing tasks on a continuum of simple to complex could assist investigators in teasing out aspects of MR and task difficulty which might more clearly define how to improve MR effectiveness. The investigator might simply count the number of responses, the kind, the movements and rates of responding, and consult the literature for similar tasks which might compare operationally. The process would be much like the free-throw, mirror drawing, and juggling examples. It is beyond the scope of the present study to examine all of the tasks in the MR literature in a similar way to the above examples, but a sample continuum appears in the Appendix.

Fine versus gross motor tasks. This is the second area of conceptual difficulty. There appears to be a lack of an operational definition for these distinctions as well. Investigators have not operationally defined whether a task is representative of a fine or gross motor skill, as no study in the literature reviewed here made a clear distinction.

It would appear that fine motor tasks were used by Kohl & Roenker (1980), Oxendine (1969), Samuels (Note 1), and Smyth (1975) with their use of a pursuit rotor as the measurement task. Rubin-Rabson (Cited in Richardson, 1967a) used a piano keyboard

task, and Perry (Cited in Richardson, 1967a) used a card handling and pegboard task. It would seem that these examples would be considered fine motor skills.

A majority of investigators have used what appear to be gross motor skill tasks. Such tasks as gymnastics moves (Gilmore, Note 3; Phipps & Morehouse, 1969), basketball shooting (Clark, 1960; Oxendine, 1969; Vandell, et.al., 1943), soccer kicks (Oxendine, 1969; Phipps & Morehouse, 1969), darts (Mendoza & Wichman, 1978; Powell, 1973; Vandell, et al., 1943), and ball and paddle tasks (Egstrom, 1964; McBride & Rothstein, 1979) have been used. Despite the obvious distinction that fine motor tasks differ from gross motor tasks depending on whether smaller or larger muscle groups are used, no further distinctions are made.

It is suggested by the present study that distinguishing fine from gross motor tasks without an operational definition is problematic, particularly if MR effectiveness is to be more critically evaluated in future research. This study differentiates gross motor tasks from fine based on the number of body areas utilized and the range of motion required to successfully perform the task.

For example, a pursuit rotor task would utilize arm, wrist, and hand muscle groups, a limited body area, and a limited range of motion, while a soccer kick would utilize both upper and lower body areas, the muscle groups in the hips, leg, and foot, and a large range of motion. By utilizing a continuum approach to the problem of fine versus gross motor tasks, each task could be measured by the above operations and compared to other MR tasks.

The present study does not place tasks in the MR literature on this continuum, but an example of the model appears in the Appendix.

Familiar versus unfamiliar tasks. This is the third area of conceptual difficulty in motor response variables. This area is doubly difficult in that a distinction needs to be made along two parameters: overall task familiarity and experiment-specific familiarity.

Richardson (1967a, b) and MacKay (1981) in their reviews of the MR literature criticize MR experiments for using familiar tasks such as baseball throws, basketball shots, dart throws, and ball kicks with which subjects are likely to have had previous exposure in the natural environment. This overall task familiarity is described as a confound to MR effectiveness. Clark (1960), Corbin (1967), Johnson (Note 2), and Smyth (1975) found that MR was not as effective with subjects who were familiar with the task used. Yet as Richardson (1967a) notes, it has been reported that some familiarity with the task is necessary for effective use of MR, and that PP which builds familiarity with the task and enhances the effectiveness of MR must be paired with it. This is misleading because different researchers are apparently referring to separate, distinct areas of familiarity; that of overall familiarity of task as likely to appear in the natural environment, or task familiarity within an experiment-specific situation. How much of such type of familiarity is required for effective MR? Should the task be an unfamiliar (overall) task or unfamiliar experiment-specific task? Must the task be so novel that subjects have had positively no experience with it? These questions regarding the

issue of familiar versus unfamiliar tasks confuse the interpretation of the reported results of the effectiveness of MR. No distinctions appear to have been made in the literature.

The present study suggests the use of a continuum on two levels: overall task (familiar to unfamiliar) and experiment-specific task (familiar to unfamiliar).

Richardson (1967b) comments that future MR research should utilize tasks which are not advantageous to any subject group. As for overall task familiarity, the chosen task could be measured by inquiring as to the subjects' previous exposure to the task. For example, it is likely that relatively few subjects have had experience with a pursuit rotor task outside an experimental situation, while many subjects have thrown a dart or kicked a ball. This problem of overall task familiarity should be addressed in selection of the task, and considered before drawing conclusions regarding the effectiveness of MR with familiar and unfamiliar tasks. Placing the task relative to other tasks based on subjects' familiarity might assist researchers in determining to what degrees familiarity and previous exposure to a task will effect performance after MR and how previous familiarity can be effected by MR.

Smyth (1975) suggests using a novel task rather than one which is well known and offering subjects a pre-test period in which to familiarize themselves with the task. This suggestion appears to relate to experiment-specific task familiarity. The measurement of experiment-specific familiarity may be tied to the amount of time subjects have with a novel task prior to MR. Researchers

could use an experiment-specific continuum of familiar to unfamiliar and compare their subjects' time with the novel task to other MR studies.

These continua might assist researchers in dealing with the ambiguous area of task familiarity. While the present study will not attempt to place previous experimental tasks on these continua, an example of the model appears in the Appendix.

Open versus closed tasks. This is the fourth area of conceptual difficulty in motor response variables. A novel definition of task issues was approached by one study in the MR literature. McBride and Rothstein (1979) distinguished tasks as to whether they were to be considered open or closed tasks based on several characteristics.

Open tasks are ones which take place in an open environment, are unpredictable, unstable, ever-changing, and require the anticipation and prediction of moving objects. The motor skills are termed externally-paced or open skills.

Closed tasks are ones which take place in a closed environment, are predictable, stable, fixed, and involve stationary objects. These motor skills are termed self-paced or closed skills.

This approach is unique in all the MR literature in that it closely examines task issues, suggests a new categorizing of tasks, and tests that approach experimentally. This study merits further comment. In their literature review McBride and Rothstein (1979) place many previous experiments in their open and closed categories. For example, pursuit rotor (Oxendine, 1969), juggling (Trussel, cited in McBride & Rothstein, 1979), and paddle ball

(Egstrom, 1964) tasks are considered open skill tasks as the subjects must be constantly working to keep pace (externally-paced) with an unpredictable, unstable, and ever-changing task. Free-throw shooting (Clark, 1960) and ring toss (Twining, 1949) are examples of closed tasks as subjects pace themselves and the demand characteristics of the experiments are fixed, stable, and predictable. This process of after-the-fact assignment of previous experiments to novel categories is the only attempt to deal with task issues in a clearly defined manner in the present literature review.

McBride and Rothstein (1979) designed a ball and paddle task which extended a study by Egstrom (1964). The task utilized a stationary ball held up by a stand and struck at a wall target by a paddle. This was considered a closed task. A ball ejected from a chute and struck at the same target by the paddle served as an open task. Since the same target was used for both conditions, the scoring or measurement method was identical. McBride and Rothstein (1979) had argued that in the reports of other MR studies, where no distinction had been made between open and closed skills, the measurement scores reflecting MR effectiveness were compared in an incorrect and unrelated manner. McBride and Rothstein (1979) report that their experiment asserts to use a design and measurement created to equalize comparison scores on open and closed skills.

The results of the study which used six experimental groups (open skill/MR, open skill/PP, open skill MR/PP combined, closed skill/MR, closed skill/PP, closed skill MR/PP combined) followed the trend of recent MR studies. Combined MR/PP in alternating

fashion demonstrated greater improvement than with either MR or PP alone. As predicted, the open skill was performed less accurately than the closed skill in all treatment conditions (McBride & Rothstein, 1979).

While this study is unique and the only one which appears to operationally define motor response variables, some aspects are still confusing. The motor response task variables are assigned to either/or categories which the present study suggests may be an artificial distinction. The present study suggests that to widen the scope of task variables and to contribute to greater clarity in future research, a continuum approach should be utilized with regard to open and closed skills. Upon closer examination open and closed skills appear a bit less distinct than suggested by McBride and Rothstein (1979). The characteristics of open skills (unpredictable, unstable, ever-changing, and requiring anticipation and prediction of moving objects) are not static conditions which can be clearly distinguished from closed skills (predictable, stable, fixed, and stationary) because of the time and duration of the experiment.

