Visual imagery and individual differences
by Paul John Chara

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Psychology
Montana State University

Abstract:
With the increased interest directed towards the study of inner experiences by contemporary psychologists, the role of visual imagery in cognitive processes has become the subject of renewed theoretical debate. Unitary theorists downplay the role of the visual image in thought processes, while dual-process theorists assert the importance of visual imagery in cognitive processes. This thesis examines the relationship between individual differences in visual imagery and performance on objective tasks. After a review of the history and varieties of visual imagery, four experiments are described in which performance on a variety of tasks is related to individual differences in the controllability and vividness of visual imagery ability. It is demonstrated that individual differences in visual imagery have important manifestations in the performance of certain tasks. The results are interpreted in terms of a dual-process model. The similarity between visual perception and visual imaging is examined. The nature of, and the benefits of developing and using visual imagery abilities are also discussed.

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PAUL JOHN CHARA, Jr.

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ABSTRACT

With the increased interest directed towards the study of inner experiences by contemporary psychologists, the role of visual imagery in cognitive processes has become the subject of renewed theoretical debate. Unitary theorists downplay the role of the visual image in thought processes, while dual-process theorists assert the importance of visual imagery in cognitive processes. This thesis examines the relationship between individual differences in visual imagery and performance on objective tasks. After a review of the history and varieties of visual imagery, four experiments are described in which performance on a variety of tasks is related to individual differences in the controllability and vividness of visual imagery ability. It is demonstrated that individual differences in visual imagery have important manifestations in the performance of certain tasks. The results are interpreted in terms of a dual-process model. The similarity between visual perception and visual imaging is examined. The nature of, and the benefits of developing and using visual imagery abilities are also discussed.

INTRODUCTION

In recent years, there has been a revival of interest in visual imagery by psychologists. This aspect of the mind was researched vigorously during the era of Structuralist psychologists (c1880-1920) and nearly banished during the era of Behavioristic psychologists (c1920-1960). There is now a climate of thought in the West in which increased interest has been directed towards the study of inner experiences, particularly in relation to individual self-control. Still, even with this recent upsurge in interest in visual imagery, many people continue to deny the usefulness and even the existence of visual imagery. It is perhaps ironic that one of the principal proponents of the cognitive psychology movement, Neisser (1967), said in his book Cognitive Psychology, that it is "...difficult to prove that images serve any immediate practical purpose (p. 156)." In a sense, the study of visual imagery symbolizes the conflict over an issue of central importance to psychologists through the years: Of what importance are subjective phenomena to psychology as a scientific discipline? People often feel they know a great deal about the world beyond their bodies, yet they are often only fleetingly aware of the world within their bodies. The purpose of this thesis is to investigate one component of this inner world, visual imagery.

A Brief History of Visual Imagery

The ability to use "inner vision" has been an integral part of the development of art, religion, philosophy, and psychology through

the ages. Since the time of the cave paintings, one of the first creative human endeavors, man has externalized his inner visions in the form of art. Before such abstract skills as language and mathematics developed, the external world was represented and internalized via visual images. Early religion and philosophy all emphasized the importance of the inner world of visual experiences. Visualization was employed as a tool for growth and rebirth in nearly every ancient culture. According to Samuels and Samuels (1975), ancient Egyptian Hermetic philosophy (the ancestral parent of alchemy) stated that:

> ...images held in the mind affect the physical universe...that thoughts have characteristics similar to the physical world, that thoughts have vibrational and energy levels which bring about changes in the physical universe...(and learning) to control mental images is one method used to produce such transmutations. (p. 21)

The ancient cultures of Mesapotamia externalized their images of gods in sculptures, mosaics and other art forms. Indian yogic practices taught people to concentrate on divine images in order to achieve a desired effect over the mind. The Old Testament of Jews and Christians and the Koran of Moslems contain many examples of the importance inner visual experiences had in shaping the course of history for particular cultures.

Ancient philosophers, influenced by the important role visual imagery played in learning, in memory and mnemonic systems, often equated thought and images. Aristotle and Plato believed that memories were stored in the format of pictorial patterns, the so-called

"wax impression" model of memory (Boring, 1950). Yates (1966) points out that nearly every ancient mnemonic system involved the use of visual imagery. The most familiar of these systems, the "method of loci," involved the association of a number of items to a succession of familiar locations. During recall, the mnemonicist would "mentally walk" past the loci, reconstructing images associated with the specific items along the way. Cicero (Yates, 1966) mentioned that he memorized long speeches by "mentally walking" through his house, each location in the house reminding him of a different section of his speech. Buggie (1974) notes that many theaters constructed during the Renaissance era were decorated with elaborate art work. These decorations were used by actors to help them remember their lines, again through the association of images with a distinctive locus, in this case a particular decoration.

