



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
© Copyright by Paul John Chara (1977)

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.

STATEMENT OF PERMISSION TO COPY

In presenting this thesis in partial fulfillment of the requirements for an advanced degree at Montana State University, I agree that the Library shall make it freely available for inspection. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by my major professor, or, in his absence, by the Director of Libraries. It is understood that any copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Signature

Paul Charaf.

Date

3/4/77

VISUAL IMAGERY AND INDIVIDUAL DIFFERENCES

by

PAUL JOHN CHARA, Jr.

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

of

MASTER OF SCIENCE

in

Psychology

Approved:

Richard A. Block

Chairperson, Graduate Committee

Robert L. Mowbray

Head, Major Department

Henry L. Parsons

Graduate Dean

MONTANA STATE UNIVERSITY
Bozeman, Montana

March, 1977

ACKNOWLEDGEMENTS

I wish to express my sincere thanks to my graduate advisor, Dr. Richard Block, for the many unselfish hours he spent supervising my thesis. I also thank the other members of my thesis committee, Dr. William Jankel and Dr. William Shontz, for valuable criticism and advice. In addition, Dr. Paul Willis has been very generous and helpful in the preparation of this research.

My sincere appreciation goes to all the students whose participation in the experiments made this thesis possible. I am especially grateful to Judy Fisher for typing this thesis and providing profoundly appreciated moral support.

TABLE OF CONTENTS

	Page
LIST OF TABLES	vii
LIST OF FIGURES	viii
INTRODUCTION	1
A Brief History of Visual Imagery	1
Varieties of Visual Imagery	6
The Nature of the Visual Memory Image	11
Unitary theories of visual memory representation	11
The dual-system theory and visual memory representation	13
The Individual Differences Approach to the Study of VMI	13
The Experiments	15
EXPERIMENT 1	18
Method	19
Tests	19
Subjects	19
Apparatus	19
Design and procedure	20
Results	21
Discussion	23
EXPERIMENT 2	25
Method	25
Tests	25
Subjects	26

	Page
Apparatus	26
Design and procedure	26
Results	27
Discussion	29
EXPERIMENT 3	30
Method	31
Tests	31
Subjects	31
Procedure	31
Part I	31
Part II	32
Results	32
Part I	32
Part II	35
Discussion	35
EXPERIMENT 4	38
Method	39
Tests	39
Subjects	40
Design and procedure	40
Part I	40
Part II	40

	Page
Results	41
Discussion	43
GENERAL DISCUSSION	46
A Review of the Research	46
Rebuttal of the Unitary Hypothesis	50
The Importance of VMI	54
APPENDIXES	57
A. The Gordon Test of Visual Imagery Control	58
B. Sheehan Short Form of Betts Vividness of Imagery Scale	59
C. Marks (1973) Vividness of Visual Imagery Questionnaire	61
D. Preferences Questionnaire Used in Experiment 3	63
E. The Chara Test of Kinesthetic Imagery Control	65
REFERENCES	67

LIST OF TABLES

Table	Page
1. Percent of Responses of Good and Poor Visual Imagers to Alternatives of Preferences Questionnaire Used in Experiment 3	34
2. Correlation Matrix Comparing Scores of Subjects on the Four Imagery Questionnaires Used in Experiment 4 . . .	42

LIST OF FIGURES

Figure	Page
1. Mean Throwing Scores for Good and Poor Visual Imagers Under Mental Practice and Distracting Task Conditions in Experiment 1	22
2. Mean Throwing Scores for Good and Poor Visual Imagers Under Mental Practice and Distracting Task Conditions in Experiment 2	28

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 Mesopotamia 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 "eidōs"--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 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 lightning 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 retrieved 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 compendium 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. Furthermore, 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 questionnaires 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.

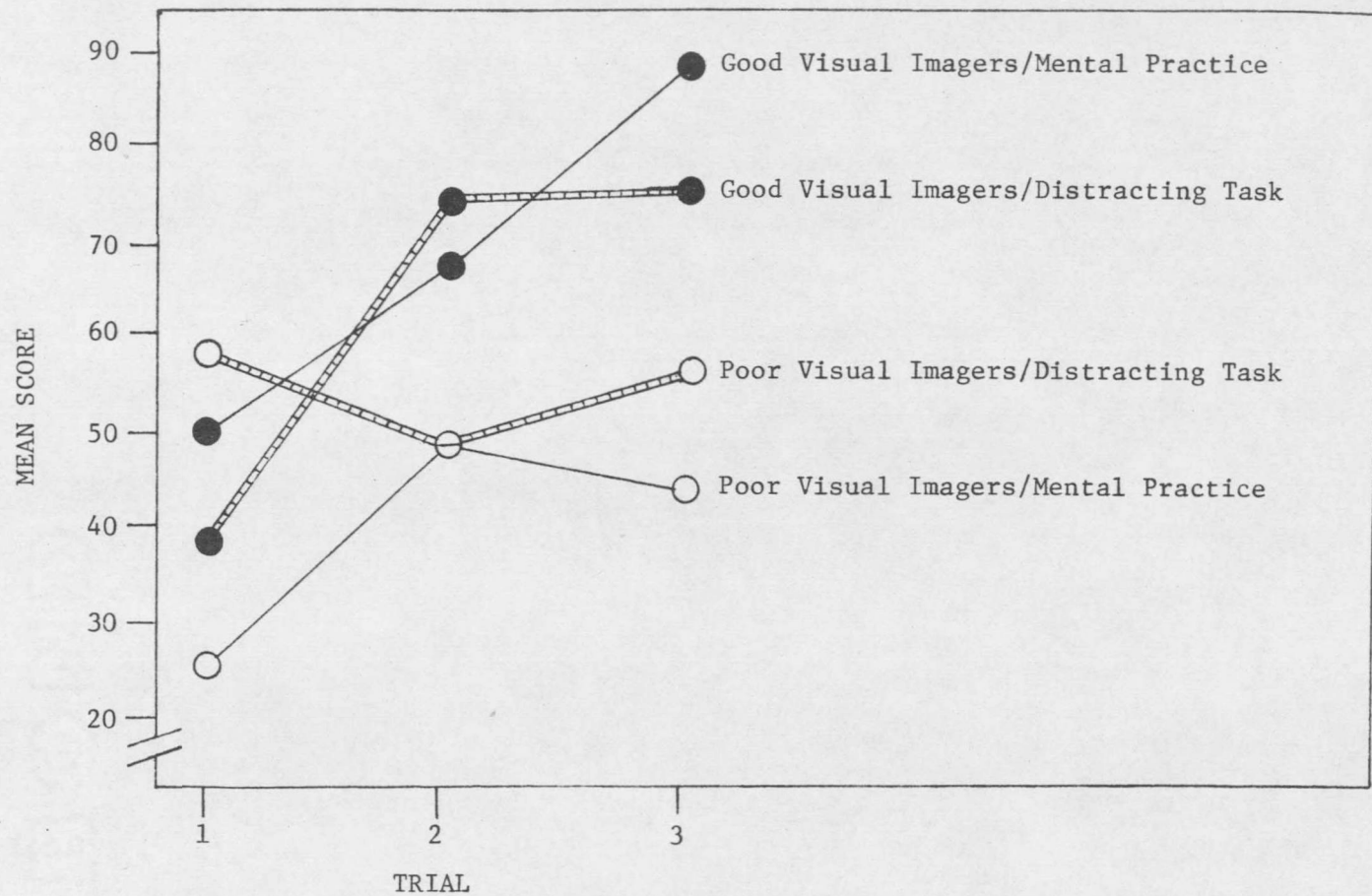


Figure 1. Mean Throwing Scores for Good and Poor Visual Imagers Under Mental Practice and Distracting Task Conditions in Experiment 1.