For example, although a pursuit rotor (open skill) is unpredictable, unstable, ever-changing, and requiring anticipation of a moving object (the target dot), it is predictable in that it will circle at a particular r.p.m.; it is stable in that it will not alter its pattern on the turntable; it is fixed in that it will continue to circle; and it is stationary in that the device will not move about the table on which it sits. A basketball free-throw (closed skill) is predictable, stable, fixed, and

stationary in that the goal itself has the preceeding characteristics. However, the shot will be effected by the spin on the ball, the stability of the release, the forward thrust, the stance of the shooter, the aim, and the wide range of variability such factors present. All of these factors bring a degree of openness to the task. While these criticisms may seem minute, the present study suggests that as in other problematic conceptual areas in motor response task variables, a continuum of open to closed skills may be a way to more clearly evaluate tasks. As with other descriptions of continua, this would allow researchers to place their tasks relative to other MR tasks.

The distinction of externally-paced versus self-paced tasks suggested by McBride and Rothstein (1979) is an excellent one, and the present study sees no criticism of that characteristic. Further study should consider that aspect, as it seems MR would be most effective when there is time for the subject to approach the task on a self-paced basis. This should be considered in future MR research.

A sample continuum for placing tasks along open to closed skills appears in the Appendix.

Cognitive-motor response variables. These variables are ones which involve the process of MR from beginning to behavioral outcome, or the experience of becoming familiar with a task, utilizing MR to imagine performance, performing the behavior, and measuring the effectiveness of MR based on the outcome.

This overall process of cognitive-motor response variables or the MR itself has not been the major focus of empirical research. MacKay (1981) notes the focus on variables within MR occupying the

greatest extent of the research. With the exception of Mendoza and Wichman (1978), a study which utilized MR with and without muscle movement, most of the literature reports are directed at schedules of combined MR and PP. Researchers have varied the proportions of combined MR/PP and measured these against MR and PP alone (Egstrom, 1964; McBride & Rothstein, 1979; Oxendine, 1969; Samuels, Note 1). These studies follow the suggestions of Richardson's (1967a, b) summaries which report that MR is most effective when combined with PP.

Egstrom (1964) reported that MR could be most useful if done in successive MR/PPMR/PP trials. McBride and Rothstein (1979) substantiate this finding in their study which alternated MR/PP combined in a series of trials and showed improved performance in both of their open and closed skill areas.

Oxendine (1969) undertook the most exhaustive study of proportions of MR/PP noted in the literature. He varied the proportions of time spent in MR/PP according to the following schedules: Group 1 - 8 trials overt PP, 0 trials MR; Group 2 - 6 trials overt PP, 2 trials MR; Group 3 - 4 trials overt PP, 4 trials MR; and Group 4 - 2 trials overt PP, 6 trials MR. Oxendine (1969) suggests that as much as a 1:1 proportion of combined MR/PP can be effective to improve performance on a motor task. Oxendine (1969) concludes that further study should be done alternating MR and PP as well as varying the proportions of time spent in each condition.

Clark (1960) noted that it was folly to attempt to accurately evaluate all the variables effecting a motor skill. While the present study does not attempt to do that, it is suggested that

many of the techniques reported by other investigators, many conclusions drawn about MR from the literature, many suggestions for future study, and many conceptual issues will be incorporated into the present study. A summary of these factors to be included in the present study follows.

Summary of theory, empirical findings and conceptual issues.

The literature of MR presents many complex findings. For purposes of clarity, summarizing the relevant and significant findings which pertain to the present study must be reviewed.

1. The phenomenon of MR is acknowledged as a real psychological issue as evidenced by fifty years of study and reports in the psychological literature.
2. Investigators have suggested that MR merits further study.
3. An agreed upon theoretical position has not been advanced for MR; however, characteristics of MR and its uses in learning, behavior analysis, psychotherapy, and sports suggest that it may fall within a Cognitive Behavioral framework.
4. Numerous experiments have found MR to be an effective method of learning and improving performance on motor skills using a variety of measurement tasks.
5. In early MR research a general design method had been used which compared MR to PP and NP.
6. Reports in the early literature generally support that of previously mentioned groups: MR showed more improvement than NP, but less improvement than PP.
7. In later MR research it was suggested that MR was most effective when paired with PP.
8. In later MR reports appearing in the literature some

conflict existed as to whether PP continued to demonstrate the greatest improvement in performance, or if MR/PP was superior to actual PP.

9. The present study suggests that there are conceptual and definitional issues present in the MR literature which relate to cognitive response variables, motor response variables, and cognitive-motor response variables combined.

10. Cognitive response variables of relaxation prior to MR, instructed MR to help subjects rehearse, five minute sessions so as to avoid subjects' distraction, and creation of an Interference mental rehearsal (I) group to be included in experiments have been suggested for future research.

11. Motor response variables present conceptual and definitional problems as there have not been operational definitions for such areas as simple versus complex tasks, fine versus gross motor skills, familiar versus unfamiliar tasks, and open versus closed tasks. This has made clarification of aspects of the effectiveness of MR complex and unclear.

12. Novel tasks of varying complexity utilizing different skills, and ones not advantageous to any particular subject group have been suggested for future MR research.

13. A cognitive-motor response variable, that of schedules combining MR/PP has been reported to enhance the effectiveness of MR. Indications are that further research is needed in comparing MR/PP to PP, MR, and NP.

In summary, each of the preceeding considerations were incorporated into the present study.

Report of Pilot Study. A pilot study was conducted to

examine some of the major effects of MR as reported in the literature. This study was conducted: to test the effectiveness of MR as a means to improve performance on a motor task; to test the hypothesis that a group using MR would improve their performance on a motor task more effectively than a group in condition I, but less effectively than a group using PP; to test the novel measurement device (a hand-held, video computer game which is used in the present study); to evaluate the experimental design and procedures to be used in the present study; and to familiarize this investigator with aspects of conducting independent research prior to proposing this thesis.

Method.

Subjects. The subjects were 10 female and 8 male (N=18) college students in an upper division psychology course taught by the experimenter. Participation was voluntary, and extra credit was given for participation. All subjects were inexperienced video game players, played video games less than once weekly, and had never played the game used as the measurement device.

Apparatus. The apparatus used in this experiment was a Cosmic Fire-Away hand-held video computer game manufactured by the Tandy Corporation and sold by Radio Shack Electronics. The object of the game can best be described by reviewing the specification sheets which appear in the Appendix. The level of difficulty was set at level 2, a moderate playing speed, yet difficult enough to be challenging to the subjects. Timing for the experiment was done with a Casio F-83 Chronograph.

Procedure. The subjects were randomly assigned to one of three groups (N=6). The groups were PP, MR, and I. Individual

subjects were tested in the experimenter's office. A script was used to maintain consistency, uniformity of instruction, directions, and presentation by the experimenter.

Subjects were informed that this was a study to examine performance variables in video game play. They were given the directions for the experimental period, and no discussion of the experiment occurred until it had been completed. Subjects were not informed of the other experimental groups. The study was approved by the chairman of the Human Subjects Research Review Committee.

All three groups played the game for a five minute period. This was done to familiarize the subjects with the particular task. This also served as the baseline scoring period. The video game ceases to function at the conclusion of a game, or when the computer has destroyed the subjects' rockets and won the game. Therefore, many scores were obtained for each subject during this initial period. The experimenter recorded the subjects' scores at the conclusion of each game during the five minute period. The mean score served as the subject's pre-test score.

Subjects in the PP group continued to play the game for two more five minute periods interrupted by a one minute rest period between trials.

Subjects in the MR and I groups received the treatment condition during the second five minute period. Following a one minute rest period between trials, subjects in both groups were given an abbreviated one minute course of muscle relaxation; they were instructed to tense and relax muscles below, then above the waist, stabilize breathing with deep breaths and to relax.

Subjects in the MR group were read a set of scripted

instructions asking them to visualize the video game, imagine themselves playing the game, and strive to improve their score. They were asked to imagine the sight, sound, movement, colors, and overall stimuli of the game. Should a game end in their imagination, they were instructed to reset the game and continue playing. The MR was done for four minutes.

Following a one minute rest period, subjects in the I group were given the same abbreviated one minute of relaxation. They were then read a set of scripted instructions asking them to visualize themselves in a beach scene, picturing themselves lying on a beach and relaxing. They were asked to imagine the sight, sound, movement, colors and overall stimuli of the beach. The I was done for four minutes.