The ancient philosophy of equating images and thoughts gave rise to the development of structuralist psychology in the late 1800's. Titchener, who brought Structuralism to America from Germany, stated that all his knowledge was represented in the form of mental images (Buggie, 1974). This belief that knowledge was largely represented in the mind in the form of images led the Structuralists to base their research on the introspective method, the only known way to study imagery. The Structuralists hoped to reveal basic components of mental processes through introspective analysis. Betts' (1909) "Vividness of

Imagery Scale," which asked for ratings of the vividness of visual, Kinesthetic, and five other types of mental images, is one example of the methodological tools employed by Structuralist investigators. However, a serious problem in the application of the introspective method developed out of the practice of dismissing many introspective reports of individual differences as "observational error," rather than considering differences in underlying mental processes. This problem became magnified as a result of Galton's work with visual imagery (1883, 1907; as cited in his book, Inquiries into Human Faculty, 1928). Speaking of his research, Galton said:

> ...The earliest results of my inquiry amazed me. I had begun by questioning friends in the scientific world, as they were the most likely class of men to give accurate answers concerning this faculty of visualizing...To my astonishment, I found that the great majority of the men of science to whom I first applied protested that mental imagery was unknown to them, and they looked on me as fanciful and fantastic in supposing that the words "mental imagery" really expressed what I believed everybody supposed them to mean. (p. 58)

The magnitude of individual differences reported by Galton (1883, 1907) and other researchers was too great for the Structuralists to attribute to observational error. In addition, the Structuralists believed that poor imagers should be handicapped conceptually because thinking involved the manipulation of images. The results of Galton's (1883, 1907) work showed this notion to be wrong. These problems, the almost total reliance put on the introspective method, and the advent of the Behaviorism in the 1920's caused the downfall of Structuralism and

the closely intertwined concept of visual imagery which was attacked by Watson as "the ghost of sensation" (Watson, 1928). The pendulum had swung the other way; instead of being a central concept in psychology, as it was during the Structuralist era, visual imagery was dismissed by Behaviorists during the era they dominated psychology (1920-1960) as unimportant in the study of behavior. Visual imagery was largely ignored and forgotten for nearly forty years.

Just as Behaviorism developed partly in reaction to Structuralism, the recent cognitive approach developed partly in reaction to the narrowness of the behavioristic point of view. Cognitive psychology has resurrected the study of visual imagery through an approach that emphasizes the study of inner mental processes in an objective and scientific manner. The cognitive psychologist transcends his Structuralist and Behaviorist counterparts in that both subjective data and objective research are deemed as useful and valid.

In 1964, Holt welcomed back visual imagery as an area of psychological study to America in a paper entitled, "Imagery: The Return of the Ostracized." It is interesting to note that visual imagery was revived as an area of scientific pursuit in British Commonwealth countries before being rediscovered in America, a reflection of just how overwhelmingly behaviorist-oriented American psychology had become.

Varieties of Visual Imagery

Through the years, a great deal of work has been spent cataloging and categorizing visual imagery experiences. Today, psychologists distinguish between several classes of visual imagery phenomena. Visual memory imagery (VMI) is the most common type of inner visual experience. The mental image that accompanies the recall of events from the past (a childhood room), ongoing thought processes (imagining a friend's face while talking over the phone), or even anticipatory actions for the future (a driver anticipates a sharp curve ahead on a familiar road) are all termed memory images. A memory image is defined as "a reconstruction or resurrection of a past perception" (Horowitz, 1970, p. 22). Richardson (1969) adds that memory images usually "refer to particular events or occasions having a personal reference" (p. 93).

Memory images, "typically more like a hazy etching, often incomplete and usually instable, of brief duration and indefinitely localized" (Richardson, 1969, p. 43), are usually described in two dimensions: vividness and controllability. Vividness refers to how closely the visual image resembles the actual stimulus percept. Controllability refers to the level of efficiency that the imager attains in manipulating, changing or summoning the memory image. Individual differences in the ability to control memory images and the degree of vividness that accompanies memory images have important consequences for a number of behavioral functions. This fact will be dealt with in

greater detail later on. VMI is the basic rudiment of most kinds of inner visual experiences.