The data were subjected to an initial analysis of variance using an r(BC)D nested, measurement unrepeated 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.

Results

Figure 2 presents the mean scores of each of the four groups on each throwing trial.

An analysis of variance using planned comparisons was used to test for linear improvement across throwing trials. While the 16 subjects in the distracting task conditions showed no significant improvement across trials [$F(1, 14) = 0.3$; $p > .05$], the 16 subjects in the MP conditions showed significant improvement [$F(1, 14) = 35.3$, $p < .001$].

More importantly, interactions were found between VMI ability, the type of intertrial activity, and performance across trials. Among poor visual imagers, no significant difference in amount of improvement was found between those under MP conditions and those under distracting task conditions [$F(1, 14) = 0.07$, $p > .05$]. Conversely, good visual imagers under MP conditions showed significantly greater improvement in performance than good visual imagers under distracting task conditions [$F(1, 14) = 19.5$, $p < .001$]. In the most important comparison, good visual imagers under MP conditions showed significantly greater improvement than poor visual imagers under the same conditions [$F(1, 14) = 14.9$, $p < .005$].

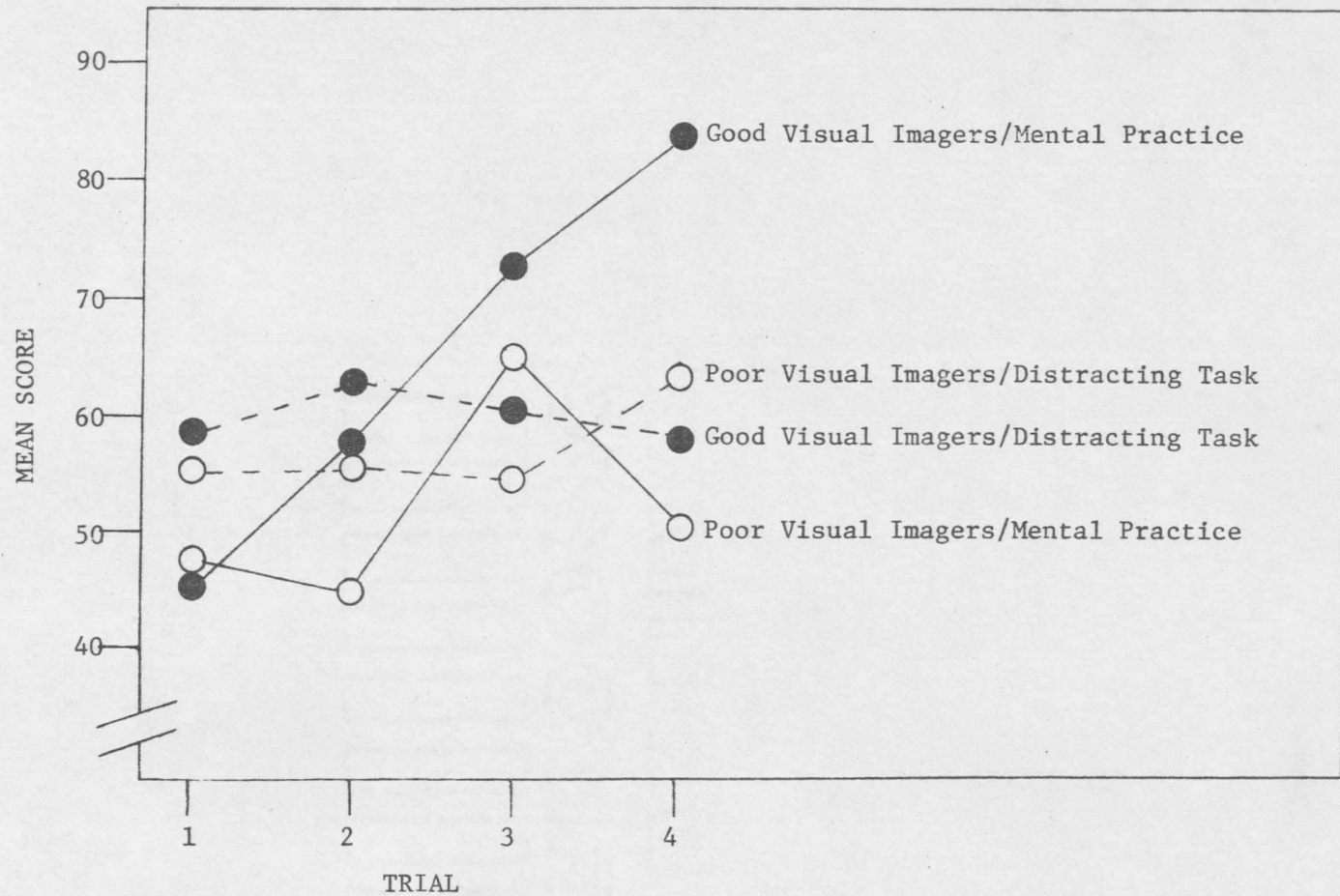


Figure 2. Mean Throwing Scores for Good and Poor Visual Imagers Under Mental Practice and Distracting Task Conditions in Experiment 2.

Discussion

The results of Experiment 2 confirm the basic findings of Experiment 1. It appears that one must have sufficient VMI ability to benefit much from MP. While MP is likely to help some people, it is probably considerably less effective for others, namely those with poor VMI. Therefore, an accurate appraisal of a subject's VMI ability would be an essential prerequisite for MP studies. Questionnaires such as those by Marks, Betts and Gordon appear to serve a useful function in this respect.

Subjects' comments about the duration of the MP sessions provide additional support for the above notions. All poor visual imagers under MP conditions said the 90 second MP sessions were too long. However, four of the eight good visual imagers said the MP session duration was "about right," two said it was too long, and two said it was too short. Apparently, good visual imagers had a much easier time working under MP conditions and thus derived greater benefit from them.

In the final analysis, MP is demonstrated as a condition where a behavioral consequence of individual VMI differences is evident. The ability to "see in the mind's eye" is definitely an advantage when it comes to learning or improving a skill under MP conditions. This is an important fact to consider before any training program or study is done involving MP.

EXPERIMENT 3

One of the more interesting findings regarding research on VMI is that VMI, as demonstrated in EEG studies, seems to be mediated mainly by the right hemisphere in most people (Gale, Morris, Lucas, and Richardson, 1972; Seaman and Gazzaniga, 1973). This placement of VMI to the right hemisphere has led many investigators to postulate that while the left hemisphere is linguistically and mathematically oriented, the right hemisphere is visuospatially oriented. In other words, many investigators believe that each hemisphere is specialized to handle certain information and actually "think" differently. Whether it is a matter of coding information (Paivio and Csapo, 1973), storing information (Begg and Robertson, 1973), or of organizing information (Bogen, 1969), the important notion is that the two hemispheres seem to have separate modes of operation.

If, as it seems, there are two modes of operation, could differences in VMI be attributed to differences in cognitive mode? In other words, if a person has strong VMI, as reported on the appropriate questionnaires, does that mean he or she is right hemisphere oriented? Likewise, if a person reports a poor VMI, does that mean he or she is left hemisphere oriented? This assumption has been proposed by such investigators as Galton (1883), Grey Walter (1953), and Richardson (1969), who distinguished between a "verbalizing" and a "visualizing" mode of cognitive operation. If this assumption is a good one, it is possible that good and poor visual imagers might differ in respect to

personality, interests, and other related variables.

The purpose of this study was to compare good and poor visual imagers on responses to preferences between different interests, activities, and self-described personality variables. Significant differences in responses between the two imagery groups could be an indicator of specific differences in cognitive mode.

Method

Tests. The Marks (1973) test was used to assess vividness of VMI. The Gordon (1949) test was used to assess controllability of VMI.