Following another one minute rest period between the treatment condition and the post-test, subjects again played the game for five minutes, having been instructed to try to obtain their best score. Scores were tabulated as before, and the game was reset if necessary.

All subjects received a one to five minute period of debriefing which included explanations of the procedures and information regarding their group and role in the study. Subjects were asked to self-evaluate their imagery if in the MR or I groups. All subjects reported that it was easy to stay on the rehearsal or interference task. Any subject questions were answered, and they were thanked for participating and dismissed.

Results. Scores for all subjects were totalled and a mean score for trials one and three was calculated. Mean difference scores were calculated between Trial 1 and Trial 3 scores.

The range and SD were also calculated. These data appear in Table I.

An analysis of variance for a randomized block design (Bruning & Kintz, 1975) was calculated to determine if there were any group differences. An $F(2, 15) = 3.94$, $p .05$ was obtained.

T-tests for independent means were calculated between all groups. PP was shown to be significantly more effective than I ($t(10) = 2.68$, $p .05$). MR was compared to PP, and despite a large mean difference score, MR was not shown to be significantly different from PP ($t(10) = 1.18$, $p .10$). This was also the case when comparing MR to I ($t(10) = 1.43$, $p .10$). Because of the lack of statistical significance, the null hypothesis that PP would be superior to MR and that MR would be superior to I could not be rejected. However, consistent with all expectations, PP resulted in the highest mean improvement, followed by MR, and with I demonstrating little or no improvement.

Discussion. The results of this pilot study indicated a mean improvement of scores on the video game task in the PP and MR groups, while the I group demonstrated an actual loss in performance ability as indicated by the lowered mean score.

This study does follow a trend reported throughout the literature. PP did demonstrate the greatest improvement in performance based on mean score, which supports the earlier MR literature. MR following PP also was consistent with trends in the literature. As indicated many times in reports of MR experiments, MR appeared to facilitate improved performance, although not in a statistically significant manner. I decreased in score,

TABLE I
MEAN, SD, AND RANGE OF PILOT DATA

<u>Group</u>	<u>Mean</u>	<u>SD</u>	<u>Range</u>
PP	+180.2	140.8	400.4
MR	+ 88.3	126.8	333.1
I	- 2.5	46.8	232.4

and this might be attributed to the conflicting imagery of the beach scene. Given the limits of the pilot study and the lack of additional comparison groups, it is difficult to make any definitive statements.

While there was a large mean difference in scores between PP and MR, it can be noted that statistically, MR could be said to be equally effective in improving performance as PP.

Despite the lack of statistical significance, this design and experiment merited further study. Additional groups of NP and combined MR/PP should be used. This would extend the pilot study closer toward being consistent with designs noted in the recent MR literature.

The pilot study groups were made up of too few subjects ($N=6$). This needed to be extended to include more subjects, possibly as many as $N=20$ per group.

The range and SD scores indicate a wide variation in individual subject performance. Increasing the number of subjects might serve to better balance the wide range of scores. Both the MR and I groups had subjects with very wide deviations from the mean, and PP had one individual who improved his score by over 400 points.

The measurement device was shown to be adequate both in terms of measurement ease and effectiveness, and in subjects' reports that the device held their interest and made MR easy to perform. The experimental design was basically adequate and the procedures were easily carried out.

Further study should modify the number of subjects, and add a combined MR/PP group as well as an NP group. These modifications were made and incorporated into the thesis experiment.

Summary and Statement of Hypothesis. This thesis will investigate parameters of MR by designing and implementing an experiment which incorporates significant aspects of the MR literature and includes suggestions made by previous researchers in the field of MR.

The dependent variable is improved performance scores in video computer game play. The independent variable is the type of treatment condition: PP, MR/PP, MR, NP, and I.

The hypothesis is that MR facilitates improved performance on video game play. A second hypothesis is that combined MR/PP may demonstrate the greatest improvement in scores. Further, the order of improved scores will be as follows: PP, MR/PP, MR, NP, and I. The experiment was conducted as described in the following sections.

CHAPTER II

METHOD

SUBJECTS

The subjects were 100 voluntary participants from upper and lower division psychology courses at Portland State University. The subject population consisted of 67 females and 33 males between the ages of 18 to 42 years. Experience with video game play ranged from less than once weekly to seven times weekly, however, no subject had ever played the particular measurement device used in this study. In some cases psychology department instructors gave extra credit to experiment participants, so a record was kept of all subjects participating, and a list of these individuals was given to all instructors to insure that participants received credit. This study was approved by the Human Subjects Research Review Committee to insure the protection and safety of the subjects.

APPARATUS

The measurement device for the present experiment was the Cosmic Fire-Away hand-held video computer game used in the pilot study. It is manufactured by Tandy Corporation, and is sold by Radio Shack Electronics stores. The selection of the hand-held video computer game was based on several factors: the game can be described by the measurements of motor response variables of MR tasks as described in the Introduction; it could be placed on the varied continua suggested; it is a novel measurement device to MR experimentation; it provides a multitude of stimuli such as color, sound, movement, speed, and requires different

movement of the right and left hands to successfully play the game; it is self-scoring, terminates play automatically and is equally controlled for all subjects; it is timely in light of recent interest in video computer games; it is easily understood by subjects, and requires only a brief orientation period for subjects to become familiar with it; and, the relevance of using video computer games is further supported in that educators and training instructors have advocated the use of video games to enhance classroom and military learning (Ball & Ball, 1979; Jones, Kennedy, & Bittner, 1981).

The play parameters of the game can be best described by reviewing the specification data which appears in the Appendix. The level of difficulty was set at Level 2, a moderate playing speed, yet difficult enough for it to be challenging to the subjects.

Timing for the experiment was done with a Casio J-100 chronograph.

PROCEDURES

The subjects were randomly assigned to one of five experimental groups. The five experimental conditions were ordered on the data sheets (PP, MR, MR/PP, I, NP), and as subjects came to the experimenter's office they were assigned to an experimental group based upon which condition appeared next on the data sheets. In some cases subjects did not attend at the assigned time, so the next subject to attend received the treatment condition initially assigned to the non-attending subject. The five groups were identified by the experimental condition they received. PP was a physical practice group; MR was a mental rehearsal group;

MR/PP was a mental practice and physical practice group which received equal portions of MR and PP, counter-balanced (10 subjects MR/PP and 10 subjects PP/MR) to control for any ordering effects; I was an interference mental rehearsal group; and NP was a no practice group. Each group consisted of 20 subjects for a total of N=100.

All subjects played the game for five minutes to familiarize themselves with the task. This was Trial 1. Scores were obtained for each game played during this five minute period, and a mean score was determined. This mean score served as the pre-test baseline.

Subjects in the PP group played the game for another five minutes during the intervention phase (Trial 2). Scores were obtained, but were not used.

Subjects in the MR, MR/PP, and I groups received the treatment conditions. All subjects in these groups were given a one minute abbreviated relaxation period. The script for this instructed relaxation can be reviewed in the Appendix. The MR subjects were then instructed from the script to visualize the game in their imagination, and to imagine themselves playing it. They did this for the remaining four minutes of the treatment condition. The subjects in the MR/PP group did both MR and PP for a two minute period each. Whether MR or PP was done first depended upon counter-balancing. Subjects assigned to the MR/PP counter-balanced group relaxed, did mental rehearsal for two minutes, and played the game for two minutes; subjects in the PP/MR condition played the game for two minutes, relaxed for one minute, and then mentally

rehearsed for two minutes. Scores were obtained for the physical practice period, but were not used. Subjects in the I group relaxed, were instructed to visualize themselves on their favorite beach, and to imagine themselves in the beach scene. The script for this I can be reviewed in the Appendix. These subjects did this mental rehearsal for four minutes of the treatment condition.

The subjects in the NP group were given a video game catalog and instructed to read the game descriptions. They were asked to circle games they might like to play on a corresponding page. They did this for the five minutes of the treatment condition.

All subjects then played the video game for a final five minute period. Scores were obtained and a mean score was calculated. This mean score served as the post-test performance measure. This final five minute period was Trial 3.

A sample data sheet as used to record subject information and scores appears in the Appendix.

The entire study was conducted over a period of two weeks. Each subject completed their participation in the study over a twenty minute period. All subjects were tested in the experimenter's office. Upon completion of the experiment, all subjects were explained their role in the study, the nature of the study, and were further debriefed. Subjects' questions were answered, they were thanked for their participation and were dismissed.