An eidetic image is essentially a vivid form of memory image that persists for relatively long durations. As opposed to the memory image, the eidetic image is never localized in the head. It is "seen" in much the same sense as a percept. People possessing eidetic imagery are commonly referred to as demonstrating a "photographic memory." Most of the early work done on eidetic imagery occurred in Germany. Purkinje is recognized (Richardson, 1969, p. 29) as the first person to give a careful description of the phenomenon in 1819. The German psychologist, Jaensch, is credited with coining the term "eidetic" (from the Greek "eidos"--that which is seen) in 1909 (Richardson, p. 29).

An important discovery concerning eidetic imagery that is relevant to all forms of visual imagery was reported in 1907 by Urbantschitsch (cited in Richardson, 1969) and since confirmed by other psychologists (Doob, 1964, 1965). Eidetic imagery is found most frequently in children, less frequently in adolescents, and even less in adults. According to Samuels and Samuels (1975):

> ...Child development researchers believe eidetic imagery is an an underlying phenomenon of the learning process and tends to diminish in adolescence--when abstract thought and higher verbal skills develop. (p. 43)

Instead of storing perceptual experiences in images, we are taught to categorize and label them. While labeling is certainly a more

economical means of storing perceptual experiences, it is a shame that an alternative means of storage is largely ignored.

After-imagery, a common type of visual imagery, is the type most dependent on the manner and conditions of sensory stimulation. An after-image is most likely to occur when the perceptual stimulus is of high intensity, brief duration and is projected upon a relatively dark field. The best example of this is when a bolt of lightening is seen at night. The original image lasts only a few seconds and is soon replaced by its negative after-image. The black and white tones of the original after-image are reversed and the colors of the original after-image are seen in their complimentary colors in the negative after-image. The after-image, unlike memory or eidetic images, cannot be scanned; as the person moves his eyes, the image shifts.

Another common inner visual experience is that of imagination imagery. An imagination image may contain memory images of past perceptions, but the images are arranged in a novel way and are not generally tied to a specific occasion. According to Richardson (1969), "Imagination images tend to be novel, substantial, vividly colored, when in the visual mode, and involve concentrated and quasi-hypnotic attention with inhibition of associations." (p. 94) Unlike memory images, imagination images are usually free of intruding thought.

Although the phenomenon of imagination imagery is relatively familiar, little scientific research in the past has been carried out

in investigation of it. It is likely that in the next few years that research dealing with this type of visual imagery experience will prove most fruitful and lead to great benefits for human development. Imagination imagery has been implicated as a very important factor in problem solving, creativity, healing, and in improving your life-style (see Samuels and Samuels, 1975, for further discussion).

There are several other kinds of visual imagery phenomena that share a common link--the visual image--but are distinguished by the antecedent conditions that give rise to them. Dreams, daydreams, and fantasy contain varying amounts of memory and imagination images but often introduce a time factor; they deal with a series of images taking place in chronological order. Often a person cannot distinguish between reality and these inner visual experiences. Twilight state imagery, hypnogogic when it occurs preceding sleep and hypnopompic when it occurs just after sleep before being fully awake, is closely related to dreams, daydreams and fantasy in that the images "tend to be vivid, detailed, and beyond the reach of conscious control" (Samuels and Samuels, 1975, p. 47). However, people generally know they are internal and rarely mistake them for events in the external world.

Hallucinations or visions are usually vivid visual images in which a person believes an image he sees is external to himself. There are many different antecedent conditions that can give rise to this form of visual imagery. Among these conditions are: praying or

meditation; hallucinogenic drugs; sleep or food deprivation; sensory deprivation; fever; boring or repetitive situations; and slow, rhythmic stimulation of various senses (flashing lights, electric pulse current, "beeping" sounds, etc.). It seems that many occurrences which result in a deviation of the normal stream of consciousness may provide a fecund condition for the development of this form of visual imagery.

A final form of visual imagery is the recurrent image. A person who spends a prolonged amount of time staring at a certain object or scene often has an image of that object or scene recur in his mind at a later time. The appearance and disappearance of the recurrent image is usually out of conscious control by the person.