A preference questionnaire (Appendix D) was compiled from 22 items selected from the Kuder Occupational Interest Survey, Form DD (1964) and the Strong Vocational Interest Test (1966). In addition, the Montana State College Knowledge Interest Test (from the Montana State Testing and Counseling Center), in which a student is asked whether he or she likes, dislikes, or is indifferent to a subject, was used.

Subjects. A total of 87 male and 122 female introductory psychology students were administered the two imagery tests and the preference questionnaire. As described below, some of the students were selected for the second part of the experiment.

Procedure. The experiment was divided into two parts.

Part I. All 209 questionnaires were scored and a separate frequency distribution was plotted for each gender. On the

basis of that distribution it was decided to designate as good visual imagers those people who scored below 14 on the Gordon (1949) test and to designate as poor visual imagers those people who scored above 32 on the test. There were 17 male and 22 female good visual imagers and 14 male and 23 female poor visual imagers who were then compared on their response to each item of the preferences questionnaire.

Part II. In the second part of the experiment (the administration of the MSC Knowledge Interest Test) 10 male ($\bar{x} = 12$ on Gordon; $\bar{x} = 22.4$ on Marks) and 10 female ($\bar{x} = 12$ on Gordon; $\bar{x} = 22.3$ on Marks) good visual imagers were selected from the 209 psychology students, as were 10 male ($\bar{x} = 32.87$ on Gordon; $\bar{x} = 39.3$ on Marks) and 10 female ($\bar{x} = 33.48$ on Gordon; $\bar{x} = 37.6$ on Marks) poor visual imagers. Responses to 29 items in that test were selected for analysis on the basis of being either a "logical/rigorous" subject, such as "logic," or being one that requires "arty or creative skill," such as "sculpture." Good and poor visual imagers were then compared in an analogous manner as described in Part I as to whether they liked or disliked the subject; "indifferent" responses were ignored.

Results

Part I. A two-way χ^2 analysis was performed on the data to determine significant differences in response between good and poor visual imagers for each gender. The total number of responses by all four groups of subjects to the alternatives of the preferences

questionnaire is listed in Table I.

Among the females there were four significant differences in response to the questions between good and poor visual imagers:

1. Good visual imagers would rather talk about the meaning of life than talk about their work or studies, a preference opposite that favored by poor visual imagers [$\chi^2 = 10.2$, $p < .01$].

2. Good visual imagers would rather take a course in modern music than modern math. No strong preference was indicated by poor visual imagers [$\chi^2 = 5.67$, $p < .02$].

3. Good visual imagers showed a much greater preference for being a teacher rather than a salesperson than poor visual imagers [$\chi^2 = 5.45$, $p < .02$].

4. Good visual imagers would rather be married to a research scientist than a sales executive, while no strong preference was indicated by poor visual imagers [$\chi^2 = 4.24$, $p < .05$].

Among males there were two significant differences in response:

1. Good visual imagers preferred to play chess while poor visual imagers preferred to take apart a new mechanical toy [$\chi^2 = 4.01$, $p < .05$].

2. Poor visual imagers would rather be married to a research scientist than to a sales executive, while no strong preference was indicated by good visual imagers [$\chi^2 = 2.84$, $p < .05$].

Table 1

Percent of Responses of Good and Poor Visual Imagers to Alternatives of Preferences Questionnaire Used in Experiment 3

ITEM	Percent of responses to alternative 1				Percent of responses to alternative 5			
	GVI-M	PVI-M	GVI-F	PVI-F	GVI-M	PVI-M	GVI-F	PVI-F
1	41.2%	35.7%	26.1%	52.2%	58.8%	64.3%	73.9%	47.8%
2	64.7%	71.4%	59.1%	34.8%	35.3%	28.6%	40.9%	65.2%
3	52.9%	71.4%	86.4%	65.2%	47.1%	28.6%	13.6%	34.8%
4	47.1%	64.3%	18.2%	65.2%	52.9%	35.7%	81.8%	34.8%
5	58.8%	42.9%	81.8%	47.8%	41.2%	57.1%	18.2%	52.2%
6	35.3%	71.4%	47.8%	39.1%	64.7%	28.6%	52.2%	60.9%
7	11.8%	28.6%	4.5%	8.7%	88.2%	71.4%	95.5%	91.3%
8	100%	100%	95.5%	95.5%	0%	0%	4.5%	4.5%
9	41.2%	71.4%	63.6%	72.2%	58.8%	28.6%	36.4%	27.8%
10	94.1%	85.7%	63.6%	50%	5.9%	14.3%	36.4%	50%
11	35.3%	46.2%	31.8%	36.4%	64.7%	53.8%	68.2%	63.6%
12	94.1%	84.6%	100%	90.9%	5.9%	15.4%	0%	9.1%
13	52.9%	61.5%	22.7%	63.6%	47.1%	38.5%	77.3%	36.4%
14	82.4%	76.9%	63.6%	50%	17.6%	23.1%	36.4%	50%
15	100%	100%	87%	77.3%	0%	0%	13%	22.7%
16	86.7%	91.7%	72.7%	86.4%	13.3%	8.3%	27.3%	13.6%
17	73.3%	91.7%	54.5%	40.9%	26.7%	8.3%	45.5%	59.1%
18	40%	27.3%	9.1%	31.8%	60%	72.7%	90.9%	68.2%
19	66.7%	75%	95.7%	69.6%	33.3%	25%	4.3%	30.4%
20	53.3%	91.7%	81.8%	52.4%	46.7%	8.3%	18.2%	47.6%
21	53.3%	58.3%	50%	63.6%	46.7%	41.7%	50%	36.4%
22	46.7%	58.3%	31.8%	33.3%	53.3%	41.7%	68.2%	67.3%

Abbreviations used: GVI=good visual imager M=Male
PVI=poor visual imager F=Female

Part II. Of the responses to the items on the MSC Knowledge Interest Test, there were two subjects on which male good and poor visual imagers differed significantly and one subject on which female good and poor visual imagers differed significantly. For males, good visual imagers reported they liked and poor visual imagers reported they disliked Calculus [$\chi^2 = 8.75, p < .01$] and Philosophy [$\chi^2 = 4.95, p < .05$]. For females a similar response pattern among good (like) and poor (dislike) imagers was indicated for History of Architecture [$\chi^2 = 4.27, p < .05$].

Discussion

The intent of the preceding study was to try and determine differences in cognitive mode between good and poor visual imagers. As far as indicating differences in cognitive mode between the four groups, the results are puzzling. While there are some significant differences in the way poor and good visual imagers responded to item alternatives, in all cases the significant differences found for one gender were not found on that same item for the other gender. In fact, there seem to be as many differences between male and female good visual imagers and male and female poor visual imagers as within the sex groups. Any study done involving VMI should be very careful to control for gender differences, as they have important implications in regards to VMI-related behavioral consequences. This will be discussed further in the general discussion.

The findings of this study do not give any evidence that differences in visual imagery are closely related to differences in cognitive mode. It seems to be a mistake to dichotomize good and poor visual imagers into right and left hemisphere oriented cognitive groups. Just because a person reports good VMI does not mean he or she is right hemisphere oriented. It may indicate, however, that the person has developed a right hemisphere ability that the person with a poor VMI has not. But developing one right hemisphere attribute does not necessarily mean that the person is overwhelmingly right hemisphere oriented. Einstein, for instance, a "prototype left hemisphere oriented person," logical, very mathematical, etc., also possessed a very vivid, controllable VMI which he says was responsible for his discovery of the theory of relativity (Samuels and Samuels, 1975, p. 248). Perhaps that only in a very small proportion of the population would one see distinct right or left hemisphere oriented cognitive modes.