DATA ANALYSIS

It was hypothesized in this study that MR would facilitate improved performance scores in video computer game play. A secondary hypothesis which was suggested by some reports in the

literature, was that MR/PP combined might demonstrate the greatest improvement in scores. It was further hypothesized that the order of improvement scores from greatest to least improvement would be as follows: PP, MR/PP, MR, NP, and I.

The data analysis consisted of first gathering then totaling the scores for Trials 1 and 3. A mean score for each Trial was then calculated. A difference score between Trials 1 and 3 was determined, and this score demonstrated either a performance increase or decrease after Trial 2 or the intervention phase. The mean increase or decrease was then converted to a percent score.

As subjects served as their own controls, a series of t-tests for related measures was calculated to examine if significant improvement occurred after Trial 2 (Bruning & Kintz, 1977).

An analysis of variance for completely randomized design (Bruning & Kintz, 1977) was done to examine between group differences.

Further, t-tests for independent measures were to be conducted between treatment groups should the analysis of variance have demonstrated between group differences. This did not occur; t-tests were not indicated as the analysis of variance demonstrated no significant differences among the treatment conditions.

Further data analysis was done to examine aspects of sex differences, video game experience, age, and a time of play variable.

The data analysis as described above is reviewed in the Results section.

CHAPTER III

RESULTS

The scores obtained in Trials 1 and 3 were totalled and a mean score calculated for each subject in each Trial. A mean difference score illustrating either an increase or decrease in performance was obtained for each subject. The mean increase or decrease was then converted to a percent score. The mean point and percent scores were totalled and a group mean calculated for each of the five treatment groups. T-tests for related measures were conducted for each group to determine if statistically significant improvement in group performance scores occurred after Trial 2. All groups demonstrated a statistically significant improvement between Trial 1 and Trial 3 scores. These data appear in Table II along with range and SD scores.

An analysis of variance for completely randomized design was calculated to examine within and between group differences. It was determined that no statistically significant differences between groups occurred ($F(4, 95) = 1.81, p > .20$). The analysis of variance results appear in Table III.

It was proposed that t-tests for independent means would be calculated to determine if statistically significant differences occurred between experimental groups. The results of the analysis of variance indicated this was not necessary. A single t-test for independent means was done comparing the two groups demonstrating the greatest mean differences: PP and I. No significant difference resulted ($t(38) = 1.88, p > .10$). It was therefore concluded that since no statistically significant differences occurred between the groups with the greatest mean difference,

TABLE II

MEAN T₁, T₃, AND IMPROVEMENT, RANGE, SD, AND
MEAN % IMPROVEMENT WITH $\bar{T}$ AND $\bar{P}$ STATISTIC

GROUP	m T ₁	m T ₃	m Imp.	Range	SD	m % Imp.	t	p
PP	229.8	308.3	78.5	619.2	108.1	74	3.75	<.01
MR	238.5	399.6	161.2	386.9	96.6	91	6.85	<.001
MR/PP	184.9	343.1	158.1	378.7	92.5	125	6.65	<.001
I	202.2	378.3	176.1	523.9	136.5	143	5.46	<.001
NP	162.9	289.8	126.9	543.9	118.9	82	4.77	<.001

TABLE III

ANALYSIS OF VARIANCE - COMPLETELY RANDOMIZED DESIGN

Source	SS	df	ms	F	p
Total	984831.0	99	—	—	—
Between group	68951.7	4	17462.9	1.81	>.20
Within group	914979.3	95	9631.4	—	—

no further t-tests were necessary.

From these data it can be determined that while the performance scores of all groups improved after the Trial 2 phase, none of the five groups demonstrated a statistically significant improvement when compared to the other groups. While the mean percent improvement scores indicated that MR improved performance, so did all the other groups (MR/PP, I, NP, and PP). The null hypothesis could not be rejected.

The secondary hypothesis that MR/PP combined might demonstrate the greatest improvement in mean score was not supported. Rank ordering of the groups by mean percent improvement scores from greatest to least indicated that I improved more than MR/PP (I = 143% improvement and MR/PP = 125% improvement).

A further hypothesis that if MR/PP did not demonstrate greatest improvement the order would be PP, MR/PP, MR, NP, and I was also not supported. The rank ordering showed that the groups improved as follows: I, MR/PP, MR, NP, and PP.

With the exception that MR did improve performance on video computer game play as indicated by mean percent improvement scores (as did all other groups), the lack of statistical significance does not support any of the three proposed hypotheses.

Additionally, the data for the MR/PP group was examined. In this group subjects had been counter-balanced to control for possible ordering effects of MR/PP. Subjects who received MR/PP improved a mean percent of 120, and subjects who received PP/MR improved a mean percent of 129. This 9% difference was not statistically significant. No ordering effect occurred in this group.

The mixed and atypical results of the initial data analysis required that some further aspects of the data be examined.

Sex differences. A mean percent improvement score was calculated for males and females ($N=33$ and $N=67$ respectively). Males demonstrated an improvement of 104% and females demonstrated an improvement of 102% across all groups. The results of these mean scores when examined by a t-test for independent means showed no significant difference ($t(98) = .05, p > .20$).

Mean percent improvement scores for males and females were calculated for each of the five treatment conditions. As indicated in Table IV, males demonstrated the greater mean percent improvement in the PP, MR/PP, and NP groups, while females demonstrated the greater mean percent improvement in the MR and I groups. The greatest mean difference occurred in the I group, with males improving a mean percent of 59, while females improved a mean percent of 179. This mean difference of 120% was examined with a t-test for independent means, and results indicated no significant difference between improvement scores ($t(18) = 1.87, p > .10$). No further analysis was done as the greatest mean difference was not significant.

Trial 1 mean scores were examined for both sexes to determine if either sex scored higher on the initial trial. The mean starting score for males was 251.6 points, while the mean starting score for females was 179.9 points. A t-test for independent means illustrated no significant difference ($t(98) = 1.94, p > .10$).

No further analysis of sex differences was done.

Video game experience. It was speculated that prior video game experience might affect performance scores on this study, so

TABLE IV
SEX, MEAN % IMPROVEMENT, AND DIFFERENCE
BY TREATMENT GROUP **

Sex	Treatment Group				
	PP	MR	MR/PP	I	NP
Males+	121	89	137	59	116
Females*	58	92	120	179	63
Difference	63+	3*	17+	120*	53+

+ = Most improvement by Males

* = Most improvement by Females

** See text for explanation

data were collected on how frequently subjects played video games on a weekly basis. Two categories were established: less than once weekly and more than once weekly. The range of experience reported by all subjects ($N=100$) was from 0 to 7 times per week; however, by the category system, subjects who played less than once weekly greatly outnumbered the remaining subjects ($N=63$ played less than once weekly, while $N=37$ played once or more weekly). The mean times played per week was 0.8.

Mean percent improvement scores were calculated for both categories. Experienced video game players improved across all treatment conditions by a mean of 82%, while inexperienced players improved a mean of 113%, a mean difference of 31%. This difference was not statistically significant ($t(8) = 2.09, p > .10$).

Further calculations were done to compare experienced players to inexperienced players by treatment group. These data appear in Table V. The greatest difference in mean improvement occurred in the MR/PP group, with inexperienced players improving 154%, and experienced players improving 56%. This 98% difference was statistically significant ($t(18) = 2.45, p < .05$). All other mean differences by group were so low as to not be significant.

It was speculated that experienced video game players would demonstrate a higher starting score than inexperienced players on Trial 1 scores. Experienced players demonstrated a mean starting score of 246.7 points, while inexperienced players scored 180.6. This difference of 66.1 points was not significant ($t(8) = 2.28, p > .10$).

Further examination of video game experience was not done.

Age differences. As a majority of the subject population fell

TABLE V
 EXPERIENCE, MEAN % IMPROVEMENT AND DIFFERENCE
 BY TREATMENT GROUP

Experience	Treatment Group				
	PP	MR	MR/PP	I	NP
Experienced	64	83	56	137	72
Inexperienced*	81	95	154	146	90
Difference	17	12	98	9	12

* Inexperienced players made superior improvement in all groups

below the age of 22 years ($N=67$, 18 to 21 years, and $N=33$, 22 to 42 years) an obvious split is apparent. A coarse analysis of age difference and mean improvement was done. The mean age of all subjects ($N=100$) was 21.9 years.