While psychologists have found the above divisions of visual imagery useful, the distinction between one form of visual imagery and another is somewhat arbitrary. For instance, a dream often contains memory and imagination images. Some psychologists such as Richardson combine dreams, hallucinations and other more spontaneous forms of imagery under the general heading of imagination imagery. However, since all the varieties of visual imagery do differ in specific ways it is useful to discriminate between them on that basis. An interesting way to consider visual imagery varieties is to view the different experiences as a continuum going from those experiences most dependent on or close to the perceptual stimulus to those farthest removed from the stimulus percept. This continuum would go from after-imagery,

eidetic imagery, and memory imagery to imagination imagery, dream-like imagery and hallucinogenic-like imagery.

The Nature of the Visual Memory Image

When talking about imagery the most obvious question to be asked is: What is an image? The subjective impression of many would be that it is a mental photograph. Intuitively, however, it makes little sense that the brain would store an infinite number of "photographs." So, the question remains: How are visual events stored in memory? This question leads to an old controversy (for a review see Paivio, 1971) in psychology, the image/no-image question, that is still a hot topic of debate. Currently there are two main types of theories concerning the nature of visual memory images. Unitary theories state that visual imagery and verbal processes are essentially the same form of representing information (the no-image side). Conversely, dual-system theories hold that there are two basic ways of representing information in memory, through either verbal or imaginal representation (the image side). These two theories will be discussed below.

Unitary theories of visual memory representation. Psychologists adhering to the unitary point of view argue that visual memories are "essentially conceptual and propositional, rather than sensory or pictorial in nature" and that, "Such representations are more accurately referred to as symbolic descriptions than as images in the usual sense" (Pylyshyn, 1973). Anderson and Bower (1973) agree with Pylyshyn and

argue that what people call images do not differ from verbal memories. In their Human Associative Memory model they advocate that all memories, visual or verbal, are represented in LTM as propositions which are abstract structures made up of related concepts, much like a linguistic tree. These propositional configurations can account for the representation of both words and pictures. Therefore, there is no need for separate internal memory codes for verbal and visual stimuli.

In his recent book, Cognition and Reality, Neisser (1976) states that: "Images are not pictures in the head, but plans for obtaining information from potential environments" (p. 131). Neisser (1976) believes that imagining is the "anticipatory phases" of perceptual activity. In other words, images are, "plans for obtaining information from potential environments...anticipations rather than pictures" (p. 131-132). According to Neisser (1976), an image is actually just a perceptual set, no more than perceptual readiness.

Be it Anderson and Bower's (1973) propositional configurations, Neisser's (1976) "anticipatory phases," or any other type of conceptual description (see Pylyshyn, 1973, for a review), the image, per se, is not an image in the true sense of the word to unitary theorists. What is called the image, the verbal trace, or whatever, is more or less one in the same, in their point of view. By whatever means, visual representations are stored very much in the same way as verbal representations in LTM.

The dual-system theory and visual memory representation. The foremost proponent of the dual-system theory is Paivio (1969, 1971). Essentially, the dual-system assumes that there are two basic ways of representing knowledge in memory; one a verbal or linguistic representation, the other a nonverbal or imaginal representation. Paivio (1969, 1971) states that the verbal system deals better with linguistic, abstract entities while, conversely, the imaginal system deals better with picturable, concrete entities. One implication of this theory is that information that can be held in both the verbal and imaginal systems should be more easily retrived than information held in just one system because there should be twice as much information about it. Thus, the recall of lists of abstract words (such as "thought"), which can be represented only in the verbal system, should not be as great as recall of lists of concrete words (such as "dog"), which can be represented by either system. Numerous studies (e.g., Gorman, 1961; Paivio & Csapo, 1969; Bower, 1972) have supported this contention. Paivio's book, Imagery and Verbal Processes (1971), provides a compedium of research studies that indicate that there are two, not one, representation systems.

The Individual Differences Approach to the Study of VMI

One basic difference between unitary and dual-system theories of visual memory representation concerns the phenomenal similarity between visual perception and visual imagery. According to a unitary viewpoint,

visual imagining is no more phenomenally similar to visual perceiving than verbal processing. On the other hand, most dual-system theorists would hold that visual imaging is more phenomenally similar to visual perceiving than verbal processing. Investigation of the relationship between visual imagery and visual perception is therefore a crucial factor to consider in debating the merits of either of the theories.