While there are problems with attempting this type of study, and the number of subjects involved precluded drawing any meaningful conclusions, the basic notion that differences in VMI ability can have important implications as far as differences in cognitive mode should not be readily dismissed. Over the past year, I have talked to many people who have good abilities in the arts (such as painting, ceramics, architecture, etc.) and they have all indicated to me that they have an

excellent ability to "see things in their mind's eye." Differences in VMI may well be an important indicator of what type of career people follow or should follow, and what type of activity they enjoy most or do best.

EXPERIMENT 4

This study was an attempt to pursue some questions that arose when considering the implications of the previous three studies. In the two studies dealing with MP, VMI was implicated as an important factor. Many of the subjects who reported controllable VMI mentioned that not only could they "see" throwing the balls in their minds, but they also reported that they could "feel" the throwing motion. It is possible that highly controllable VMI involves the use of kinesthetic imagery, especially in the context of a perceptual motor task. This notion is related closely to a study done by Jacobson (1932), who found that when imagining a movement the person activates minute movements of the appropriate muscles. The difference between poorly controllable VMI and highly controllable VMI may well be due, in part, to the use of kinesthetic imagery. Controlling VMI may involve an operation in which kinesthetic imagery plays a major role.

While conducting Experiment 3, it seemed to me that some of the subjects selected as good or poor imagers were actually average imagers. While the phenomenal report questionnaires have been shown to adequately distinguish between the abilities they purport to measure, there are problems -- people may use different criteria to evaluate their VMI, and some people may not honestly answer the questions. It would be very helpful if more objective tests of VMI ability could be found. Thus, in experiments where individual differences in VMI are of importance, the experimenter could use questionnaires to select a

sample of good and poor visual imagers and then give that sample objective tests to find the best and worst visual imagers. Such a procedure would seem to assure finding the best and worst visual imagers among a general population. While Marks (1973) has mentioned that a test of pictorial memory is highly correlated with self-reported vividness of VMI, an objective test of controllability of VMI would seem to be more important, since the ability to manipulate VMI probably is a much more valuable ability. Snyder (1972) mentions that the Space Relations subtest of The Differential Aptitude Tests is highly correlated with controllability of VMI and thus may be a more objective measure of that ability.

The purpose of the present study was threefold: (1) Design a test of controllability of kinesthetic imagery; (2) Investigate the relationships between the vividness and controllability of VMI and kinesthetic imagery, and (3) Determine the relationship between controllability of VMI and scores on the Space Relations test.

Method

Tests. In the first part of the experiment four imagery tests were used: the kinesthetic and visual portions of the Sheehan short form of the Betts vividness of imagery questionnaire, the Gordon test of VMI controllability, and the newly developed (see Design and Procedure section) Chara Test of Kinesthetic Imagery Control (Appendix E).

In the second part of the experiment, Form T of the Space Relations subtest of the Psychological Corporation's Differential Aptitude Tests (1973) was used.

Subjects. In part one, 406 introductory psychology students were given the four self-report imagery tests. In part two, 36 students were selected on the basis of their scores on the Gordon and Chara tests. These included: nine male good imagers ($\bar{x} = 12.6$, Gordon; $\bar{x} = 12.6$, Chara); nine female good imagers ($\bar{x} = 13.1$, Gordon; $\bar{x} = 12.2$, Chara); nine male poor imagers ($\bar{x} = 35.8$, Gordon; $\bar{x} = 30.1$, Chara); and nine female poor imagers ($\bar{x} = 37.1$, Gordon; $\bar{x} = 34.8$, Chara).

Design and procedure.

Part I. A test of controllability of kinesthetic imagery was developed by arranging questions dealing with kinesthetic sensations into a chronological scene, like the Gordon test. This test and the three previously-mentioned tests were then administered to 406 introductory psychology students. The responses to all four questionnaires were subsequently added and the total scores of each questionnaire were then correlated with each other.

Part II. Good and poor imagers were selected from the students given the four imagery questionnaires. Both male and female good and poor imagers were selected on the basis of the low and high point totals on the Gordon and Chara questionnaires. All 36 subjects

were then administered the Space Relations subtest. The mean score of each of the four groups was calculated and good and poor imagers were then compared in terms of performance on the Space Relations test.

Results

Table 2 presents the correlations among the total scores of each of the four imagery scales. Five of the six correlations were found to be significant. The imagery test most highly correlated with Gordon's controllability of VMI questionnaire was the Chara Test of Kinesthetic Imagery Control.

Perhaps the most interesting aspect of the correlation matrix was the fact that while the correlation between the vividness of VMI (Betts test) and controllability of VMI (Gordon test) was not significant, the correlation between vividness of kinesthetic imagery (Betts test) and controllability of VMI (Gordon test) was significant. A comparison of correlation coefficients between the two relationships was performed via a Correlated Groups Test and it was found that the two correlation coefficients were significantly different [$Z = 4.2$, $p < .001$]. This will be dealt with in the discussion section.

In the second part of the experiment, it was found that male ($\bar{x} = 49.55$) and female ($\bar{x} = 40.88$) good imagers performed better on the Space Relations test than poor visual imagers of the same sex (male $\bar{x} = 41.77$; female $\bar{x} = 38.66$). The means of the two imagery groups were

Table 2

Correlation Matrix Comparing Scores of Subjects on the Four Imagery Questionnaires Used in Experiment 4

No.	Tests Correlated	<u>r</u>	<u>p</u>
1	a) Betts Vividness of Visual Imagery b) Betts Vividness of Kinesthetic Imagery	.317	<u>p</u> < .001
2	a) Betts Vividness of Visual Imagery b) Gordon Controllability of Visual Imagery	.066	<u>p</u> > .05
3	a) Betts Vividness of Visual Imagery b) Chara Controllability of Kinesthetic Imagery	.173	<u>p</u> < .001
4	a) Betts Vividness of Kinesthetic Imagery b) Gordon Controllability of Visual Imagery	.200	<u>p</u> < .001
5	a) Betts Vividness of Visual Imagery b) Chara Controllability of Kinesthetic Imagery	.359	<u>p</u> < .001
6	a) Gordon Controllability of Visual Imagery b) Chara Controllability of Kinesthetic Imagery	.288	<u>p</u> < .001

N = 406; df = 404

compared for each sex and, while male good and poor imagers were found to differ significantly ($t(16) = 1.75, p < .05$), female poor and good imagers were not found to differ significantly ($t(16) = 0.46, p > .05$).

Discussion

The finding that vividness of kinesthetic imagery is much more highly correlated with controllability of VMI than is vividness of VMI is most intriguing. Controlling VMI may involve two operations. One would be the activation of specific visual memories, the other would be a manipulating operation that quite possibly involves kinesthetic imagery. In controlling VMI not only do you "see" an image, you almost have a "feel" for it and thus can manipulate it. It does not seem to be necessary, although it is likely helpful to have vivid VMI in order to control visual memory images. It would seem that vividness and controllability of VMI are two distinct abilities.

If vividness of kinesthetic imagery is closely related to controllability of VMI, then it would seem logical that controllability of kinesthetic imagery is even more closely related to controllability of VMI. The distinction between vividness and controllability of kinesthetic imagery is a close one. The difference between "feeling" a sensation (holding a weight) and doing something with that over time (lifting the weight over your head and then lowering it to your feet) would be the distinction between vividness and controllability of kinesthetic imagery. While this dichotomy does not seem particularly

clear cut, the three correlations involving the controllability of kinesthetic imagery were different enough to indicate that controllability of kinesthetic imagery is distinguishable from vividness of kinesthetic imagery. To my knowledge, no attempt has previously been made to design a test of kinesthetic imagery control. Obviously, much more research is needed before any inferences regarding the nature of kinesthetic imagery and its relationship to VMI can be made.