A mean percent improvement score was calculated for subjects 18 to 21 years of age, and subjects 22 to 42 years of age. The mean percent improvement for these groups was 105% and 98% respectively, a difference of 7%. This difference was not statistically significant. No further analysis of age data was done.

Playing time. A last variable, that of minutes played was examined. Since the PP group was the only one to play for 15 minutes and all others played for 10, the PP scores after 10 minutes of play were examined. Since all other groups (MR, MR/PP, NP, and I) improved significantly over that 10 minutes of play (see Table 2), a mean score for the Trial 2 phase was calculated for PP subjects. As noted in Procedures, these scores were gathered but not used in the initial analysis.

A t-test for related means showed no significant improvement between Trial 1 and Trial 2 in the PP group ($t(18) = 1.96$, $p > .10$). This was different than all other groups after 10 minutes of playing time.

Further, t-tests for independent means were computed. These compared mean percent improvement of PP (50%) to other groups after 10 minutes of playing time. I and MR/PP (the two groups demonstrating the greatest mean percent improvement with 143% and 125% respectively) were shown to have improved significantly more than PP on the time variable ($t(38) = 2.53$, $p < .02$ (I); $t(38) = 2.64$, $p < .02$ (MR/PP)). However, while NP and MR also improved more than

PP after 10 minutes of playing time (82% and 91% respectively) there was no statistically significant difference when compared to PP ($t(38) = 1.45, p > .10$.(NP); $t(38) = 1.60, p > .10$ (MR)).

In summary the data from this experiment yields widely varied and mixed results which are highly atypical of the reports in the MR literature and of the pilot study. The implications of these results will be reviewed in the Discussion.

CHAPTER IV

DISCUSSION

The results of the present study are atypical of reports in the MR literature, do not coincide with the results of the pilot study, and do not support any of the three hypotheses suggested.

The first hypothesis that MR facilitates improved performance on video game play was not supported by the data. While MR did improve performance based upon mean percent improvement scores, these data were not statistically significant. All five of the experimental groups improved their performance significantly between Trial 1 and Trial 3; however, when the groups were compared to each other to determine if any experimental group significantly improved performance, none was shown to be superior. The three groups which received an MR exercise (I, MR/PP, and MR) demonstrated greater mean percent improvement than the groups that did not receive an MR exercise (PP and NP); however, the improvements were not significant. The null hypothesis could not be rejected.

A second hypothesis based on the literature review was that MR/PP might demonstrate the greatest improvement in performance. This was also rejected. The I group showed a greater mean percent improvement than the MR/PP group, although not a statistically significant one.

A final hypothesis that should MR/PP not exceed PP in improving performance, the rank order of improved performance would be PP, MR/PP, MR, NP, and I was also rejected by the data. The rank ordering of the groups from greatest to least mean percent improvement was not as predicted, and I, MR/PP, MR, NP

and PP was the resultant rank order. This final hypothesis was also rejected.

These data, which are in conflict with the literature and with the earlier pilot study, are very atypical. Trends in over 50 years of experimentation on MR have indicated that MR was more effective than NP, but less effective than PP in improving performance (MacKay, 1981). More recent trends have shown MR/PP combined to be more effective than MR alone and possibly as effective as PP in some tasks (Johnson, Note 2; Oxendine, 1969). No reports in the literature reviewed for the present study described results consistent with the data for this study.

The present study attempted to control many variables which the literature suggested were confounded in MR research. Such aspects as limiting MR to five minutes (Johnson, Note 2), relaxation to enhance imagery (Mahoney, 1979; Suinn, 1972, 1977), instructed MR (Johnson, Note 2), combined MR/PP (Egstrom, 1964; McBride & Rothstein, 1979; Oxendine, 1969), a period of practice time to familiarize subjects with the task to be rehearsed (Clark, 1960; Richardson, 1967a, b; Smyth, 1975), and the addition of an Interference mental rehearsal group which rehearsed an unrelated task (Richardson, 1967a; Samuels, Note 1) were incorporated into the present study. The previous researchers had suggested that controlling these methodological inadequacies might result in a clearer understanding of the phenomenon of MR.

In the present study with these variables controlled, results still demonstrate different findings than the literature suggests. Because of these atypical findings, we will discuss these results

in both general and specific areas. The general area will address results which conflict with MR literature, and the specific area, which will be issues pertinent to the present study, may account for some of the unusual findings.

General. Richardson (1967a) suggests that PP demonstrates the greatest improvements in performance followed by MR and NP. In effect, Richardson (1967a) is stating that nothing substitutes for actual physical practice to improve performance on a task. The MR studies reviewed in his report support his finding. The present findings refute that. Of the five experimental groups, PP showed the least mean percent improvement.

A possible explanation of experimental fatigue would seem unlikely due to the brevity of time subjects were involved in the task (15 minutes). Yet when the PP group was compared to the other four groups on the time of play variable, even after 10 minutes of play (comparable to the total playing time of the other four groups) PP had not demonstrated significant improvement in performance. It seems possible that on the video computer game task continued play (PP) might not improve performance to the degree that Richardson (1967a) would suggest.

The I group, while not statistically significantly better than the other groups, did demonstrate the greatest mean percent improvement (143%). It might be suggested that as the PP group demonstrated the least mean percent improvement (74%) while playing almost continuously, and the I group demonstrated the greatest mean percent improvement with the least video game related time, doing a relaxation exercise and imagining something other

than video game play might be the best thing to do if trying to improve performance on this level of task. While this is contrary to what the literature reports about practice being the best to improve performance, it may be that the heightened arousal of continued play, the continual responses to rapidly changing stimuli, and the pace of a video computer game served to diminish performance capability. The rest, relaxation, and even imagery of the computer game might benefit subjects more than continued practice. This might be a tenuous explanation in light of the close mean percent improvement of the MR/PP group (125%), yet that group also relaxed and practiced MR in the Trial 2 phase of the experiment. This aspect might bear further discussion.

Mahoney (1979) in his article about interventions for use in athletic training, suggests that literature has noted that higher arousal interferes with performance involving complex skills, fine muscle movement, steadiness, coordination, and general concentration. Too much arousal, or heightened responsiveness to stimuli has been shown to decrease performance. An intervention strategy for arousal control in athletes has been training in muscle relaxation, breathing, and self-talk; these features, which occur in a portion of the MR process, and have been shown to be successful with athletes, may be analogous to what happened with the groups of subjects in the present study. While not conclusive evidence, the results in the present study might support the data from sports psychology as described by Mahoney (1979).

As there were no sex differences and no age related differences of significance, it would appear that the sex and age of the players do not effect performance improvement across any of the experimental groups. Males and females played equally well; however, males did somewhat better in PP, MR/PP, and NP groups, while females did better in the MR and I groups. Subjects under the age of 22 years played as well as subjects over 22 years of age.

Richardson (1967a) suggested that future research in MR should examine subjects games ability, imagery ability, and motor ability. That suggestion may have relevance to this study since these issues were not addressed in the selection or grouping of subjects in the present study. It is possible that these abilities would have an impact on the results of research which use video computer game tasks.

There are no other general areas of consistency between the reported literature and the present study.

Specific. Chapter I of the present study identified conceptual considerations of the empirical findings in MR research. Three areas of conceptual consideration were reviewed: cognitive response variables (those which involve mental, cognitive, and symbolic rehearsal itself); motor response variables (those tasks used to measure MR effectiveness); and cognitive-motor response variables (those involved in the process of MR from learning, rehearsing, and performing the behavior to measurement of the outcome). The present study suggests that by reviewing some of these considerations, further explanations of

the results may be determined.

Cognitive response variables. Richardson (1967a) suggested, and Samuels (Note 1) incorporated the use of an I group into his study on MR. Unfortunately, his data are not available, and no comments on the impact of the Interference MR group are reported. It is not yet known how this type of group performs on MR tasks, as there is no evidence about their improvement available. The results of the present study are in direct contradiction with the pilot study in which subjects decreased in performance. It is not understood why in the present study such a dramatic reversal would occur when conditions were held constant for both experiments. It would seem that the role of the I group in MR studies is yet to be determined.

Anecdotally, subjects in the present study reported good mental imagery during the MR in Trial 2. Powell (1973) noted that what a subject imagines when doing MR has an impact on the eventual behavioral outcome. Based on the information provided by the subjects in the present study that they viewed themselves successful in beating the machine, and that they were able to maintain their imagery, Powell's (1973) contention would be supported.