Several studies investigating this relationship have indicated that perceptual and imaginal operations do share many of the same components. In fact, the pathways are so similar that the two operations sometimes occur together or interfere with each other. Segal and Nathan (1964) found that sometimes a person whose eyes are opened can superimpose a memory image upon a perceptual stimulus so clearly that the memory image can distort or even blot out the external stimulus. Brooks (1968) demonstrated that examining a visual image interfered more with looking at an object than examining a verbal image. It has also been found that during the scanning of visual images there are corresponding eye movements (Roffwarg, Dement, Muzio & Fisher, 1962; Richardson, 1969).

If, as the research indicates, VMI is the phenomenal reflection of some perceptual operations, then one would expect people with good VMI to perform better on tasks in which these operations are important than people with poor VMI. Futhermore, such differences in performance of individuals selected on the basis of VMI abilities would indicate

the presence of a form of visual imagery that at least partly uses the same physical components involved in visual perception. Evidence of this nature would fit favorably into the framework of a dual-system theory. Conversely, such evidence seems at variance with a unitary viewpoint.

The purpose of the present research was two-fold: (1) To compare the performance of good and poor visual memory imagers on a variety of tasks in order to demonstrate the important role of VMI in certain cognitive operations, and (2) To investigate further the nature of individual differences in VMI. The general approach in all of the experiments was the same: in all four experiments a large group of students were given specific phenomenal report questionaires on VMI. Students who reported the best VMI and students who reported the worst VMI on these questionnaires were then selected as good and poor visual imagers, respectively, and compared on performance on a specific measure.

The Experiments

Students in Experiment 1 were tested for vividness of kinesthetic imagery and VMI on the Sheehan short form of the Betts vividness of imagery scale (in the form that appears in Richardson, 1969), and controllability of VMI on the Gordon (1949) test of visual imagery control. Good and poor imagers, selected on the basis of their responses to the questionnaires, were then given a mental practice task

to perform. Mental practice (MP) refers to the act of imagining a physical skill without the accompaniment of any gross muscular movements. Half of the subjects were instructed to mentally practice a ball-throwing task in between actual throwing trials, while the other half were given a distracting task (designed to prevent MP) in between trials. The results indicated an important correlation between VMI and performance on a task under conditions of MP.

Experiment 2 was essentially a replication of Experiment 1 with several methodological changes. Among the more important changes were: the number of subjects was doubled, MP sessions were modified, and experimental sessions were lengthened. In addition, the Marks (1973) test of vividness was substituted for the ten vividness items of the Betts scale used in Experiment 1. The results demonstrated the importance of VMI in facilitating effects of MP, adding further support to the conclusions of Experiment 1.

Experiment 3 was an attempt to find a relationship between the degree of development of VMI and differences in cognitive mode. In other words, could differences in the ability to use VMI be an indicator of whether a person could be described as right or left hemisphere oriented? Good and poor imagers took a 22-item preferences questionnaire and the MSC Knowledge Interest Test. While there were some significant differences between good and poor imagers on specific items, there were greater differences between males and females. The results

were equivocal at best, and suggested that methodological changes be made.

Experiment 4 was partitioned into two sections. In the first section students were given a four-part imagery questionnaire consisting of the Betts vividness scales of VMI and kinesthetic imagery, the Gordon test of VMI control, and a test of kinesthetic imagery control developed by the author. The purpose of giving the four-part questionnaire was to investigate the interrelationships between vividness and controllability of VMI and vividness and controllability of kinesthetic imagery. The most interesting revelation of the matrix of correlations between the four separate tests was that while vividness of kinesthetic imagery was significantly correlated with controllability of VMI, vividness of VMI was not, indicating that kinesthetic imagery plays a more important role in good controllability of VMI than vividness of VMI.

In the second section, good and poor controllers of VMI and kinesthetic imagery, selected on the basis of their scores on the questionnaire, were given the Space Relations sub-test of the Differential Aptitude Tests, Form T (The Psychological Corporation, 1973). Good male controllers of VMI and Kinesthetic imagery performed better on the test than poor male controllers, while no significant difference was found between good and poor female controllers of VMI and kinesthetic imagery.

EXPERIMENT 1

In recent years, many studies have been done by psychologists on MP, which is often used as a training method in athletics and requires the practitioner to imagine the performance of a perceptual-motor skill. While many studies have attested to its facilitating effects in improving the performance of a perceptual motor skill (Ulich, 1967; Richardson, 1967a; Simms, 1976), some studies have failed to find a significant effect (Wilson, 1960; Welsey, 1961; Smyth, 1975). According to Richardson (1967b), MP is effective in facilitating the performance of a perceptual-motor skill because during the MP process there is activation of the muscle group patterns actually used in the performance of the specific muscular movements involved in the skill. Thus, through MP a person is not only imagining a movement; he is also facilitating the coordination of the proper neuromuscular patterns. This notion goes back to the work of Jacobson (1932), who demonstrated that when a person imagines a movement, he also activates the specific muscles involved in that movement.

If Richardson is correct, then it seems reasonable to assume that the better a person visualizes during MP, the more benefit he will get from MP. We thus have an ideal situation for applying the individual differences approach to the study of VMI. Good visual imagers should benefit more from MP than poor visual imagers. The present study was designed to compare the amount of improvement of good and poor imagers on the performance of a perceptual motor task under

conditions of MP. If good visual imagers benefit more from MP than poor visual imagers, then it would be reasonable to assume that some of the equivocal results of some MP studies may be due, at least in part, to individual VMI differences. Furthermore, this finding would demonstrate the importance of VMI and suggest that VMI questionnaires are valid measures of VMI abilities.

Method

Tests. Three imagery questionnaires were used: the Gordon (1949) test of VMI control (Appendix A); and the kinesthetic and visual portions of the Sheehan shortened form of the Betts Questionnaire upon Mental Imagery, in the form in which they appear in Richardson's (1969) Mental Imagery (Appendix B).

Subjects. A total of 133 introductory psychology students were administered the imagery tests. Four males and four females who recorded the lowest scores on the two Betts tests ($\bar{x}$ = 13) and the Gordon (1949) test ($\bar{x}$ = 12.5) and four males and four females who recorded the highest scores on the two Betts tests ($\bar{x}$ = 23.1) and the Gordon (1949) test ($\bar{x}$ = 38.1) were selected as good and poor imagers, respectively.

Apparatus. A velcro target board 18 inches in diameter was placed 6.5 feet above the floor on a blank wall. Three velcro balls about 2 inches in diameter when properly thrown at the target by

subjects from a restraining distance of 8 feet, would stick to the target whose bull's eye of 40 points was surrounded by concentric rings worth 30, 20, and 10 points. Two chairs, a desk, four magazines, and the experimenter's recording equipment were the only other objects in the room.

Design and procedure. An equal number of males and females from both imagery groups were assigned to each of two treatment conditions. Four good and four poor visual imagers received MP throughout the experiment, while the remaining subjects received a distracting task (consisting of being asked to read either Penthouse, Viva, or National Lampoon) throughout the experiment to prevent MP.

After being contacted, each subject was taken by the experimenter to the testing room. Each subject was then given the following instructions:

> ...The experiment in which you are about to participate is designed to test the effects of practice on the performance of a perceptual motor task. The task consists of throwing three balls against the target. This experiment is divided into five steps. In the first step you will have two sets of three throws against the target. You are to try and get the highest possible score. The set having the highest total score will be counted. In the second step you will have a two minute period in which you will do the following...

At this point subjects assigned to the MP condition were told:

> ...Have you ever heard of mental practice? It is defined as the process of thinking about the physical practice involved in a skill, or in other words, imagining the performance of that skill. During the two minute periods I want you to conjure up in your mind a visual image of what it is like to perform the ball-throwing

movement necessary to score a bull's eye on the target. Do not accompany the MP with any gross muscular activity such as moving your arm in a throwing motion. Try to find the locus of your imagery; is it in front of your eyes, the back of your head, or someplace else. Try what is best for you. The important thing is that I want you to concentrate as fully as possible during the two minute periods on the mental practice of the ball-throwing task. This is very critical.

Instead of receiving these instructions, subjects assigned to the control (distracting task) conditions were told the following:

...I want you to look at one of these magazines (Penthouse, Viva, and National Lampoon), looking for something that interests you. Try and find something that grabs your attention. (During this period, the experimenter usually talked to subjects about magazine content).

Finally, the following was read to all subjects:

...Steps 3 and 5 will be a repeat of step 1, throwing balls at the target. Step 4 will be a repeat of step 2, the two minute period. In other words, you will have two 2 minute periods and three throwing trials. Please try and do your best; the outcomes of this experiment depend on each subject doing his or her best. Are there any questions?

The set scores during each of the three throwing trials were recorded after each subject had thrown the balls. The highest set score was then recorded for each of the three throwing trials. The subjects were asked for comments on the experiment after all five steps were completed. Session duration with each subject was approximately 12 minutes.

Results

Figure 1 presents the mean score of each of the four groups on each throwing trial.

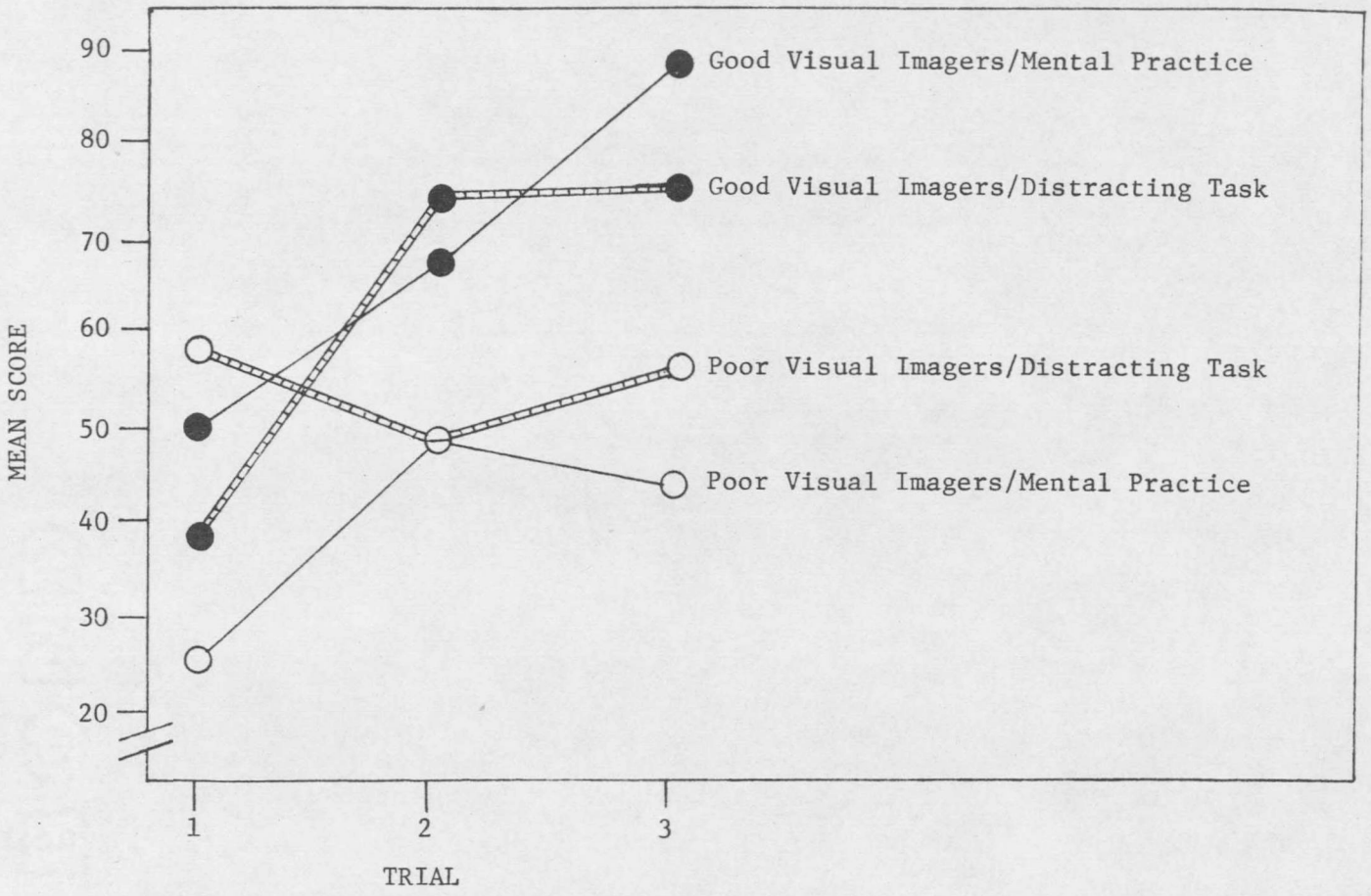

Figure 1. Mean Throwing Scores for Good and Poor Visual Imagers Under Mental Practice and Distracting Task Conditions in Experiment 1.

The data were subjected to an initial analysis of variance using an r(BC)D nested, measurement unreplicated model to test three variables (good vs. poor imagers, MP vs. distracting task, and test trials) and the interactions between them. The main effects of two variables were significant: imagery ability [F (1, 12) = 6.85, p <.05] and test trials [F (1, 12) = 9.04, p <.01]. None of the four interactions between the variables were significant.

Four simple analyses of variance were also performed on the data. While no significant difference was found between the eight good and eight poor imagers on test trial 1 [F (1, 14) = .04, p >.05], a significant difference in performance was found on test trial 3 [F (1, 14) = 10.8, p <.01]. Furthermore, no significant difference in performance was found between the eight good and poor imagers under MP conditions on test trial 1 [F (1, 6) = 2.14, p >.05], while a significant difference in performance was found between good and poor imagers on test trial 3 [F (1, 6) = 7.84, p <.05].

Discussion

The most interesting aspect of these results was that good visual imagers under MP conditions improved twice as much in performance from trial 1 to trial 3 than did poor visual imagers under MP conditions. Good visual imagers showed an average gain of 40 points, while poor visual imagers showed an average gain of 20 points. This

finding strongly indicates that VMI is an important variable in MP effectiveness. Such a difference in performance between good and poor visual imagers also indicates that MP is a task in which individual differences in VMI are likely to be manifested.

In view of these findings, it would appear that an accurate appraisal of VMI ability is an important variable to consider before people are selected for an MP study or training program. In addition, it would appear that questionnaires such as those used in this study, perform a useful function in this capacity.

A puzzling aspect of the results was the large improvement in performance demonstrated by good visual imagers under distracting task conditions. However, nearly all the improvement occurred between the first two trials. Good visual imagers under MP conditions showed a steady improvement in performance throughout the experiment. The addition of an extra throwing trial would seem to be necessary to interpreting performance trends in this type of study.

EXPERIMENT 2

The purpose of this study was to investigate further the relationship between VMI and MP. The design of the experiment was basically the same as Experiment 1, although several important changes were made. Most important of the changes were increasing the number of trials and subjects. The number of subjects was doubled and an additional MP/distracting task session and throwing trial were added. Thus, there were four throwing trials and three MP/distracting task sessions. Instead of reading magazines, subjects selected for the distracting task condition were instructed to solve a paper and pencil maze (taken from McKim, 1972, p. 109), a task that required far more concentration than looking through magazines. The MP/distracting task sessions were reduced from 2 minutes to 90 seconds, as many subjects in the Experiment 1 complained that the sessions were too long. Another change made was the means of analysis used. An analysis of variance using planned comparisons, with each testing the amount of linear improvement across trials, was deemed a more appropriate statistical tool to use. Finally, the Marks (1973) "Vividness of Visual Imagery Questionnaire" was substituted for the 10 items selected from the Betts questionnaire (Appendix C).

Method

Tests. The 16-item Marks "Vividness of Visual Imagery Questionnaire" and the 12-item "Gordon Test of Visual Imagery Control" (in the

revised form that appears in Richardson, 1969) were used to assess the vividness and controllability of VMI.

Subjects. A total of 210 introductory psychology students were administered the two imagery tests. The eight males and eight females who scored the lowest point total on the Marks test ($\bar{x}$ = 22.5) and reported a perfect score on the Gordon test ($\bar{x}$ = 12.0) were selected as good visual imagers. Likewise, the eight females and eight males who scored the highest point total on the Marks ($\bar{x}$ = 38.5) and Gordon ($\bar{x}$ = 39.6) tests were selected as poor visual imagers.

Apparatus. All items used in Experiment 1 (target board and balls, etc.) were used in Experiment 2.

Design and procedure. An equal number of males and females from both imagery groups were assigned to one of two treatment groups. Eight good and eight poor visual imagers received MP throughout the experiment, while the remaining subjects received a distracting task (attempting to solve a maze) throughout the experiment to prevent MP.

The instructions given to each subject were identical to those given in Experiment 1 with two exceptions. Subjects were told there would be seven steps (3 MP/distracting task sessions, 4 throwing trials), and the MP/distracting task sessions were described as lasting 90 seconds each.