More puzzling than intriguing to this author were the results of the second part of the study. Previous research (Snyder, 1972) indicated a rather high positive correlation between scores on the Gordon questionnaire and scores on the Space Relations test ($r(8)$, $p < .005$). However, this correlation was based on only ten subjects. Although male and female good imagers both had higher mean scores on the Space Relations test than their poor imaging counterparts, the difference was not large, just barely significant when males were considered. The Space Relations test, which involves imagining what an unfolded box or item would look like when folded, intuitively would seem to be a good test of the controllability of VMI.

Following the completion of Experiment 4, I talked to a student who reported highly controllable VMI and kinesthetic imagery yet scored very poorly on the Space Relations test. While saying he answered the imagery questionnaires honestly, he admitted that he could not imagine in his mind what the unfolded items in the Space Relations test would

look like when folded. It seems likely he was overrating his controllability of imagery. Variability in judgement criteria used to respond to the items on the imagery scales could be responsible for the results found in the second part of this study. This will be dealt with in the GENERAL DISCUSSION.

GENERAL DISCUSSION

A Review of the Research

The experimental results reported here demonstrate that VMI is an important factor in a number of tasks. Subjects selected on the basis of good VMI were found to surpass the performance of subjects selected on the basis of poor VMI. Since it has been shown that there are a number of tasks on which good visual imagers do not surpass the performance of poor visual imagers (see Snyder, 1972, for a review of this), it is reasonable to assume that differences in performance on certain tasks are due to differences in specific abilities which are related to differences in VMI. People with good VMI probably possess specific abilities to a much greater degree than people with poor VMI. The research reported here is at variance with the opinion of Neisser (1967) that: "The image hardly seems to be a step in the recall process at all, but rather a kind of 'cognitive luxury,' like an illustration in a novel." The studies reported here indicate that, at least in certain tasks, the image is more of a "cognitive necessity" than a "cognitive luxury." It is apparent to this author that the image, especially the visual memory image, is a lot more important than Neisser ((1967) and some other contemporary cognitive researchers believe.

The problem with the study of VMI is that it is an inner experience that lends itself to objective study with some difficulty. It is more difficult to measure than a perceptual ability such as

visual acuity. While visual acuity is accurately measured by instruments, visual imagery is most often measured by introspective questionnaires. Although VMI can be shown to be important in a variety of objective tasks, the researcher is still dependent to a degree on self-report data. After the administration of questionnaires to over a thousand people, I have concluded that it would be wrong to take the responses at face value. While such questionnaires do an adequate job in discriminating people on the basis of imagery, it is important to be careful in interpreting the results. While the visual imagery questionnaires have been shown to be reliable (Sheehan, 1967; Juhasz, 1972; Westcott and Rosenstock, 1976) and research reported here and elsewhere (e.g., Snyder, 1972; Richardson, 1969) indicates they do measure what they purport to, people are still assessing their own abilities, and it must be expected that there is a wide variability in regards to response criteria. What one person considers a rating of "1" ("perfectly clear and vivid as the actual experience") on a five-point scale, another person may consider a rating of "2" ("moderately clear and vivid") on that same scale. Some people use a strict criterion in assessing their VMI, while others use a relaxed criterion. Because using the imagery questionnaire entails dealing with people's subjective judgements, it is therefore unwise to accept the responses given as the final word. It would be better, perhaps, to use the questionnaires as an initial screening device to select good and poor

visual imagers and then give more objective measures of VMI ability to that group of people to get the best and worst visual imagers. Of course, it must be certain that the objective measures are valid indicators of VMI ability themselves. Further research should be directed towards finding such objective measures which would promise more precise measurement of VMI. For the present time, however, the imagery questionnaires do serve a useful function.

In all of the studies, an equal number of males and females were used. The results of Experiment 3 showed that there were as many differences between male and female good visual imagers and male and female poor visual imagers as within each gender. The distinction between males and females in relation to VMI capacity is well worth noting.

Research by Anastasi (1958) revealed that adult females do better than adult males on tests of verbal abilities, whereas adult males do better on mathematical and spatial tasks. Since VMI would seem to be more important in spatial tasks, it would be reasonable to assume that males have better VMI. Seemingly at variance with this, however, is a study by Marks (1973) in which he reported that females do better than males on tasks requiring the memorization of pictorial material. In the same study he found a high positive correlation between vividness of VMI and good pictorial recall. The answer to this dilemma could be that the tasks require different aspects of VMI

ability. While pictorial memorization is related to vividness of VMI, spatial tasks requiring the movement of visual stimuli, external and internal, would seem more related to controllability of VMI. It could be, then, that males and females differ in the nature of their VMI; females having a little better vividness, males having a little better control. This trend of differences, albeit minute, was found throughout the studies. For example, in Experiment 3, males on the average reported better controllability of VMI ($\bar{x} = 22.9$) than females ($\bar{x} = 23.6$) while females reported better vividness ($\bar{x} = 30.8$) than males ($\bar{x} = 31.6$). While these sex differences were not significant for either vividness [$F(207) = 1.47, p > .05$] or controllability [$F(207) = .59, p > .05$], the trend of males reporting slightly more controllable VMI and females slightly more vivid VMI was evident in all of the studies.

These differences between males and females in respect to VMI may lie in differences in hemispheric lateralization between the two sexes. According to Levy (1972) female brains are similar to male left-handers in that there is less hemispheric specialization than male right-handers. It could be, therefore, that less hemispheric specialization is advantageous when it comes to vividness of VMI, while more hemispheric specialization is advantageous to controllability of VMI.

Recent research concerning the genetic components of spatial reasoning may also shed light on the gender differences observed for

controllability of VMI. Bock and Kolakowski (1973) have supported earlier research (Stafford, 1961) that indicates "that the ability of human subjects to visualize spatial relations and mentally manipulate visual images is influenced by an X-linked gene." Furthermore, they postulate that proficiency on spatial tasks is also testosterone influenced. Since controllability of VMI would seem to be closely related to spatial reasoning, the same genetic components responsible for gender differences in spatial reasoning may be similarly responsible for gender differences observed in controllability of VMI.

Rebuttal of the Unitary Hypothesis

Although the unitary hypothesis seems to be gaining more and more support by contemporary psychologists, there are a number of problems with theories of visual imagery embodied under this title.

The idea that there is not a separate code for visual and verbal material is refuted by an overwhelming body of evidence. Paivio and various associates (see Paivio, 1971, for a review) have shown that there is an imaginal system that best handles memory for pictures and a verbal system that best handles memory for words and that each system is best fit to code the two types of stimuli. Concrete nouns, words that are easily visualized (such as "dog"), have been found to be best memorized by imaginal mediation. Abstract nouns, words that are not easily visualized (such as "thought"), have been found to be best

memorized by verbal mediation (Paivio and Csapo, 1969). If verbal and visual processes are the same way of representing information, why then would some words best be memorized and therefore mediated by imaginal mediation while other words would be memorized best through verbal mediation?

In establishing the framework for his unitary theory of imagery and verbal coding, Neisser (*Cognition and Reality*, 1976) dismisses the idea that visual images are closely related to percepts by saying that this idea has "some difficulty in explaining why images and percepts are not systematically confused with one another" (p. 129). He goes on to say: "Although an experiment by Perky is often cited as proving that percepts and images are confusable, it is seriously flawed and has not really been replicated" (p. 130). This statement is disputed by experiments conducted by Segal and Nathan (1964), Brooks (1968), Segal and Fusella (1970), and Atwood (1971). These experiments have replicated and extended the work of Perky (1910) and found that imaging and perceiving are sufficiently related so that the two activities can interfere with each other.

The main problem with the unitary view of visual imagery is that it considers only VMI and fails to consider that there are many other varieties of visual imagery, all part of the same continuum. For example, can a dream always, if ever, be explained as an "anticipatory phase" of perception (Neisser, 1976)? Is an eidetic image an "abstract

structure composed of related concepts" (Anderson and Bower, 1973)? While unitary theorists can put up a stiff argument when considering just VMI, it is hard to extend those arguments to other varieties of visual imagery. Research indicates that imagery and verbal processes are distinctly different, rather than the same process.

On the other hand, the dual-system theory of memory representation is in agreement with what is known about visual images on a neurophysiological level. Neisser (as cited in Samuels and Samuels, 1975) states that:

...visual images are apparently produced by the same integrative processes that make ordinary perception possible... Visual memory differs from perception because it is based principally on stored, rather than on current information, but involves the same kind of synthesis. (p. 57)

The origin of a visual image is probably started in the visual association zone which surrounds the visual area of the brain's cerebral cortex. In this visual association zone, impulses arising from visual stimulation are coded and decoded. Next to the visual association zone is the "relatively 'silent' area of the temporal lobe in which...mechanisms of memory, hallucinations, and dreams may be located" (Gatz, 1970, p. 112). It is here where the coded visual information, "a congealed neuronal pattern or 'engram' ready to be replayed by appropriate input," in the words of the neurophysiologist, Eccles (as cited in Gatz, 1970, p. 37), is likely stored. What is then needed for a person to experience a visual image is the proper

stimulation, external or internal, of the right neuronal pathways; the firing of which gives rise to a visual image. This was evidenced in the course of surgery on epileptic patients by Penfield. In placing electrodes in certain locations of the "silent area" of the temporal lobe, he found that he could stimulate the patient to experience vivid visual images (Gatz, 1970, p. 38). The patients would describe in detail lifelike scenes that suddenly unfolded "before their eyes." Stimulation of other areas of the brain would give rise to auditory sensations, and a patient, for instance, would report hearing music. The important point is that the stimulation of specific areas of the brain gives rise to a specific experience, be it a visual image, an auditory sensation, or sometimes both.

Studies of the functions of the two hemispheres of the brain are also compatible with the dual-system theory. It has been found that each hemisphere functions in a distinctly different way. According to Ornstein (1972), the left hemisphere "is predominantly involved with analytic, logical thinking, especially in verbal and mathematical functions" (p. 52). Conversely, the right hemisphere "is primarily responsible for orientation in space, artistic endeavor, crafts, body image, recognition of faces" (p. 52). Ornstein sees the left hemisphere as the one that deals primarily with verbal, sequential thought, while the right hemisphere deals primarily with visual, simultaneous thought. If the brain has two modes of thought then it is very likely

that it has at least two different means of representing reality, through verbal processes and images.

While, to this author, the dual-system best interprets visual imagery phenomena, the image/no image question, now in the form of the unitary/dual-system controversy, is likely to go on. Perhaps as long as people differ in the strength of their visual imagery, the debate will go on. People with poor imaginal abilities will deny the existence of visual images while people with good imaginal abilities will assert their importance. One such person was Albert Einstein, who said, "The psychical entities which seem to serve as elements in thought are certain signs and more or less clear images which can be voluntarily reproduced and combined" (as cited in Samuels and Samuels, 1975, p. 250). Evidently, the existence of visual images is in the "eye" of the beholder.

The Importance of VMI

The ability to control VMI may have vast importance in many facets of living. The ability to take memory images and combine them with and develop them into imagination images may well be one of the most important abilities of the human mind. Bill Koch, the only American to ever win a silver medal in cross-country skiing at the Olympics, trained by a mental practice technique requiring visualization (Suinn, 1976). T. W. Simeons, M.D., is a physician who teaches

people weight control through visualization (Simeons, 1966). Many psychiatrists have had patients use visual images to deal with problems (Leuner, 1969; Assagioli, 1965; Gerald, 1963). Many famous inventive people, such as Albert Einstein, Bertrand Russel and Vincent Van Gogh, have described the importance of visual images in the creative process (Ghiselin, 1952). A technique in natural childbirth emphasizes the use of visual imagery (Dick-Read, 1953). Finally, Dr. Carl Simmonton has had remarkable success in the treatment of cancer patients by a technique employing visualization (Bolen, 1973).

These practical uses of visual imagery probably represent just the tip of the iceberg. As more attention and research are devoted to visual imagery, the importance of it will likely be magnified. While people possess visual imagery abilities to varying degrees, the potential uses of it exist for all (except probably the congenitally blind); the word "potential" to be emphasized. Because our culture emphasizes logical, verbal, and mathematical abilities in this increasingly technical world, little attention is paid to creative and imaginal abilities. Through school, for instance, language, mathematics, and disciplined subjects are emphasized. Subjects that would facilitate the development of visual imagery, such as art related topics, are considered "minor" subjects. Increased emphasis in such minor subjects may well lead to a better educated, more well-rounded mind. The fact that the ability to form visual images is a partially

learned ability (Horowitz, 1970, p. 202) has two important implications regarding visual imagery abilities. The first is that emphasis on developing imaginal abilities should be put in educational programs, from kindergarten through the twelfth grade, in order to facilitate the growth of those and related abilities. The second is that no matter how poor your visual imagery is, you can learn to improve it.

APPENDIXES

APPENDIX A

The Gordon Test of Visual Imagery Control

Instructions:

The following questions are concerned with the ease with which you can control or manipulate visual images. For some people this task is relatively easy and for others relatively hard. One subject who could not manipulate his imagery easily gave this illustration. He visualized a table, one of whose legs suddenly began to collapse. He then tried to visualize another table with four solid legs, but found it impossible. The image of the first table with its collapsing legs persisted. Another subject reported that when he visualised a table the image was rather vague and dim. He could visualize it briefly but it was difficult to retain by any voluntary effort. In both these illustrations the subjects had difficulty in controlling or manipulating their visual imagery. It is perhaps important to emphasize that these experiences are in no way abnormal and are as often reported as the controllable type of image.

Read each question, then close your eyes while you try to visualize the scene described. Record your answer by marking in 1 for "yes," 3 for "unsure," and 5 for "no." Remember that your accurate and honest answer to these questions is most important for the validity of this study. If you have any doubts at all regarding the answer to a question, mark 3 for "unsure." Please be certain that you answer each of the twelve questions.

Rating Scale: 1Yes; 3 . . .Unsure; 5No

Items:

1. Can you see a car standing in the road in front of a house? 1 3 5
2. Can you see it in color? 1 3 5
3. Can you now see it in a different color? 1 3 5
4. Can you now see the same car lying upside down? 1 3 5
5. Can you now see the same car back on its four wheels again? 1 3 5
6. Can you see the car running along the road? 1 3 5
7. Can you see it climb up a very steep hill? 1 3 5
8. Can you see it climb over the top? 1 3 5
9. Can you see it get out of control and crash through a house? 1 3 5
10. Can you now see the same car running along the road with a handsome couple inside? 1 3 5
11. Can you see the car cross a bridge and fall over the side into the stream below? 1 3 5
12. Can you see the car all old and dismantled in a car-cemetery? 1 3 5

APPENDIX B

Sheehan Short Form of Betts Vividness of Imagery Scale

Instructions for doing test:

The aim of this test is to determine the vividness of your imagery. The items of the test will bring certain images to your mind. You are to rate the vividness of each image by reference to the accompanying rating scale, which is shown below. For example, if your image is 'vague and dim' you give it a rating of 4. Record your answer by filling in the appropriate blank on the mark-sense sheet. Before you proceed to the items below, familiarize yourself with the different categories on the rating scale. Throughout the test, refer to the rating scale when judging the vividness of each image. Try to do each item separately, independent of how you may have done other items.

Rating Scale:

The image aroused by an item of this test may be:

- Perfectly clear and as vivid as the actual experience . . .Rating 1
- Moderately clear and vivid.Rating 2
- Not clear or vivid, but recognizable.Rating 3
- Vague and dimRating 4
- No image present at all, you only 'knowing' that you
are thinking of the object.Rating 5

Think of some relative or friend whom you frequently see, considering carefully the picture that rises before your mind's eye. Classify the images suggested by each of the following questions as indicated by the degrees of clearness and vividness specified on the Rating Scale.

- | <u>Item:</u> | <u>Rating:</u> |
|--|----------------|
| 1. The exact contour of face, head, shoulders and body | () |
| 2. Characteristic poses of head, attitudes of body, etc. | () |
| 3. The precise carriage, length of step, etc. in walking | () |
| 4. The different colors worn in some familiar costume | () |

Think of seeing the following , considering carefully the picture which comes before your mind's eye; and classify the image suggested by the following question as indicated by the degree of clearness and vividness specified on the Rating Scale.

- 5. The sun as it is sinking below the horizon ()

Think of performing each of the following acts, considering carefully the image which comes to your mind's arms, legs, lips, etc., and classify the images suggested as indicated by the degree of clearness and vividness specified on the Rating Scale.

APPENDIX B (continued)

	<u>Rating:</u>
6. Running upstairs	()
7. Springing across a gutter	()
8. Drawing a circle on paper	()
9. Reaching up to a high shelf	()
10. Kicking something out of your way	()

APPENDIX C

Marks (1973) Vividness of Visual Imagery Questionnaire

Instructions for doing test:

The aim of this test is to determine the vividness of your imagery. The items of the test will bring certain images to your mind. You are to rate the vividness of each image by reference to the accompanying rating scale, which is shown below. For example, if your image is 'vague and dim' you give it a rating of 4. Record your answer by filling in the appropriate blank on the mark-sense form. Before you proceed to the items below, familiarize yourself with the different categories on the rating scale. Throughout the test, refer to the rating scale when judging the vividness of each image. Try to do each item separately, independent of how you may have done other items.

Rating Scale:

- | | |
|--|----------|
| "Perfectly clear and as vivid as normal vision". | Rating 1 |
| "Clear and reasonably vivid". | Rating 2 |
| "Moderately clear and vivid". | Rating 3 |
| "Vague and dim". | Rating 4 |
| "No image at all, you only know that you are thinking
of the object". | Rating 5 |

For items 1-4, think of some relative or friend whom you frequently see (but is not with you at present) and consider carefully the picture that comes before your mind's eye.

Item:

1. The exact contour of face, head, shoulders and body.
2. Characteristic poses of head, attitudes of body, etc.
3. The precise carriage, length of step, etc., in walking.
4. The different colors worn in some familiar clothes.

Visualize a rising sun. Consider carefully the picture that comes before your mind's eye.

5. The sun is rising above the horizon to a hazy sky.
6. The sky clears and surrounds the sun with blueness.
7. Clouds. A storm blows up, with flashes of lightening.
8. A rainbow appears.

Think of the front of a shop which you often go to. Consider the picture that comes before your mind's eye.

9. The overall appearance of the shop from the opposite side of the road.
10. A window display including colors, shapes and details of individual items for sale.

APPENDIX C (continued)

11. You are near the entrance. The color, shape and details of the door.
12. You enter the shop and go to the counter. The counter assistant serves you. Money changes hands.

Finally, think of a country scene which involves trees, mountains and a lake. Consider the picture that comes before your mind's eye.

13. The contours of the landscape.
14. The color and shape of the trees.
15. The color and shape of the lake.
16. A strong wind blows on the trees and on the lake causing waves.

APPENDIX D

Preferences Questionnaire Used in Experiment 3

Below are several pairs of activities, occupations, and interests. Show which one of the pair you like better: If you prefer "1," then mark "1" on the mark-sense form; if you prefer "5," then mark "5" on the mark-sense form. Work as fast as possible. Be sure to mark either "1" or "5" for each question. Please be certain that you answer each of the twenty-two questions.

Items:

1. 1) Play a game that requires mental arithmetic.
5) Work mechanical puzzles.
2. 1) Take a broken lock apart to see what is wrong.
5) Add columns of figures.
3. 1) Visit an exhibit of famous paintings.
5) Visit an exhibit of laboratory equipment.
4. 1) Talk about your work or studies.
5) Talk about the meaning of life.
5. 1) Take a course in modern music.
5) Take a course in modern math.
6. 1) Take apart a new mechanical toy to see how it works.
5) Play chess.
7. 1) Construct tables on the cost of living.
5) Repair and refinish old furniture.
8. 1) Explore the site of ancient cities.
5) Write articles or give lectures about ancient cities.
9. 1) Teach children who are not very bright.
5) Teach children who are very bright.
10. 1) Help a child with his arithmetic problems.
5) Help a child improve his handwriting.
11. 1) Write articles about birds.
5) Draw sketches of birds.
12. 1) Doing a job yourself.
5) Telling somebody else to do the job.
13. 1) Dealing with things.
5) Dealing with people.
14. 1) Taking a chance.
5) Playing safe.

APPENDIX D (continued)

15. 1) Outside work.
5) Inside work.
16. 1) Physical activity.
2) Mental activity.
17. 1) Thrilling, dangerous activities.
5) Quieter, safer activities.
18. 1) Statistician.
5) Social worker.
19. 1) Teacher.
5) Salesperson.
20. 1) Being married to a research scientist.
5) Being married to a sales executive.
21. Which group of words best describes your cognitive mode (way you think)?
1) Analytic, verbal; intellectual, sequential.
5) Gestalt; spatial; intuitive; simultaneous.
22. Would you describe yourself as:
1) More extroverted.
5) More introverted.

APPENDIX E

The Chara Test of Kinesthetic Imagery Control

Instructions:

The following questions are concerned with the ease in which you can control or manipulate your kinesthetic imagery (the sensations associated with the position, movement, tension, etc., of parts of the body). The items are presented in the context of an action-scene that you are to try to kinesthetically experience. Read the items below and try to "feel" the kinesthetic sensations associated with each item. Respond to each item by marking on the mark-sense form provided: "1" if your answer is yes, I can definitely experience or feel that kinesthetic sensation; "3" if your answer is unsure, if I can feel that sensation; "5" if your answer is no, I can not feel that sensation. If you have any doubts at all regarding the answer to a question, mark "3" for unsure. Remember, the validity of this questionnaire depends on your honest, most precise response to each item.

Rating Scale: 1Yes; 3Unsure; 5No

Items:

Imagine yourself to be taking a journey through the forest. Think of performing the following acts, considering the image which comes to your mind's arms, legs, etc.

1. Can you feel what it is like to be leisurely walking along a path?
2. Can you now feel what it is like to run along the same path?
3. Can you feel what it is like to tense your muscles as you prepare to jump over a creek?
4. Can you now feel what it is like to lose your balance and fall upon landing on the other side of the creek?
5. Can you now feel what it is like to push yourself off the ground?
6. Can you feel what it is like to pick up a heavy rock?
7. Can you now feel what it is like to throw that rock into the creek?
8. Can you feel what it is like to kick a stone into the creek?
9. Can you feel what it is like to hoist yourself via a branch into a tree?
10. Can you feel what it is like as your legs get tired from climbing a steep hill?
11. Can you feel what it is like to roll down the other side of that hill?
12. Can you now feel what it is like to lie down and relax upon completion of your journey?

REFERENCES

REFERENCES

- Anastasi, A. Differential Psychology: Individual and Group Differences in Behavior. New York: Macmillan, 1958.
- Anderson, J. R., and Bower, G. H. Human Associative Memory. Washington, D. C.: Winston, 1973.
- Assagioli, R. Psychosynthesis. New York: Hobbs, Dorman, and Co., 1965.
- Atwood, G. An experimental study of visual imagination and memory. Cognitive Psychology, 1971, 2, 290-299.
- Begg, I., and Robertson, R. Imagery and long-term retention. Journal of Verbal Learning and Verbal Behavior, 1973, 689-700.
- Bock, R. D., and Kolakowski, D. Further evidence of sex-linked major-gene influence on human spatial visualization ability. American Journal of Human Genetics, 1973, 25, 1-14.
- Bogen, J. E. The other side of the brain, I, II, III. Bulletin of the Neurological Societies, July, 1969, 34, 3.
- Bolen, J. Meditation and psychotherapy in the treatment of cancer. Psychic Magazine, July, 1973.
- Boring, E. G. A History of Experimental Psychology. New York: Appleton-Century-Crofts, 1950.
- Bower, G. H. Mental imagery and associative learning. In L. Gregg (ed.) Cognition in Learning and Memory. New York: Wiley, 1972.
- Brooks, L. R. Spatial and verbal components in the act of recall. Canadian Journal of Psychology, 1968, 22, 349-368.
- Buggie, S. E. Imagery and relational variety in associative learning. Unpublished dissertation, University of Oregon, 1974.
- Dick-Read, G. Childbirth Without Fear. New York: Harper & Row, 1953, 14.
- Doob, L. W. Eidetic images among the Ibo. Ethnology, 1964, 3, 357-363.
- Doob, L. W. Exploring eidetic imagery among the Kamba of Central Kenya. Journal of Social Psychology, 1965, 67, 3-22.

- Gale, A., Morris, P. E., Lucas, B., and Richardson, A. Types of imagery and imagery types: an EEG study. British Journal of Psychology, 1972, 63, 4, 523-531.
- Galton, F. Inquiries into Human Faculty. New York: E. P. Dutton and Co., 1928.
- Gatz, A. Manter's Essentials of Clinical Neuroanatomy and Neurophysiology. Philadelphia, Pa., F. A. Davis Co., 1970.
- Gerard, R. Symbolic visualization - a method of psychosynthesis. Topical Problems in Psychotherapy, 1963, 4, 70-80.
- Ghiselin, B. The Creative Process. New York: New American Library, 1952.
- Gordon, R. An investigation into some of the factors that favor the formation of stereotyped images. British Journal of Psychology, 1949, 39, 156-157.
- Gorman, A. Recognition memory for nouns as a function of abstractness and frequency. Journal of Experimental Psychology, 1961, 1, 23-29.
- Holt, R. Imagery: the return of the ostracized. American Psychologist, 1964, 19, 254-264.
- Horowitz, M. Image Formation and Cognition. New York: Appleton-Century-Crofts, 1970.
- Jacobson, E. Electrophysiology of mental activities. American Journal of Psychology, 1932, 44, 677-694.
- Juhasz, J. B. On the reliability of two measures of imagery. Perceptual and Motor Skills, 1972, 35, 874.
- Kelsey, I. B. Effects of mental practice and physical practice upon muscular endurance. Research Quarterly, 1961, 32, 47-54.
- Leuner, H. Guided affective imagery (GAI). American Journal of Psychotherapy, 1969, 23, 6, 4-22.
- Levy, J. Lateral specialization of the human brain: behavioral manifestations and possible evolutionary basis. Biology of Behavior, Oregon State University Press, 1972.

- Marks, D. F. Visual imagery differences in the recall of pictures. British Journal of Psychology, 1973, 64, 1, 17-24.
- McKim, R. H. Experiences in Visual Thinking. Monterey, California: Brooks-Cole Publishing Co., 1972.
- Neisser, U. Cognition and Reality. San Francisco: Freeman, 1976.
- Neisser, U. Cognitive Psychology. New York: Appleton-Century-Crofts, 1967.
- Ornstein, R. E. The Psychology of Consciousness. San Francisco: W. H. Freeman and Co., 1972.
- Paivio, A. Imagery and Verbal Process. New York: Holt, Rinehart and Winston, 1971.
- Paivio, A. Mental imagery in associative learning and memory. Psychological Review, 1969, 76, 241-263.
- Paivio, A., and Csapo, K. Picture superiority in free recall: imagery or dual coding? Cognitive Psychology, 1969, 5, 176-206.
- Perky, C. W. An experimental study of imagination. American Journal of Psychology, 1910, 21, 422-452.
- Pylyshyn, Z. W. What the mind's eye tells the mind's brain: a critique of mental imagery. Psychological Bulletin, 1973, 80, 1, 1-24.
- Richardson, A. Mental practice: a review and discussion; Part I. Research Quarterly, 1967, 38 (1), 95-107.
- Richardson, A. Mental practice: a review and discussion; Part II. Research Quarterly, 1967, 38 (2), 263-273.
- Richardson, A. Mental Imagery. New York: Springer Publishing Co., Inc., 1969.
- Roffwarg, H., Dement, W., Muzio, J., and Risher, C. Dream imagery: relationship to rapid eye movements of sleep. Archives of General Psychiatry, 1962, 7, 235-258.
- Samuels, M., and Samuels, N. Seeing With the Mind's Eye. New York: Berkeley, Calif.: Random House-Bookworks, 1975.

- Seaman, J. G., and Gazzaniga, M. S. Coding strategies and cerebral laterality effects. Cognitive Psychology, 1973, 5, 3, 249-256.
- Segal, S. J., and Fusella, V. Effects of imaging on signal-to-noise with varying social conditions. British Journal of Psychology, 1969, 60, 459-464.
- Segal, S. J., and Nathan, S. The Perky effect revisited: blocking of visual signals by imagery. Perceptual and Motor Skills, 1964, 18, 385-395.
- Sheehan, P. W. Visual imagery and organizational properties of perceived stimuli. British Journal of Psychology, 1967, 58, 247-252.
- Simmons, A. T. W. Pounds and Inches. Los Angeles: Medical Weight Control, 1966.
- Smyth, M. M. The role of mental practice in skill acquisition. Journal of Motor Behavior, 1975, 7, 3, 199-206.
- Snyder, C. R. R. Individual differences in imagery and thought. Unpublished dissertation, University of Oregon, 1972.
- Start, K. B., and Richardson, A. Imagery and mental practice. British Journal of Educational Psychology, 1964, 34, 280-284.
- Suinn, R. M. Body thinking: psychology for Olympic champs. Psychology Today, July, 1976, 38-42.
- Ulich, E. Some experiments on the function of mental training in the acquisition of motor skills. Ergonomics, 1967, 10, 4, 411-419.
- Walter, W. G. The Living Brain. New York: Norton, 1953.
- Watson, J. B. The Ways of Behaviorism, New York: Harper, 1928.
- Westcott, T. B., and Rosenstock, E. Reliability of two measures of imagery. Perceptual and Motor Skills, 1976, 42, 1037-1038.
- Wilson, M. E. The relative effect of mental practice and physical practice in learning the tennis forehand and backhand drives. Unpublished dissertation, University of Iowa, 1960.

MONTANA STATE UNIVERSITY LIBRARIES
 3 1762 10013314 7

[REDACTED]

N378 Chara, Paul J
 C371 Visual imagery and
 cop.2 individual differences

DATE	ISSUED TO
JAN 27 1978	AS D.W. E. Asmussen 712 S. W. Wilson
FEB 28 1978	Psych Dept. Ryles 524 N. Wallace
2-28-78	Heed Sheh
FEB 27 1978	McGowan
R	MAR 2 1978
JUN 1 1978	[REDACTED]
R	[REDACTED]

N378
C371
Cop 2