Some further issues in cognitive response variables are those of symbolized desired performance outcome (Johnson, Note 2), and familiarity with the task to be rehearsed (Clark, 1960). They will be reviewed in the section on motor response variables, as there may be a relationship between symbolized desired performance and familiarity with the measurement task used to assess MR effectiveness.

Motor response variables. The data and results in the present study are most consistent with the literature of MR that is concerned with the area of motor response variables, or those tasks used to measure MR effectiveness. Unfortunately, as noted in the literature review, this area presents the most conceptual difficulty. There is a lack of operational definitions concerning tasks. Richardson (1967a) noted that investigators have not reported information regarding the reliability or appropriateness of tasks selected to measure MR; however, these investigators have reported on the effectiveness of MR without critically evaluating the tasks used. This makes clear evaluation of findings difficult. Since the area of motor response variables (task) was suggested by the present study to be the most problematic, and since the data in the present study are most consistent with reports in the MR literature related to task problems, it is possible that the present results can be evaluated by more closely reviewing motor response or task variables.

Johnson (Note 2) suggests that for MR to be effective, subjects should be able to symbolize a desired successful performance outcome. It is possible that the video game task itself does not lend a clear successful performance outcome. The highly varied and random configurations of the game may prevent the subject from doing this. While a subject may know that s/he must fire missiles at the invaders while moving the toggle to avoid destruction by the invader's bombs, carrying out these behaviors under the demands of the computer game while in the playing phase of the experiment might be too difficult. While subjects reported

anecdotally that their MR was successful and effective, it is possible that the actual transition from MR to playing did not occur. This successful symbolized performance outcome may be dependent upon a more stable task. This will be addressed later, as these related issues might help to explain the results in the present study.

Investigators have commented on MR effectiveness relative to task simplicity or complexity. Corbin (1967), Mendoza and Wichman (1978), and Phipps and Morehouse (1969) suggest that MR is more effective when used with simple tasks. Smyth (1975) suggested that a complex task be used to measure the effectiveness of MR; one which was novel and had been well thought out by the investigator should be used.

A continuum approach was suggested as a method to assess task complexity. As there are no operational definitions for what makes a task simple or complex, the present study suggested placing tasks along a continuum from simple to complex based on number, kind, range of movement, and the rate of response to stimuli required to successfully complete the task.

It is suggested that the video computer game is a complex task. Other tasks such as mirror drawing, pursuit rotor, and juggling have also been described as complex tasks. Simple tasks have been reported to be basketball free-throws, kicks, and dart throwing. By comparing the video game with previously used tasks along the continuum by the dimensions of number, kind, range of movement, and rate of response to stimuli, it may be established that the video game is in most respects more complex than those

previously used to measure MR. Past literature reports show MR to be less effective with complex tasks. This task may have been too complex to be sensitive to improved performance by MR.

For example, mirror drawing consists of looking into a mirror, placing pencil to paper, moving the hand, and drawing a modeled object (Smyth, 1975). Pursuit rotor tasks consist of holding the wand, attempting to place the stylus tip on the dot on the revolving turntable, and keeping pace (with the stylus tip on the dot) as the turntable rotates. (Smyth, 1975). Juggling tasks (Corbin, 1967) consist of constant movement of the head, arms, and hands, a much wider range of movement, and faster responses to stimuli to perform the task successfully than do mirror drawing or pursuit rotor. It is suggested that juggling would be more complex than mirror drawing or pursuit rotor, and that when placed along the continuum of features mentioned above, would be closer to complex, with pursuit rotor and mirror drawing moving toward simple respectively. A task such as dart throwing would be very close to simple, and Mendoza and Wichman (1978) have called their dart throwing task a simple one.

Corbin (1967) reported that covert rehearsal (MR) was not effective in facilitating development of skilled performance within the conditions of his juggling experiment. Corbin (1967) suggests that task complexity (juggling) and difficulty might relate to the effectiveness of MR. Smyth (1975) also reported that MR was effective only with one group on her mirror drawing task, and not effective in the pursuit rotor one. All of these reports suggest that on tasks which are complex MR may not be an

effective way to improve performance.

The video computer game task would be placed along the continuum between pursuit rotor and juggling. The video game task in the present study consisted of multiple movements (both in number and kind) of both hands (right thumb pressing down a button; left thumb controlling a toggle laterally), and while the range of movement is limited, the rate of responding to stimuli (both visual and motor) is continuous. Based on the operational criteria, the task would seemingly be more complex than mirror drawing and pursuit rotor, but less complex than juggling. Since mirror drawing, pursuit rotor, juggling, and this hand-held video game have not demonstrated significant improvement with MR, it might be said that this video computer game falls within a group of complex tasks which may not be receptive to MR for improved performance. It must be noted however, that both MR/PP and MR groups did demonstrate mean percent improvement scores of 125% and 91% respectively, more than NP or PP (82% and 74% respectively), and although not significant, it is still conceivable that under appropriate conditions MR might be effective at improving performance on complex tasks. Task complexity is an area that should be investigated further.

A method to do this given the same video computer game task, might be to break the task into two parts: firing missiles and avoiding invader's bombs. Subjects might first mentally rehearse avoidance maneuvers, and then actually play the game to avoid bombs. Later, subjects might mentally rehearse launching missiles, then play the game and launch missiles. Breaking down complex

tasks into component parts, much like the Behavioral concept of successive approximation to learn a complex behavior chain, might be improved by MR first in parts, then assimilated into the whole of the task. The findings of this study suggest further research in this area.

There are two areas of concern relative to the issue of task familiarity and the present study.

First, there is the issue of experiment-specific task familiarity, or how much time a subject spends with a task to become familiar with it prior to MR. This is not of major concern or importance here; however, it can be noted that since no subject had played the video game which served as the measurement device, the experiment-specific familiarity was held constant. It appears that the five-minute Trial 1 period was adequate to familiarize subjects with the parameters of play. That a familiarization period for subjects to learn the task is necessary is well documented in the literature (MacKay, 1981; Richardson, 1967a; Smyth, 1975) and supported by the present study.

All groups appeared to have adequately learned the task as evidenced by the statistically significant mean improvement in performance between Trials 1 and 3. These data support that an experiment-specific familiarity is required in studies of MR which utilize PP, MR/PP, MR, and NP groups.

Second, there is the area of overall familiarity. The results of the present study indicate that experienced video game players (those playing more than once weekly) improved a mean of 82% across all experimental conditions, while inexperienced

video game players (those playing less than once weekly) improved a mean of 113%. While not a statistically significant difference (31%) these data support an important contention by Clark (1960) that subjects who are experienced or familiar with a task will improve less than naive or inexperienced subjects. As applied to MR specifically, this contention (Clark, 1960) was supported by only one of the groups using MR; that of MR/PP which combined two minutes of PP with two minutes of MR. In this group inexperienced players improved 154% as compared with experienced ones who improved 56%. This 98% difference was statistically significant. However, the other groups using MR and relaxation (MR and I) only demonstrated improvements of 12% and 9% respectively. If Clark's (1960) contentions were completely supported, the MR group should have shown greater improvement than it did. This did not occur.

While experienced players had higher starting scores in Trial 1 than did inexperienced players (a mean difference of 66.1 points), the higher score was not significant. MR or MR/PP did not affect overall performance when compared to the other treatment groups.

What can be said about these data as applied to overall task familiarity is that combined MR/PP is effective for improving the performance of inexperienced subjects as indicated by the present study. That MR/PP or MR alone was not as effective in subjects who were experienced with video game play supports the reports of Clark (1960), Johnson (Note 2), and Smyth (1975).

That MR/PP is the most efficient use of MR to improve performance has been supported throughout the literature (Egstrom,

1964; MacKay, 1981; McBride & Rothstein, 1979; Oxendine, 1969; Richardson, 1967a; Samuels, Note 1). This contention is strongly supported by the present study as MR/PP combined demonstrated a greater mean percent improvement than did MR alone, NP, or PP, despite being less effective than I. The results of the present study are somewhat consistent with the MR literature in this regard.

Another area of conceptual concern and difficulty addressed in the literature review was that of McBride's and Rothstein's (1979) distinction of tasks as open or closed. The motor skills utilized in open tasks are called externally paced, while the skills in closed tasks are called self-paced.

The present study indicated a problem with clearly distinguishing tasks as open or closed based on some of the definitions used by McBride and Rothstein (1979). This contention was that such areas of predictability, stability, and change as determined by McBride and Rothstein (1979) were relative and dependent upon the task used. The present study agreed that pacing (external or self-paced) of the task was an excellent distinction.

Within the context of the results of the present study, both the issues of externally paced or self-paced, and open and closed tasks apply to the video computer game used.

In McBride's and Rothstein's (1979) examples, a basketball free-throw was determined to be a closed skill in that the goal itself is stable, predictable, fixed, and stationary. A pursuit rotor is described as an open task as it is unpredictable, unstable, ever-changing, and requires the anticipation and prediction of a moving object. If the pursuit rotor was placed at

the open end of the continuum (described in the literature review) and the free-throw placed at the closed end, the video game task would be placed toward the open end. It may even be more open than the pursuit rotor. The object of the video computer game is unpredictable as the invader's targets move constantly and prediction is difficult. Because the game is a computer, it is programmed to perform in an erratic manner, hence, the images on the screen are both unstable and ever-changing. Since the targets move and drop bombs which must be avoided, the game requires responding to moving objects and requires anticipation. The video game task is an open one.

McBride and Rothstein (1979) reported that on their tasks (one open and one closed) MR/PP combined demonstrated greater improvement in performance than MR or PP. In all of their experimental conditions these skills were performed less accurately on the open tasks than on the closed tasks.

The results of the present study, while not demonstrating statistically significant results, support McBride and Rothstein (1979). The MR/PP group improved more than MR or PP in the present study on a task which can be called open based on the McBride and Rothstein (1979) criteria.

Second, if the video game task can be called an open skill based on the previous criteria, it would also be called externally paced. As noted earlier (Johnson, Note 2), subjects need to symbolize a desired performance outcome which is successful for MR to be effective. It is possible that in a manner similar to aspects described in simple and complex tasks, the video game is too open (unpredictable, unstable, ever-changing,

and requiring too much anticipation of moving objects) and too externally paced for subjects to symbolize the desired successful performance outcome.

Some examples from the area of sport may more clearly represent this concept. Sports psychology advocates the use of MR to facilitate improved performance on varied skills (Mahoney, 1979; Suinn, 1972, 1977). Dwight Stones, a world class high jumper who consistently jumps 7 feet or better, has utilized MR in over 10 years of competition. By observing Stones and listening to his description of his MR prior to jumping, one can see and understand the use of MR in a somewhat more easily observed setting. Stones mentally rehearses all aspects of his jump; the steps of the approach; the plant of the foot prior to take-off, the take-off itself, and the clearing of the bar, repeatedly, until he has made the jump correctly in his mental rehearsal. He often repeats this procedure until it is absolutely correct, deliberating and rehearsing each portion of his jump until perfect in his imagination. It is this type of symbolized desired successful performance outcome that Johnson (Note 2) might be describing. The high jump task also represents a closed task, as the placement of the bar is predictable, stable, fixed, and does not require anticipation of its moving. As the jumper can set his own pace in the jump itself, the task is self-paced. These considerations suggest a task which is suited for improving performance by use of MR.

By contrast, a soccer move which consists of dribbling a ball with the feet, running, attempting to maintain ball control, avoiding defenders whose goal it is to interrupt progress and break

the play, and eventually setting up a pass or shot is much different than the high jump. Given the speed of the game and the multitude of variables involved, symbolizing a desired performance outcome may occur, however, the nature of the moment in competition may alter the desired outcome at any given time. The game itself is an open task, as the movement of the ball, the field, the defender's position and the activity of the player is constantly unpredictable, unstable, ever-changing, and requiring anticipation. Further, the play of the game is an externally paced situation. These considerations suggest a task which is not well suited to improved performance by MR.

The high jump task could be called a task which constitutes an interaction between an active and a passive process, while the soccer task could be called a task which constitutes an interaction between two active processes. The literature on MR, and the results of the present study would seem to support that MR efficacy is best on a task which is like the high jump and less on a task like the soccer game.

It may be possible that these examples are related to the video game task. The I group with its removal from stimuli, relaxation, and focus on an unrelated task for the use of MR might have sufficiently reduced arousal to improve later performance. The task may not have been suited to the kind of task which is sensitive to improved performance by MR. Unless the task is one which can be self-paced and not so complex as to disrupt successive approximations toward the behavior, in a relatively stable situation, MR may not be effective. This is not without question however. The NP group for example, did not demonstrate a high

mean percent improvement after removal from the stimuli of the game or after completing a self-paced task, but neither did they do MR or relaxation.

The absence of significant results in what seems to be a well controlled study of MR supports MacKay's (1981) observation that interest in MR has waned due to many difficulties in theoretical, conceptual, and methodological issues. The results of this study suggest that before any further conclusions can be drawn about measuring MR, more refined studies with varied and complex tasks must be undertaken. The body of MR literature provides parameters which have been tested and shown to be effective in learning and improving performance, and those should not be overlooked or discarded despite the current limitations and unanswered questions surrounding mental rehearsal.

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APPENDIX A

MODEL CONTINUA FOR MOTOR RESPONSE VARIABLES

Appendix A: Model Continua for Motor Response Variables

Simple versus Complex Continuum

Simple ————— Complex

(Tasks placed based on: number, kind, range, and rate)

Fine versus Gross Continuum

Fine ————— Gross

(Tasks placed based on: body areas used and range of motion)

Familiar versus Unfamiliar Task Continua

Fam. ————— Unfam.

(General)

(Tasks placed based on subjects
general familiarity with task)

Fam. ————— Unfam.

(Experiment-specific)

(Tasks placed based on exp.
time allowed to familiarize)

Open versus Closed Skill Continuum

Open ————— Closed

Unpredictable

Unstable

Ever-changing

Anticip. moving objects

Predictable

Stable

Fixed

Stationary objects

(Tasks placed based on: relatedness to
other MR tasks on the above criteria)

APPENDIX B

VIDEO GAME SPECIFICATIONS AND INSTRUCTIONS

Appendix B: Video game specifications and instructions

Appendix B: Video game specifications and instructions

□ BATTERIES

1. Remove battery compartment cover by sliding in direction of the arrow.
 2. Put in 4 penlight "AA" batteries; observing + and - terminals as indicated. For longest battery life, we recommend using alkaline batteries such as Radio Shack Catalog Number 23-552.
 3. Replace cover.
- * You can use an AC adapter such as Radio Shack's 270-1551 (and thus conserve battery power). Select the plug that will fit into jack and set tip polarity to positive. Connect to the jack on the top of the unit. Connect the other end to a standard AC outlet. When an AC adapter is connected, internal batteries are automatically disconnected.

□ HOW TO PLAY

1. Choose one of the playing speeds (1, 2, 3), slow to fast.
2. Set OFF/ON RESET Switch to ON.
3. Move the missile rudder lever from side to side to aim at invaders or UFOs. The missile station explodes when struck by an invader beam.
4. Time your shots and press missile fire button to shoot at invaders.
5. Cumulative score showing total of invaders and UFOs destroyed is continuously displayed. You score ten points for hitting a UFO and from one to five points for shooting down an Invader (depending on the Invader's position on the screen).
6. Each player has three missile stations. Game ends when all stations are destroyed by invaders, when invaders capture G zone and raise their arms in victory or when you have fired 250 Missiles. The player with the highest score is the winner. If more than one player gets the maximum score of 999 points, the player with the most missile stations remaining is the winner.
7. When you reach 700 points, you'll get an extra Missile station and 50 Missiles.
8. Before playing again, switch OFF power and choose playing speed.

□ MORE FIRE-AWAY GAME IDEAS

1. Set a time limit and compete for the highest score.
2. See how many invaders you can destroy before losing your missile station.
3. See how long you can defend the base before losing your missile station.
4. Team up with a partner. Let him move the missile station lever, while you press the missile fire button.

APPENDIX C

EXPERIMENTAL SCRIPTS

Appendix C

Introduction to Experiment Script - All Groups

Subject enters and is seated. Subject identifying data is gathered.

Experimenter: Thank you for coming. This is an experiment which examines performance variables in video game play. The experiment will take twenty minutes to complete.

You will play this game for five minutes.
Let me show you how it works.

Experimenter demonstrates: Instructions

This switch turns on and re-starts the game.
This toggle controls the movement of the rockets across the surface - left to right and right to left.

This button fires missiles at the invaders above. The invaders drop bombs - the white blips - and if a bomb hits a rocket the rocket is destroyed. The game is over when all the rockets are destroyed. It makes a sound like this.

At that time I will record your score. Just tilt the game slightly, I will record the score, and you re-start the game by switching the reset button.

Any questions?

(Experimenter gives game to Subject)

Subject begins play and Experimenter starts the chronograph.

Subject plays the game for five minutes. Experimenter records scores as they occur.

Experimenter: STOP.

Subject returns the game to the Experimenter.

Experimenter: Take a moment to relax. We will continue shortly.

The above script is used for all subjects participating in the experiment during the Trial 1 phase. This five minute period is to familiarize the subject with the demands of the video game task. At the conclusion of this five minute period, and dependant upon which of the treatment conditions the subject will participate, the Experimenter turns to the next appropriate script.

Appendix C

PP Group Script

Experimenter: You will play the game for another five minute period. During this five minutes do just as you did before. Should all of your rockets be destroyed, just tilt the game slightly so I can record your score.

(Experimenter gives game to Subject)

Subject begins play and Experimenter starts the chronograph.

Subject plays the game for five minutes. Experimenter records scores as they occur.

Experimenter: STOP.

Subject returns the game to the Experimenter.

Experimenter: Take a moment to relax. We will continue shortly.

The above script is used for those subjects assigned to the PP group. During the Trial 2 or Intervention phase of the experiment, PP subjects play the game for a second five minute period. At the conclusion of this five minute period, the Experimenter turns to the Trial 3 script.

Appendix C

MR Group Script

Experimenter: I want you to seat yourself comfortably.
Close your eyes and listen to my directions.
We are going to do a brief relaxation exercise.
Take two deep breaths and let them out slowly.
Now, tense the muscles in your feet, calves,
and thighs. Hold them tightly -- now relax.
Next, tense the muscles in your abdomen, chest,
and arms. Hold them tightly -- now relax.
Next, take two deep breaths and let them out
slowly.
Just relax.

Subject follows Experimenter's instructions and completes relaxation exercise.

Experimenter: Visualize the video game in your hands; your left thumb is on the toggle switch and your right thumb is on the fire button.
Visualize the targets on the screen - moving back and forth, and down, dropping bombs.
Listen to the sound the game makes, while in your imagination you move the toggle to avoid the bombs, and press the fire button to launch missiles at the invaders.
Should all your ships be destroyed, reset the game in your imagination, and continue to play.
Try to make it as realistic as possible in your mind, and concentrate on equalling or bettering your scores from your last few minutes of play.

Subject performs mental rehearsal for four minutes.

Experimenter: STOP.

Experimenter: How was your imagery?

Subject describes imagery to Experimenter.

Experimenter: Take a moment to relax. We will continue shortly.

The above script is used for those subjects assigned to the MR group. During the Trial 2 or Intervention phase of the experiment, MR subjects do relaxation for one minute and MR for four minutes. At the conclusion of this five minute period, the Experimenter turns to the Trial 3 script.

Appendix C

MR/PP Group Script

Depending upon the counter-balance and whether the subject is in MR/PP or PP/MR, this script is read from the appropriate section. This example is for a subject assigned to MR/PP.

Experimenter: I want you to seat yourself comfortably.
Close your eyes and listen to my directions.
We are going to do a brief relaxation exercise.
Take two deep breaths and let them out slowly.
Now, tense the muscles in your feet, calves, and thighs. Hold them tightly -- now relax.
Next, tense the muscles in your abdomen, chest, and arms. Hold them tightly -- now relax.
Next, take two deep breaths and let them out slowly.
Just relax.

Subject follows Experimenter's instructions and completes relaxation exercise.

Experimenter: Visualize the video game in your hands; your left thumb is on the toggle switch and your right thumb is on the fire button.
Visualize the targets on the screen - moving back and forth, and down, dropping bombs.
Listen to the sound the game makes, while in your imagination you move the toggle to avoid the bombs, and press the fire button to launch missiles at the invaders.
Should all your ships be destroyed, reset the game in your imagination, and continue to play.
Try to make it as realistic as possible in your mind, and concentrate on equalling or bettering your scores from your last few minutes of play.

Subject performs mental rehearsal for two minutes.(MR).

Experimenter: STOP.

Experimenter: Now you will play the game for two minutes. Work to get your best score.

Subject plays video computer game for two minutes (PP).

Experimenter: STOP.

Experimenter: Take a moment to relax. We will continue shortly.

The above script is used for those subjects assigned to the MR/PP group. During Trial 2 or Intervention phase of the experiment, MR/PP subjects do relaxation for one minute, do MR for two minutes and do PP for two minutes. As a result of counterbalancing the order of MR/PP, 10 subjects will do PP/relaxation/MR, and 10 subjects will do relaxation/MR/PP. At the conclusion of this five minute period, the Experimenter turns to the Trial 3 script.

Appendix C

I Group Script

Experimenter: I want you to seat yourself comfortably.
Close your eyes and listen to my directions.
We are going to do a brief relaxation exercise.
Take two deep breaths and let them out slowly.
Now, tense the muscles in your feet, calves,
and thighs. Hold them tightly -- now relax.
Next, tense the muscles in your abdomen, chest,
and arms. Hold them tightly -- now relax.
Next, take two deep breaths and let them out
slowly.
Just relax.

Subject follows Experimenter's instructions and completes relaxation exercise.

Experimenter: Imagine you are at your favorite beach.
Visualize it in your mind.
Imagine yourself walking on the beach.
Be aware of your thoughts and feelings.
Look out to the water, see the sky, and
listen to the sounds of people, the roar of
the ocean and the sound of the waves.
Now lie down on the sand in your imagination.
Be aware of how relaxed you are, and how com-
fortable you feel.
Just relax and hold this scene in your imagination
for a few minutes.

Subject performs mental rehearsal for four minutes.

Experimenter: STOP.

Experimenter: How was your imagery?

Subject describes imagery to Experimenter.

Experimenter: Take a moment to relax. We will continue shortly.

The above script is used for those subjects assigned to the I group. During Trial 2 or Intervention phase of the experiment, I subjects do relaxation for one minute and I for four minutes. At the conclusion of this five minute period, the Experimenter turns to the Trial 3 script.

Appendix C

NP Group Script

Experimenter: Here is a catalog which describes video game cartridges for home video systems by Atari, M-Network, Intellivision, and Activision. Would you please take the next few minutes, review the descriptions, and select games that you might like to play at a later time. Please circle the title of the games on this sheet of paper.

(Experimenter gives catalog and sheet to Subject)

Subject begins to examine catalog and Experimenter starts chronograph.

Subject selects games and circles titles for five minutes.

Experimenter: STOP.

Subject returns catalog and sheet to Experimenter.

Experimenter: Take a moment to relax. We will continue shortly.

The above script is used for those subjects assigned to the NP group. During the Trial 2 or Intervention phase of the experiment, NP subjects review the catalog and select game titles. At the conclusion of this five minute period, the Experimenter turns to the Trial 3 script.

APPENDIX D

PARAMETERS OF MENTAL REHEARSAL DATA SHEET

Appendix D

Parameters of Mental Rehearsal Data Sheet

PARAMETERS OF MENTAL REHEARSAL -- DATA SHEET

Subject Name:	Sex:	Age:	Exp. VCG (x's wk.):
Subject No.:			Exp. w/ meas. dev.:

<u>Trial 1</u>	<u>Int.</u>	<u>Trial 3</u>	<u>Mean Scores:</u>
			Trial 1:
			Trial 3:
			Improvement:
			% :

Subject Name:	Sex:	Age:	Exp. VCG (x's wk.):
Subject No.:			Exp. w/ meas. dev.:

<u>Trial 1</u>	<u>Int.</u>	<u>Trial 3</u>	<u>Mean Scores:</u>
			Trial 1:
			Trial 3:
			Improvement:
			%:

Subject Name:	Sex:	Age:	Exp. VCG (x's wk.):
Subject No.:			Exp. w/ meas. dev.:

<u>Trial 1:</u>	<u>Int.</u>	<u>Trial 3</u>	<u>Mean Scores:</u>
			Trial 1:
			Trial 3:
			Improvement:
			%: