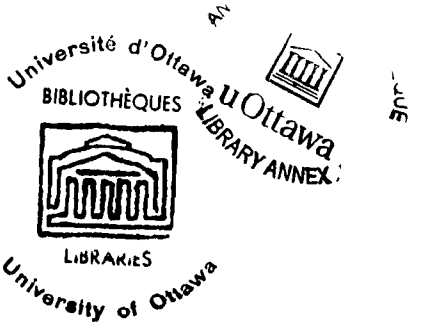
HIGH AND LOW IMAGERS AND HEMISPHERE DIFFERENCES IN RECOGNITION MEMORY PERFORMANCE FOR PICTURE AND WORD STIMULI

by Wolodymyr Dacko

Thesis presented to the School of Graduate Studies of the University of Ottawa as partial fulfilment of the requirements for the degree of Doctor of Philosophy



Ottawa, Canada, 1973

ACKNOWLEDGMENTS

This thesis was prepared under the joint supervision of Dr. Robert Stelmack, Assistant Professor at the Faculty of Psychology of the University of Ottawa, and Dr. William Barry, Chairman of the Department of General-Experimental Psychology at the Faculty of Psychology of the University of Ottawa. The writer gratefully acknowledges their counsel and continuous involvement in this research project.

The writer also wishes to thank Mrs. M. Sadler and Mrs. J. Kresic for enlisting the support of the student nurses of the Ottawa Civic Hospital who served as subjects. Grateful appreciation is also expressed to Mr. William Zuro for the preparation of picture stimuli, to Mrs. Mary Dacko for her assistance in scoring, and to Mr. Kenneth Campbell for his help in computer analyses.

Thanks are also extended to Mr. Edwin Achorn and Mr. Pierre Boudreault for their technical advice and assistance.

CURRICULUM STUDIORUM

Wolodymyr Dacko was born November 4, 1945, in Goslar, Germany. He received the Bachelor of Arts degree from University College, Dublin, Ireland, in 1967. He received the Postgraduate Diploma in Psychology from University College, Dublin, Ireland, in 1969. The title of his research was Social Competence of Mentally Handicapped Patients at Stewart's Hospital.

TABLE OF CONTENTS

Appendix page

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

This research undertook to investigate whether imagery differences are dependent on hemispheric specialization. More specifically, whether the locus of imagery ability lies in the right hemisphere. This question was suggested by the findings in hemispheric studies that the right hemisphere is dominant in spatial and practic functions, and by repeated observations in imagery research that high imagers are superior to low imagers in memory, be it recognition memory or paired-associate learning, of picture stimuli. To answer this question it was important that the experiment be so designed as to offer minimum variation between pictures and concrete words, but sufficient discrimination so that pictures would not forfeit their spatial quality in a verbal task. For this reason a coding recognition memory paradigm was employed to tackle the imagery-hemisphere issue.

If imagery differences are dependent on hemispheric specialization then one would expect in a coding recognition memory task the high imagery group to perform better in the right hemisphere condition.

Further, should the locus of imagery ability prove to be the right hemisphere, then if a task is given that is known to involve primarily the left hemisphere, would high imagers still fare better? If so, this would suggest that right hemisphere skills contribute to the execution of left hemisphere

tasks; if not, the opposite would be true. If right hemisphere skills do contribute to the execution of left hemisphere tasks, then how do they contribute? Do high imagers perform better in picture recognition and low imagers in word recognition, or do high imagers prove superior in both picture and word conditions? The latter alternative is disparate with the literature on imagery differences where it has been expressed that high imagers manifest greater recognition memory for pictures than low imagers, and low imagers manifest greater recognition memory for concrete words than high imagers. However, in view of the fact that the imagery findings on this issue are still unsettled, any objections to this alternative remain tentative. Finally, if the left hemisphere task is truly left hemispheric, then the results should show significant differences between right and left hemispheres in favour of the left hemisphere.

To test these three questions an item recognition memory paradigm was used so as to tap recognition memory of conceptual forms. The latter are known to be functions of the left hemisphere.

The first chapter of this study begins by presenting the historical perspectives of imagery research and the question of imagery differences. Then the pertinent hemispheric literature is reviewed. This is followed by a brief discussion of relevant recognition memory research and of the signal detection procedure. The chapter is concluded with

the presentation of the hypotheses in null form.

The second chapter describes the sample, the instruments, the experimental procedures and the statistical techniques employed in the testing of the hypotheses.

The third and final chapter presents and discusses the results of this experiment in relation to the hypotheses stated in chapter one.

CHAPTER I

REVIEW OF THE LITERATURE

This chapter presents the theoretical context and research findings from which the hypotheses to be tested in the present study emerged. The historical perspectives and the definition of imagery are presented in section one. Section two reviews the literature pertaining to the nature and function of individual differences in imagery habit. Section three relates these concepts to the findings on hemispheric specialization. The relevant studies on recognition memory and the theoretical rationale of Signal Detection as well as its contribution to the present study are examined in sections four and five, respectively. The chapter ends with a brief synopsis of the theoretical background and the presentation of the hypotheses in the null form.

1. Historical Perspectives and Definition of Imagery.

As early as 500 B.C. words were spoken of as images of things by the Greek poet Simonides[1]. Aristotle[2] wrote of a faculty of the sensitive soul called imagination, the

---

1 Bowra, C.M., Greek Lyric Poetry, London, Oxford University Press, 1961, p. 363.

2 Ross, David, Aristotle, London, Methuen, p. 143.

function of which was the interpreting of present sensations, the formation of after-images and memory. Locke[3] believed that perception was the first operation of all our intellectual faculties, that ideas were nothing but actual perceptions in the mind which ceased to be anything when there was no perception of them, and that the mind had the power in many cases to revive perceptions which it once had, with the additional realization that it has had them before. Locke questioned whether images can provide meaning in view of the fact that all things that exist are particular and discrete, while words are general in reference. His reply was that words become general by being made signs of general ideas that are abstractions from simple ideas.

Hume[4] divided all the perceptions of the mind into two classes which were distinguished by their different degrees of "force and vivacity". He referred to the less forcible as ideas which were copies or faint images of "impressions" that were the immediate lively perceptions of hearing, of seeing, of feeling . . . This distinction between impressions (sensations, perceptions) and ideas (images) is fundamental to Hume

---

3 Locke, John, "An Essay Concerning Human Understanding", (Abridged), in The Empiricists, New York, Doubleday, 1961, p. 7-133.

4 Hume, David, "An Enquiry Concerning Human Understanding", in The Empiricists, New York, Doubleday, 1961, p. 307-430.

for it characterizes the primary state of consciousness. Complex impressions or complex ideas are but compounds of simple sensations or simple images; and substances are ideas that have names and are therefore referred to as objects but are really explained by association as complexes. Hume disagreed with Locke, just as Berkeley did, that there were "abstract general ideas", for if the "idea" was an image or copy it had to be particular. They contended that what were called abstract ideas were in fact particular images that became general in their representation.[5]

Out of this empirical climate via John and James Stewart Mill emerged Wundt and the Wurzburg School of Kulpe. In Wundt[6] under the notion of "psychological compounding" one finds that the mind is to be described in terms of formal elements, like sensation, which have attributes of their own and which are connected by association. The goal of psychology is the analysis of mind into these simple qualities and the determination of the form of their ordered multiplicity[7]. He suggested that when one recalls the impressions that any particular experience has left on the mind, one can distinguish

---

5 Copleston, Frederick, A History of Philosophy, New York, Doubleday, 1964, Vol. 5, Part II, p. 77.

6 Boring, Edwin G., A History of Experimental Psychology, New York, Appleton, 1957, p. 329.

7 Ibid., p. 333.

in it three distinct elements - the image or idea; the reaction or feeling; and an effort or impulse. These three form a unity, but they can be distinguished, and each can be studied separately. The characteristic of the image is that it is present to the mind in the form of knowledge.[8]

For Kulpe, who studied and worked for a period with Wundt, the psychology of thought was to become his prime concern. It was under him that the Wurzburg school of imageless thought developed. The main theoretical importance of the school was that they exhibited the inadequacy of the assumption of the earlier tradition that mental events were describable in terms of sensations or images. It was Marbe[9] who discovered that the mind seemed, by the introspective method, to be an irrational associative train of mental contents that nevertheless reached a rational conclusion. A subject who would be asked to lift two weights and judge which was the heavier, would express plenty of conscious content, like sensations and images, but introspection revealed no psychological conditions of the judgment. Apparently the thinking involved in making the appropriate response did not necessarily involve images. Hence the possibility of "imageless thought". These experiments raised serious questions

---

8 Peters, R.S.,(ed.), Brett's History of Psychology, (Abridged). Cambridge, M.I.T. Press, 1965, p. 505.

9 Boring, Op. Cit., p. 403.

concerning both the memory and mediational functions that traditionally had been attributed to images. It occurred to those of a behaviouristic bent that some of the functions attributed to images in thought and memory might belong to words and their covert responses. It was suggested that implicit muscle responses were essential elements in the flow of thinking processes. This idea was tested by Jacobson[10], Max[11], and others. The results showed that implicit movements frequently occurred during thinking, and that reduced to a subvocal level, words could serve in thinking as cue-producing responses. However, some of the early behaviourists overstated their case when they concluded that thinking was nothing but a sequence of implicit responses.

Bartlett recognized the behaviourists' objection that images do not accurately reflect reality but he did not find it necessary to conclude that images have no function in relation to memory. Rather he felt that "by the aid of the image, and particularly of the visual image, . . . a man can take out of its setting something that happened a year ago, reinstate it with much if not all of its individuality

---

10 Jacobson, L.E., "The Electrophysiology of Mental Activities", in the American Journal of Psychology, Vol. 44, 1932, p. 677-694.

11 Max, L.W., "Experimental Study of the Motor Theory of Consciousness", in the Journal of Comparative Psychology, Vol. 24, 1937, p. 301-344.

unimpaired, combine it with something that happened yesterday, and use them both to help him solve a problem with which he is confronted today.[12] During the thirties and forties the problems associated with imagery continued to be discussed and, as mentioned by Paivio[13], it was not unusual to find the concept of imagery reappearing essentially in its pristine form but with its respectability enhanced by a behaviouristic cloak. Thus Leuba[14] referred to images as "conditioned sensations" in his study involving a classical conditioning paradigm.

The early fifties witnessed the dawning of new interests in the study of imagery. Aserinsky and Kleitman's[15] paper on rapid eye movements during sleep had drawn attention to the dream image, and the reality of nonverbal central events. At roughly the same time Barratt[16] had obtained in a factor-analytic study three factors which he called spatial

---

12 Bartlett, F.C., Remembering, Cambridge, Cambridge University Press, 1932, p. 219.

13 Paivio, Allan, Imagery and Verbal Processes, New York, Holt, 1971, p. 6.

14 Leuba, C., "Images as Conditioned Sensations", in the Journal of Experimental Psychology, Vol. 26, 1940, p. 345-351.

15 Aserinsky, E., and N. Kleitman, "Regularly Occurring Periods of Eye Motility and Concomitant Phenomena During Sleep", in Science, Vol.118, 1953, p. 274-284.

16 Barratt, P.E., "Imagery and Thinking", in Australian Journal of Psychology, Vol. 5, 1953, p. 154-164.

manipulation, spatial reasoning and shape recognition. It was found that subjects who reported most vivid imagery also performed better on tests which defined Barratt's spatial manipulation factor. These developments brought the revival of imagery studies.

Mention has been made of Leuba's definition of imagery as "conditioned sensations". Bartlett[17] defined an image as a stored percept, and imaging as the reference to a concrete object or situation, in the absence of peripherally aroused stimulation adequate to account for the reference. More recently Richardson[18] referred to imagery as all those quasi-sensory or quasi-perceptual experiences of which we are self-consciously aware, and which exist for us in the absence of those stimulus conditions that are known to produce their genuine sensory or perceptual counterparts, and which may be expected to have different consequences from their sensory or perceptual counterparts. On the other hand, Paivio has suggested a definition of imagery that is close to Bartlett's notion of imagery, and is less dependent on subjective reporting in that it requires that representations be "actively generated and manipulated by the individual":

---

17 Bartlett, F.C., "The Relevance of Visual Imagery to the Process of Thinking, III", in the British Journal of Psychology, Vol. 18, 1927, p. 23-29.

18 Richardson, A., Mental Imagery, New York, Springer, 1969, p. 2.

> The term image and imagery will generally be used to refer to concrete imagery, that is, nonverbal memory representations of concrete objects and events, or nonverbal modes of thought (e.g. imagination) in which such representations are actively generated and manipulated by the individual. This will usually be taken to mean visual imagery, although it is clear that other modalities (e.g. auditory) could be involved and when they are this must be specified.[19]

He added that imagery so defined is distinguished from verbal symbolic processes which are assumed to involve implicit activity in the auditory-motor speech system.

The term "image" has also been extended to the phenomena of afterimages and eidetic images. The former are most dependent upon the actual conditions of sensory stimulation and refer to the continuance or the revival of a sensory experience after the removal of the stimulus. They are not to be thought of as after-sensations or the terminal lags of sensations that are attributed to the continuance of the physiological activities in the receptors. The term eidetic image has been used to describe an unusually vivid memory image, a percept-like image, that differs from an after-image by lasting longer and by being nearly exclusive to children.

Unless otherwise stated, in this study the use of the word "image" has been restricted to the regular memory image as defined above by Bartlett or Paivio.

---

19 Paivio, Op. Cit., p. 12.

2. Individual Differences in Imagery.

The empirical foundations of the research on individual differences were laid by Galton[20], who had circulated a questionnaire to his scientific colleagues, asked them to bring to mind a picture - for example, of their breakfast table - and questioned them on the extent and nature of their image. He was surprised to find that many of his acquaintances denied having images. This suggested to him the possibility that "an over-ready perception of sharp mental pictures is antagonistic to the acquirement of habits of highly generalized and abstract thought".

Although Galton found little evidence for the existence of imagery types, that is, the differentiation of individuals on the basis of a dominant modality through which their imagery finds greatest expression, the following twenty-five years could be considered as a period of search for pure types[21,22,23]. No clear-cut types were found for it became evident that most people experience all kinds of imagery to

---

20 Galton, F., Inquiries Into Human Faculty and Its Development, London, MacMillan, 1883, p. 60.

21 Lay, W., "Mental Imagery", in the Psychological Review, Monograph Supplements, Vol. 2, 1898, p. 1-59.

22 French, F.C., "Mental Imagery of Students", in the Psychological Review, Vol. 9, 1902, p. 40-56.

23 Colvin, S., "Methods of Determining Ideational Types", in the Psychological Bulletin, Vol. 6, 1909, p. 223-237.

The then new force of the spreading behaviouristic movement was exerting greater and greater influence on psychology. Interests switched and two new directions appeared. One was the study of physiological correlates of mental processes, ironically reminiscent of Wundt's physiological psychology, that became a branch of its own which has continued up to the present[27,28,29,30]. The other was a birth of interests in the factorial structures of symbolic processes which gradually resulted in handing over to the field of imagery of certain performance tests[31,32].

It was not until the late fifties and early sixties that a number of studies, other than those concerning physiological or measurement questions, of imagery began to appear.

---

27 Golla, F.L., and S. Antonovitch, "The Respiratory Rhythm in its Relation to the Mechanism of Thought", in Brain, Vol. 52, 1929, p. 491-510.

28 Golla, F.L., E.L. Hutton and W.G. Walter, "The Objective Study of Mental Imagery", in the Journal of Mental Science, Vol. 89, 1943, p. 216-223.

29 Short, P.L., "The Objective Study of Mental Imagery", in the British Journal of Psychology, Vol. 44, 1953, p. 38-51.

30 Slater, K.H., "Alpha Rhythms and Mental Imagery", in Electroencephalography and Clinical Neurophysiology, Vol. 12, 1960, p. 851-859.

31 Barratt, Op. Cit., p. 154-164.

32 Thurstone, L.L., and T.E. Jeffrey, Flags: A Test of Space Thinking, Chicago, Education Industry Service, 1956.

Of these two were of specific interest to this study and both were doctoral dissertations - those of Kuhlman (1960)[33] and Stewart (1965)[34].

Kuhlman started with the supposition that imagery was a necessary mode of thought of the preverbal child but the fostering of it was a function of the child's history of rewards and punishments. She believed that when a child acquired language and thereby started to switch to adult categories, the survival of the image was dependent upon the permissiveness of parents and teachers. If they allowed the use of imagery and language analogous to imagery then the child would remain a high imager, but if they insisted on the categories and concepts of adult language, then the child would gradually adopt these at the expense of imagery and thus become a low imager. Kuhlman set out to test two hypotheses. One, that high imagers would learn the names of a series of objects in fewer trials than low imagery children because the visual image would facilitate silent rehearsal of the stimulus-label association in the absence of the object. Two, that low imagers would require fewer instances of a given concept before being able to identify correctly an example of the

---

33 Kuhlman, C.K., Visual Imagery in Children, unpublished Doctoral thesis, Radcliffe College, 1960.

34 Stewart, Joan Chalmers, An Experimental Investigation of Imagery, unpublished Doctoral thesis, University of Toronto, 1965.

object than high imagers because the low imagery child would be more concerned with locating the basis of the experimenter's categorization. Both hypotheses were supported. But she also found that nearly all the differences between high and low imagery children decreased with age and grade level, and that in some instances they became insignificant. She thus suggested that high imagers, as a group, became less frequent as age and the use of more abstract language increased.

Stewart questioned the above conclusion and reasoned that the lack of differences might be due not to age but to the fact that the experimental tasks in Kuhlman's studies were not difficult enough to differentiate between imagers in the higher grades, and that with suitable tasks the differences in performance between high and low imagers might continue to adulthood[35]. Her major expectation was that the habit of imaging continues to adulthood. She decided to investigate this in the context of memory strategies of individuals varying in imagery, and hypothesized: first, that the more "concrete" the matter to be memorized, the better will be the performance of all subjects; second, that "concreteness" compared to "abstractness" in the material to be memorized will favour the higher imager more than the low imager; third, that "abstractness" of the material will benefit the low imager

---

35 Ibid., p. 36.

more than the high imager[36]. She tested these hypotheses in three experiments involving three types of memory tasks: paired associate learning, recognition memory, and free recall. Her expectations were supported in the first two experiments. The results of the third, however, were consistent only with some of her expectations. Although she found that free recall was best for the high vivid list of words, next for the medium-vivid list, and poorest for the low-vivid list, imagery ability did not interact significantly with word vividness in the way it had with the picture-word variable in the previous two experiments[37]. Thus, Stewart's hypotheses were supported when "concreteness" was represented by the use of pictures and "abstractness" by the use of words, but not when "concreteness" was denoted by high vivid words and "abstractness" by low vivid words. It seemed that one was caught in a paradoxical situation of both positing and denying the efficacy of individuals varying in imagery on memory tasks.

Paivio[38] tackling the issue asked whether the effects of stimulus concreteness, instructions to use imagery, and individual differences in imagery were all attributable to

---

36 Ibid., p. 38.

37 Ibid., p. 86.

38 Paivio, Op. Cit., p. 509.

a common intervening process. With respect to picture-word variation and imagery ability his answer was positive. But he found it necessary to admit that the results of Stewart's noun vividness experiment appeared inconsistent. He thus concluded:

> These findings suggest that the imagery factor involved in the spatial ability tests and differential memory for pictures and words is not the same imagery variable that mediates the effect of noun imagery,

and suggested that a consistent imagery interpretation of the various findings could be preserved by assuming two kinds of imagery ability, one tied closely to perception and short-term memory for concrete events, the other to words as conditioned stimuli for long-term nonverbal memory images.

Apart from Paivio's attempt to reconcile the anomaly by the supposition of the duoprocess theory, Stewart's findings are of particular interest when taken in conjunction with the research on hemispheric differences which will be discussed in the following section.

In the studies of hemispheric differences it has been observed that the right hemisphere is dominant in spatial tasks whereas the left is dominant in verbal tasks[39]. One would therefore expect different handling of content that

---

39 Mountcastle, V.B., (ed.), Interhemispheric Relations and Cerebral Dominance, Baltimore, John Hopkins Press, 1962, p. 273.

differs on spatial or verbal loading as against content that is distinguished within the verbal dimension only. Is this not what Stewart found: that the "picture-word" dimension was not interchangeable with the "high-low vividness" dimension? Could it not be that imagery differences are set in hemisphere differences? If so, then in the studies of hemispheric organization one might be able to find further cues in explaining imagery.

It was this question - whether imagery differences were founded in hemisphere differences - that this research attempted to answer.

In the following section attention has been focused on the theoretical and empirical support for hemispheric specialization.

3. Hemispheric Specialization.

Most animals are characterized by an essentially symmetrically structured nervous system[40]. In man, however, the two cerebral hemispheres differ greatly in their functions. For man has acquired mental processes that are free of specific spatial reference and are distributed asymmetrically

---

40 Milner, Brenda, "Interhemispheric Differences in the Localization of Psychological Processes in Man", in the British Medical Bulletin, Vol. 27, 1971, p. 272.

between the cerebral hemispheres[41]. For long it has been recognized that the left hemisphere generally subserves language functions, but less attention has been paid to the right hemisphere; even though Hughlings Jackson in the nineteenth century expressed some interesting conceptions about the latter. There were probably many reasons why interests focused on the left hemisphere. Those that seemed most obvious were, first the early interests in aphasias and other language disorders[42]; second, the fact that various language disorders were often more easily recognizable in the western society where so many tests were of linguistic orientation; and third, possibly western man's preoccupation with linguistic categories as primarily representative of human thought. This led to the belief that the left hemisphere was the dominant one. However, by the early sixties it became evident that one cannot call one hemisphere dominant as such, because dominance manifested itself only for special functions: in the left hemisphere, dominance existed for language (sometimes also in the left-handers), including reading and calculation. In the right hemisphere, dominance seemed to exist for certain spatial

---

41 Kinsbourne, Marcel, "Eye and Head Turning Indicates Cerebral Lateralization", in Science, Vol. 176, 1972, p. 539.

42 Kimura, Doreen, "The Asymmetry of the Human Brain", in Scientific American, Vol. 228, 1973, p. 70-78.

and practic functions and some special gnostic performances[43,44]. Thus, it is now generally accepted that the superiority of a given hemisphere depends on the kind of ability under consideration.

Kimura has related observed asymmetries in auditory[45], melodic[46], and visual[47] perception to asymmetry of function in human cerebral hemispheres, and had suggested that the effects were a consequence of more efficient information transmission by the shorter pathways in that the input transmitted along the shorter pathways better maintained its integrity and therefore was more amenable to processing[48]. She reported that the predominance of the left hemisphere for speech was reflected in superior recognition for words arriving at the right ear, while the predominance of the right hemisphere in

---

43 Semmes, J., "Hemispheric Specialization: A Possible Clue to Mechanism", in Neuropsychologia, Vol. 6, 1968, p. 11.

44 Mountcastle, Op. Cit.

45 Kimura, Doreen, "Functional Asymmetry of the Brain in Dichotic Listening", in Cortex, Vol. 3, 1967, p. 163-173.

46 Kimura, Doreen, "Left-Right Differences in the Perception of Melodies", in the Quarterly Journal of Experimental Psychology, Vol. 16, 1964, p. 355-358.

47 Kimura, Doreen, "Dual Functional Asymmetry of the Brain in Visual Perception", in Neuropsychologia, Vol. 4, 1966, p. 275-285.

48 Ibid., p. 281.

melodic-pattern perception was reflected in superior identification of melodies arriving at the left ear[49]. With reference to visual perception, she concluded that the left posterior part of the brain played an important role in the identification of verbal-conceptual forms, while the corresponding area on the right had other functions in the registration of non-verbal stimuli[50].

Kinsbourne in a series of experiments has shown that the effects of perceptual asymmetry are not necessarily the consequence of more efficient information transmission by the shorter pathways, but could be interpreted as a function of differential expectancy[51]. In view of the fact that habit shares certain characteristics of preparatory set and that Kuhlman and Stewart accepted that imagery differences were to some extent a function of habit, it may be of interest to suggest that imagery differences may be related to attention.

Semmes[52], approaching the problem of hemispheric specialization from the vantage point of a possible clue to the mechanism, found that both with respect to the hemisphere as a whole and with respect to the sensorimotor region, there

---

49 Kimura, 1967, Op. Cit., p. 177.

50 Kimura, 1966, Op. Cit., p. 275.

51 Kinsbourne, Marcel, "The Cerebral Basis of Lateral Asymmetries in Attention", in Acta Psychologica, Vol. 33, 1970, p. 196.

52 Semmes, Op. Cit., p. 11-26.

appeared to be a less focal representation of reflex function in the right hemisphere than there was in the left[53], thus bearing out that the hemispheres differed in the way they represented contralateral function. She then asked whether they also differed in the way they represent ipsilateral function. Her conclusion was that the findings favour the view that the asymmetries observed in the effects of lesions were expressive of a difference in the fundamental organization plan of the right and left hemisphere, because impaired orientation was related to locus of injury only for left hemisphere lesions, not for right[54]. Semmes, therefore, proposed that focal representation of elementary functions in the left hemisphere favoured integration of similar units and consequently specialization for behaviours which demanded fine sensorimotor controls such as manual skills and speech. Conversely, diffuse representation of elementary functions in the right hemisphere, she suggested, may lead to integration of dissimilar units and hence specialization for behaviours requiring multimodal coordination, such as the various spatial abilities[55].

---

53 Ibid., p. 16.

54 Ibid., p. 18.

55 Ibid., p. 11.

If what Semmes proposed is the case, namely that the mode of representation reflected the differing characteristics of the hemispheres, then one would expect thought processes to exhibit two distinct arrangements of material when processed by one as against the other hemisphere. One would expect the left hemisphere to be superior in handling data that required fine or focal organization, and the right hemisphere to be more successful in the organization of diffuse content. With reference to imagery one could say that one would expect imagery ability to be tied closely to diffuse material (perceptions, pictures), and less closely to focal data (words).

Bogen has asked in a series of review papers the question: "What is the right hemisphere for, in the human scheme of things?"[56] He went on to offer a synthesis of the subject on the specialization of the right hemisphere[57]; and was impressed by the fact that the right hemisphere recognized stimuli (including words), apposed or collated data, compared them with previous data, and that while receiving the very same stimuli as the other hemisphere would often

---

56 Bogen, Joseph E., "The Other Side of the Brain I: Dysgraphia and Dyscopia Following Cerebral Commisurotomy", in the Bulletin of the Los Angeles Neurological Societies, Vol. 34, 1969, p. 73-105.

57 Bogen, Joseph E., "The Other Side of the Brain II: An Appositional Mind", in the Bulletin of the Los Angeles Neurological Societies, Vol. 34, 1969, p. 135-162.

arrive at different results[58]. He opted for the terms "appositional" to characterize the right brain and "propositional" to denote the left hemisphere. He preferred the term "appositional" to any other, because it "implies a capacity for apposing or comparing of perceptions, schemas, engrams, etc., but has in addition the virtue that it implies very little else"[59]. By assuming two kinds of cognition or two distinct modes of thought - that of the appositional and propositional brain - Bogen[60] expressed that one would be more effective than the other in dealing with certain problems from which it followed that in an individual with customary lateralization, each hemisphere would contribute a varying proportion depending upon the situation or problem presented to the individual.

Further, Bogen[61] suggested that the expression of the functions of a given hemisphere may very well be determined by the culture that one inhabits. The concept of individual "hemisphericity" was used to denote a tendency for a person to rely more on one hemisphere than the other. In a similar way, Kuhlman believed, as noted above, that the survival of

---

58 Ibid., p. 148.

59 Ibid., p. 150.

60 Bogen, Joseph E., et al., "The Other Side of the Brain IV: The A/P Ratio", in the Bulletin of the Los Angeles Neurological Societies, Vol. 37, 1972, p. 49-61.

61 Ibid., p. 50.

the image habit in the child was a function of the child's immediate surroundings, especially of parent and teacher approval.

Semmes' hemispheric findings; the mutual complementarity of Bogen's "hemisphericity" concept with Kuhlman's acceptance of cultural determinants of imager; the observation that lateralization of spatial functions favoured the right hemisphere and that the appositional brain was capable of both collating and interpreting data with the knowledge that visual imagery findings differed from noun vividness results - all these concurrencies served as reasons for this study, and warrant the investigation of whether or not the locus of imagery is in the right hemisphere.

It was decided that this question should be approached in the context of a recognition memory paradigm because it not only enables one to answer the question of closeness of imagery and hemisphere variables, but also allows a replication of Stewart's second experiment, and offers an opportunity to study the relationship between the hemispheric variable and recognition memory for pictures and concrete words.

The proceeding section discusses relevant recognition memory research.

4. Recognition Memory.

In the study of memory two theoretically separate processes have been postulated: the storage of traces and their retrieval[62]. Attempts have also been made to demonstrate that the two processes are experimentally separable. Estes and Da Polito[63] asked of their subjects to learn paired-associate items under either intentional or incidental instruction conditions and then tested them for recognition or recall. They reported that recognition scores indicated very little difference in the amount learned following either of the two types of instructions. However, recall performance was greatly superior under the condition of intentional instructions. These results were interpreted as supporting the assumption that recall performance involved a retrieval process, whereas recognition did not, and that the intentional condition provided for rehearsal, thereby making the material more readily available for retrieval. In another study Wolf and Jahnke[64] investigated the effects of intraserial repetition

---

62 Melton, A.W., "Implications of Short-Term Memory for General Theory of Memory", in the Journal of Verbal Learning and Verbal Behavior, Vol. 2, 1963, p. 1-21.

63 Estes, W.K., and F. Da Polito, "Independent Variation of Information Storage and Retrieval Processes in Paired-Associate Learning", in the Journal of Experimental Psychology, Vol. 75, 1967, p. 18-26.

64 Wolf, T.M., and J.C. Jahnke, "Effects of Intraserial Repetition on Short-Term Recognition and Recall", in the Journal of Experimental Psychology, Vol. 77, 1968, p. 572-580.

on short-term recognition and recall. The Ranschburg effect of inhibition of performance on repeated digits appeared in the recall condition, but memory for repeated items was facilitated in the recognition situation. They suggested that the Ranschburg phenomenon may be a function of retrieval and its absence in the recognition situation was suggestive that retrieval did not occur in recognition. No conclusive evidence that shows that storage and retrieval are experimentally separable has been provided, but it has been suggested that a recognition memory task provides an optimal setting for the investigation of storage minimally confounded by retrieval operations[65]. For this reason, as well as that it requires no particular identifying response, recognition memory has generally been regarded as the least complex of memory tasks.

In describing Stewart's work, it was stated that her second experiment involved a recognition memory task. The purpose of the experiment was to investigate whether pictures were recognized more easily than words; if so, whether this more precise recognition of pictures versus words was greater for high imagers than for low imagers; and to obtain some measure of the coding methods of the two types of imagers[66].

---

65 McCormack, P.D., "Recognition Memory: Storage or Retrieval?", unpublished paper, Ottawa, Carleton University, 1970, p. 28.

66 Stewart, Op. Cit., p. 53.

Her results indicated that pictures were recognized more easily than words by both high and low imagers; that high imagers were superior to low imagers in picture recognition but inferior in word recognition; and that high imagers were more likely to call a word a picture, and the low imagers were more likely to call a picture a word when they made associate errors. Stewart interpreted the latter to mean that, in memory, the high imagers were more likely to code a word as a picture, and low imagers were more likely to code a picture as a word[67]. These findings are in general consistent with other research in recognition memory.

Shepard[68] investigated recognition memory in three experiments in which the stimuli were, respectively, words of two levels of familiarity, short sentences and about 750 pictures. His results showed: first, high recognition memory for all stimulus types; and second, that best recognition was for pictures.

Similar results were obtained by Nickerson[69], who was interested in researching the ability to recognize complex

---

67 Stewart, Op. Cit., p. 74.

68 Shepard, R.N., "Recognition Memory for Words, Sentences, and Pictures", in the Journal of Verbal Learning and Verbal Behavior, Vol. 6, 1967, p. 156-163.

69 Nickerson, R.S., "Short-Term Memory for Complex Meaningful Visual Configurations: A Demonstration of Capacity", in the Canadian Journal of Psychology, Vol. 19, 1965, p. 155-160.

meaningful visual configurations as, for example, pictures of people, places, and things. His results showed that the general performance level was high with 95 percent of all responses correct and that the lowest subject was better than 80 percent of the trials.

Haber[70] has suggested that the capacity of memory for pictures may be unlimited. In an experiment which he conducted with Standing[71] they showed 2,560 photographic slides at the rate of one every 10 seconds over a period of either two days to one group of subjects or four days to another. The results showed 85 to 95 percent correct recognition and that subjects whose endurance had been pressed did as well as subjects who had followed a more leisurely viewing schedule. The high scores were maintained even when the pictures were shown as their mirror images during the identification sessions. Haber and Erdelyj[72] also commented that recognition is based on some type of representation in memory that is maintained without labels, words, names or the need for rehearsal.

---

70 Haber, Ralph Norman, "How We Remember What We See", in the Scientific American, Vol. 222, 1970, p. 104-112.

71 Ibid., p. 104.

72 Ibid., p. 105.

Jenkins et al[73] were also interested in the question of stimulus concreteness, more precisely in comparing the effects of using either pictures or words in a recognition memory task. Their data confirmed that recognition is higher for pictures of familiar objects than for their concrete-noun labels, and supported the hypothesis that pictures are encoded and stored with their verbal label, without the necessary implications of a facilitative effect in recognition. Gorman[74], on the other hand, researched the question of concreteness versus abstractness within the word group, and reported more accurate recognition for concrete than for abstract words.

The question of familiarity or frequency of stimulus has been raised by a number of researchers. Dale[75] examined the predictions that when stimuli are drawn from a category in which the members are not all highly familiar then differences in familiarity will effect the probability of recall, but not that of recognition; and second, recognition will be

---

73 Jenkins, et al., "Differential Memory for Picture and Word Stimuli", in the Journal of Educational Psychology, Vol. 58, 1967, p. 303-307.

74 Gorman, A.M., "Recognition Memory for Nouns as a Function of Abstractness and Frequency", in the Journal of Experimental Psychology, Vol. 61, 1961, p. 23-29.

75 Dale, H.C.A., "Familiarity and Free Recall", in the Quarterly Journal of Experimental Psychology, Vol. 19, 1967, p. 103-108.

superior to recall if unfamiliar stimuli are used, but not otherwise. The stimuli were a list of English county names. The findings supported his predictions that familiarity would have a positive effect on recall, but no effect on recognition, and that recognition would be superior to recall when unfamiliar stimuli were used.

Some authors have looked at the familiarity variable within the context of recognition memory alone. Gorman, in the study mentioned above, employed high and low frequency words and noted better recognition for the low frequency group. Similar findings were also reported by Shepard[76].

Schonfield and Robertson[77] approached the problem of recognition from the standpoint of aging. They administered recall and recognition tests to subjects ranging in age from 20 to 75 years. The results indicated no deterioration with age in recognition scores, but a consistent drop in recall performance which they interpreted as due to the requirements of retrieval from storage in recall tests.

These findings clearly indicate that recognition memory is not the same as perceptual recognition for perceptual

---

76 Shepard, Op. Cit.

77 Schonfield, D., and B. Robertson, "Memory Storage and Aging", in the Canadian Journal of Psychology, Vol. 20, 1966, p. 228-236.

recognition has been shown to be relatively unaffected by word concreteness and positively related to word frequency[78].

In all, the major empirical contributions of the recognition memory research reviewed above were: first, that retrieval has a minimum effect if not entirely absent in recognition; second, that imagery has shown a positive effect on recognition; third, that stimulus concreteness has a positive effect in that pictures are more easily recognized than concrete nouns and concrete nouns are better recognized than abstract words; fourth, that positive familiarity or frequency of stimulus has a neutral effect on recognition when compared to recall; fifth, that negative frequency when varied within words has a positive effect in that rare words are more easily recognized than common words; and finally, that recognition memory shows no deterioration with age.

5. The Signal Detection Approach.

The theory of signal detection emerged from statistical decision theory and originally was developed in connection with problems in radar[79]. In classical psychophysics

---

78 Winnick, W.A., and K. Kressel, "Tachistoscopic Recognition Thresholds, Paired-Associate Learning, and Immediate Recall as a Function of Abstractness-Concreteness and Word Frequency", in the Journal of Experimental Psychology, Vol. 70, 1965, p. 163-168.

79 Swets, John A., Wilson P. Tanner and Theodore G. Birdsall, "Decision Processes in Perception", in the Psychological Review, Vol. 68, 1961, p. 301-340.

provisions were made for the parameter associated with the sensitivity of the observer, but the problem of confounding nonsensory or personal determinants remained. The value of signal detection approach lies in that it contains an analytic procedure for specifying independently the subject's criterion. By providing this quantitative measure of the criterion that the subject uses in making the judgment, what remains is a relatively pure measure of the subject's perceptual or recognition style, which is generally referred to as the discrimination index, or d'.

In main, there are three procedures of obtaining a d'[80]. The first of these is the single-interval method. It involves a "yes" or "no" response to a single observation interval. The listener knows that a signal, if presented, will occur in a well-delineated interval of time and that he will have to take a decision after each observation as to whether or not the signal was in fact presented. If the subject recognizes the signal when in fact it was presented, he scores a hit; if he indicated that the signal was present when in fact it was not, he scores a false-alarm. The level of the subject's decision criterion is determined by the number of false-alarms.

---

80 Egan, James P., and Frank R. Clarke, "Psychophysics and Signal Detection", in Joseph B. Sidowski, (ed.), Experimental Methods and Instrumentation in Psychology, New York, McGraw-Hill, 1966, p. 211-246.

The second method used is the forced-choice procedure. Generally two or more observation intervals are presented in succession to the subject and he is to state which one of the observation intervals has signal energy been added to.

The third approach is the rating method. Here the subject is asked to adopt a multiple criteria; or, as Egan and Clarke[81] have expressed it, "the rating method requires a statement by the observer about the odds that the signal was presented". In effect, it permits to plot the subject's receiver-operating-characteristic (ROC) curve without the need of running a series of similar experiments with different pay-off probabilities that would be required of a binary-decision procedure.

The ROC curve is a curve that depicts the nature of the subjects responding under different likelihood ratios. If these likelihood ratios are either manipulated by a number of similar experiments where only the probabilities of noise and signal plus noise are altered, or where the subject is permitted to adopt a number of different probabilities as in the rating method, a series of proportions is obtained that is used to estimate the probabilities of noise and noise plus signal, and thus, yield a number of points that determine the slope of the ROC curve. The slope of the curve at a given

---

81 Ibid., p. 232.

point on the curve corresponds to the value of the likelihood ratio at which the subject has placed his criterion. Thus from the ROC curves it is possible to infer the criterion that is employed by a person.

In the context of this study signal detection provided the means of considering the influence of recognition memory of high and low imagers when pictures and words were presented to the right and left hemisphere, apart from personal determinants like motives or sets.

The use of signal detection for recognition memory was originally proposed and developed by Egan in a technical report which in its essentials was reproduced by Green and Swets[82]. It has been used among others in recognition memory by Wickelgren[83] and Schulman[84] who reported higher d'-values for rare than for common words.

This closes the presentation of the theoretical context from which the research questions emerged. The final section presents a brief summary and a statement of the hypothesis of this study.

---

82 Green, David M., and John A. Swets, Signal Detection Theory and Psychophysics, New York, Wiley, 1966, xi-455 p.

83 Wickelgren, W.A., "Exponential Decay and Independence from Irrelevant Associations in Short-Term Recognition Memory for Serial Order", in the Journal of Experimental Psychology, Vol. 73, 1967, p. 165-171.

84 Schulman, A.I., "Word Length and Rarity in Recognition Memory", in Psychonomic Science, Vol. 9, 1967, p. 211-212.

6. Summary and Statement of the Hypotheses.

In the research on individual differences in imagery Kuhlman found that children differed in the degree to which they retained imagery habit and in their performance on tasks varying in the level of concreteness. However, she noticed that these differences between high and low imagery children decreased with age and concluded that imagery became less frequent as age and the use of more abstract language increased. Stewart questioned the above conclusion and reasoned that the disappearance of differences in the older age group in Kuhlman's research was due to the fact that the experimental tasks were not difficult enough to differentiate between imagers, and believed that with suitable tasks the differences in performance between high and low imagers would continue to adulthood. Her view was substantiated by her research, but an interesting side phenomenon appeared. She found that concreteness compared to abstractness in the material to be memorized favoured the high imager more than the low imager, but only when she used pictures to represent concreteness of material and words to signify abstractness of content, but not when she used high vivid words to denote concreteness and low vivid words to represent abstractness.

Paivio faced this issue by suggesting the duoprocess approach to imagery, which assumes two kinds of imagery

ability - one tied closely to perception and short-term memory for concrete events, and the other to words as conditioned stimuli for long-term nonverbal memory images. He implied that the picture-word condition dealt with imagery ability as closely linked to perception and short-term memory, whereas the high-low vividness condition was an example of imagery ability as bound to words that function as conditioned stimuli for long-term nonverbal memory images.

Stewart's findings and Paivio's tackling of the discrepancy in them, and the fact that the inconsistency seemed to be resolvable in terms of hemispheric observations, suggested to this author the possibility of the imagery variable being closely connected to hemisphere specialization. In the studies of hemispheric differences it has been observed that the right hemisphere tends to be more involved in spatial functions whereas the left favours verbal information. On the basis of this, one would expect different findings when right-left involvement was being compared, as it would seem to have been in Stewart's picture-word condition, as against research concerned with a comparison of within-left hemispheric functioning that seemed to be tapped in Stewart's high-low vividness experiments.

To test the question of whether or not imagery differences were linked to hemisphere differences, the coding recognition memory paradigm was employed. To follow up this

issue and extend it to the question of imagery differences proper the item recognition memory paradigm was used.

Thus the main variables of this research are: first, imagery as expressed in two groups of high imagers and low imagers; second, the hemispheric dimension as defined by presentation to the right or left hemisphere; and third, the stimulus variable as described by whether pictures or words were shown to the subject. The dependent variables are the subject's coding recognition memory performance and item recognition memory performance as qualified by Signal Detection theory, so as to eliminate as much as possible nonrecognition factors affecting recognition accuracy.

With these variables in mind and the question of relation of imagery to hemisphere differences, the following null hypotheses are put forth:

1. There are no significant differences in coding recognition memory indices of subjects classified as high and low in imagery ability when picture and word stimuli are presented to the right and left hemispheres.

2. There are no significant differences in coding recognition memory indices based on the comparison of right and left hemispheres when picture and word stimuli are presented to subjects classified as high and low in imagery ability.

3. There are no significant differences in coding recognition memory indices based on the comparison of picture and word stimuli presented to the right and left hemispheres of subjects classified as high and low in imagery ability.

4. There is no significant interaction between levels of imagery ability and hemispheres with respect to coding recognition memory indices obtained from the presentation of picture and word stimuli.

5. There is no significant interaction between levels of imagery ability and stimulus type with respect to coding recognition memory indices obtained from the presentation of stimuli to the right and left hemispheres.

6. There is no significant interaction between hemispheres and stimulus type with respect to coding indices obtained from the presentation of stimuli to subjects classified as high and low in imagery ability.

7. There is no significant interaction among levels of imagery ability, hemispheres and stimulus type, with respect to coding recognition memory indices.

8. There are no significant differences in item recognition memory indices of subjects classified as high and low in imagery ability when picture and word stimuli are presented to the right and left hemispheres.

9. There are no significant differences in item recognition memory indices based on the comparison of right and left hemispheres when picture and word stimuli are presented to subjects classified as high and low in imagery ability.

10. There are no significant differences in item recognition memory indices based on the comparison of picture and word stimuli presented to the right and left hemispheres of subjects classified as high and low in imagery ability.

11. There is no significant interaction between levels of imagery ability and hemispheres with respect to item recognition memory indices obtained from the presentation of picture and word stimuli.

12. There is no significant interaction between levels of imagery ability and stimulus type, with respect to item recognition memory indices obtained from the presentation of stimuli to the right or left hemispheres.

13. There is no significant interaction between hemispheres and stimulus type with respect to item recognition memory indices obtained from the presentation of stimuli to subjects classified as high and low in imagery ability.

14. There is no significant interaction among levels of imagery ability, hemispheres and stimulus type, with respect to item recognition memory indices.

The methods employed to test these hypotheses are presented in the following chapter.

CHAPTER II

EXPERIMENTAL DESIGN

This chapter considers the methodology of this research. First, are described the subjects who participated in the experiment and the procedure used to classify them into groups of high and low imagers. Next, follows an account of the stimuli used and how these were prepared. Then the apparatus for showing the stimuli to the right and left hemisphere is presented. The fifth section details the procedures used in conducting the experiment. The dependent variables are presented in the sixth section. The chapter concludes with a discussion of the statistical analysis used in testing the hypotheses outlined at the end of chapter one.

1. Subjects.

A group of ninety-seven female volunteers who were enrolled in the first year at the Ottawa Civic Hospital School of Nursing participated in the initial testing. Two tests were administered to them: the Revised Minnesota Paper Form Board Test (MPFB) - Form AA[1], and the Spatial Relations (SR)

---

1 Likert, Rensis, and William H. Quasha, The Revised Minnesota Paper Form Board Test, New York, Psychological Corporation, 1948.

Subtest of the Differential Aptitude Tests - Form L[2]. Samples of these tests are shown in Appendix 1. From the initial sample of ninety-seven subjects, fifteen described themselves as either left handers or of mixed handedness and were therefore excluded from further participation, so as not to confound the hemispheric variable; for it has been shown[3] that language dominance is a function of the left hemisphere in right handers, but not necessarily so in left handers. Of the remaining eighty-two subjects one dropped out of the Nursing School in the interim period between the initial testing and the actual experiment, and one was randomly eliminated so as to equalize the sample size. Thus eighty subjects remained and they constituted the final experimental sample. Their ages ranged from 18 to 27 years, with a mean age of 19.57 and a median age of 19 years.

2. Imagery Classification Procedure.

Many tests have been employed as possible measures of imagery ability: Galton's Imagery Questionnaire, Betts Imagery Questionnaire, Sheehan's shorter version of Betts Imagery Questionnaire - generally referred to as Betts QMI Vividness

---

2 Bennett, George K., Harold G. Seashore and Alexander G. Wesman, Differential Aptitude Tests, New York, Psychological Corporation, 1966.

3 Mountcastle, Op. Cit.

of Imagery Scale - Space Relations Test, Minnesota Paper Form Board and Flags Tests and a few others. Of these Galton's questionnaire is generally honoured as the first of imagery tests and is, like the Betts Questionnaire and its shortened version, a subjective test of vividness or ease of imagery. The SR, MPFB and Flags tests are primarily performance tests of perceptual or figural ability. In this study imagery differences were operationally defined in terms of subjects' performance on MPFB and SR tests. The rationale for selecting these tests was, first that the SR and MPFB have a high loading on the imagery factor of figural transformational ability (SR = ,79, MPFB = .64), and second that the MPFB of all the performance tests has the highest loading on the imagery factor as defined by subjective reports (MPFB = .48). Both tests require finding a figure that is composed of the same parts as the sample figure. This can only be achieved by rotating the parts of the sample figure and juxtaposing them together in one's mind so as to form one of the alternative figures. The MPFB, however, differs from the SR test in that the figures of the MPFB test are all two dimensional, and thus require the subject to operate within two dimensional space; whereas those of the SR are three dimensional and require the subject to operate within three dimensional space. Since the ability to

hold a figure in mind and then manipulate it is a function of imagery, these two tests seemed most suitable.

The raw scores of subjects' performances on these tests were converted to standard scores so that the tests could be combined giving equal weight to each score. The subjects were then divided into two groups using the median split method. The top forty were designated as high imagers and the bottom forty as low imagers. The raw and converted scores of MPFB and SR tests are shown in Appendix 2.

In view of the fact that all subjects were first year student nurses with a relatively similar educational background and that hitherto no significant relationship has been found between imagery ability and intelligence scores no measures of intelligence were taken. This issue will be more thoroughly discussed in the final chapter.

3. Construction and Classification of Stimuli.

The stimuli were common pictureable objects. Four criteria determined the choice of a stimulus. First, each stimulus item had to be able to be drawn clearly. Second, the drawn objects had to be as unambiguous as possible - that is, a picture had to call forth a one-word name. Third, two items were not included in the series if they were likely to call forth the same name. Fourth, all the pictures had to be capable of being represented in two-dimensional form.

Following these criteria 288 items were listed. The sources of these items were Stewart's list, children's ABC and colouring books and shopping catalogues. Of all these items pictures were drawn in Indian ink on white 8½x10 inches tracing paper, each picture being represented on one sheet of paper. The words of the 288 items in like manner were typed on sheets of paper by an IBM Selectric typewriter with a pica type.

From the 288 items 140 were randomly chosen and called the picture items. From the remaining 148 items 8 were randomly selected and named the trial items of which four were picture items and four were word items. The remaining 140 items were designated as word items.

The picture items were then again randomly divided into two even groups of 70 items per group and one group was called the target group, and the other was termed the distractor group. The same procedure was used to divide the word items into two different groups - the target and the distractor group.

The items were then photographed and made into slides. Two sets of black and white orthoreversal slides were prepared from the 70 items designated as picture target group and from the 70 items termed word target group. One set of slides was prepared from the 70 items designated as picture distractor group, from the 70 items called the word distractor group and

from the 8 trial items. In all 428 slides were prepared.

A set of picture and word slides was then randomly sorted into a 140-slide Kodak Carousel tray, labelled the target tray. The other set of target slides was randomly mixed with the picture and word distractor slides and this time the 280 slides were sorted into two 140-slide Carousel trays. These were the recognition trays.

All the picture slides depicted different items from the word slides and all the target slides were distinct from the distractor slides. They are all listed in Appendix 3.

4. Presenting to the Hemispheres: Apparatus.

On a solid table 6 feet long by 30 inches high and 30 inches wide a rear projection assembly 28 inches high by 24 inches wide was placed 2½ feet in from the head of the table at the subject's end. The dimensions of the rear projection screen without the supports were 14½ inches by 14 inches high. A white sheet of Bristol paper of the same dimensions as the screen itself was placed just behind the projection screen, and in it a rectangular aperture of 5 inches by 3¼ inches was cut out, so that the centre point of the stimulus would always fall within 2¼ to 2½ inches from the fixation point. The fixation point was a black dot with a 3/8-inch diameter, 16¼ inches high from the surface of the table and 7¼ inches in from the side of the projection screen.

The aperture served as the viewing area and by rotating the Bristol sheet it appeared to the right or left of the fixation point. It also performed the function of eliminating the occurrence of the phi phenomenon due to the superimposition of the two projectors one on top of the other and the alternating of the stimulus slides with the blank slides.

The two projectors were placed approximately 14 inches behind the screen on an elevation device, 9 inches high, and on top of each other. The bottom projector was a Kodak Carousel, Model 600H. The top projector was a Kodak Carousel, Model 650H, identical to the 600H model except that it was equipped with a remote control slide switch: Standard Kodak Forward/Reverse Switch. Both had identical projection lamps: Canadian General Electric, Quartzline, 120V, 300 watts, Model ELH. Their lenses were also the same: a 4-inch Ektanar lens with an aperture of f3.5. Because the presentation of stimuli was of the rear projection type, it was necessary to cut down on the brightness of the two lamps. Thus, two regular incandescent dimmer switches (600 watt maximum) were in series with the projectors' lamps. Also two neutral density .30 Kodak Wratten filters were attached over a black, opaque iris with a ½-inch diameter opening and fitted onto the outside lenses of both projectors. The level of illumination on the visual fields was 1.26×10^3 foot lamberts as measured by a Spectra Pritchard Photometer, Model 1970-PR. To make it possible for

one person to conduct the experiment it was necessary to couple the manual remote control slide switch of the 650H projector to a Sony:FS-6 type footswitch.

The two projectors were aligned in such a way as to present their slides on the screen through the viewing aperture. So that the viewing aperture would remain constantly illuminated, the bottom projector was designated the function of handling the blank slide, whereas the top projector was responsible for the stimulus slides. The two projectors were then connected to a Lafayette Repeat Cycle Timer, Model 5040B, which made it possible to alternate the exposures of the blank slide with the stimulus slides, as well as to control the stimulus slides' exposure duration, and by way of the push-button remote exposure control trigger the onset of the stimulus slides.

Finally, a B&L type adjustable chin and forehead rest was attached to the subject's end of the table so as to help the subject check possible head movements, as well as to insure that the midline of the viewing distance was same for all subjects. The viewing distance from the subject to the stimulus was 30 inches.

5. The Experiment.

The recognition memory experiment took place approximately one month after the psychological testing. It was

conducted in a pleasant seminar room.

On arrival the subjects were asked to take a seat at the head of the table facing the screen. They were then informed that the experimental instructions would be given to them as soon as they made themselves comfortable and the chin rest and chair were adjusted to their height. The eye level for all subjects was 16¼ inches.

The method employed of presenting stimuli to the right and left hemisphere was the visual field method. It has recently been well described by Kimura[4] and has frequently been used by other researchers[5,6,7]. It is based on the fact that the connections between the eye and the visual cortex are not from each eye to the opposite half of the brain but from each half of the visual field to the visual cortex on the opposite side. If a person fixates at a given point then the stimuli that fall to the right of the fixation point are received by the left half of each retina and travel by the

---

4 Kimura, 1973, Op. Cit.

5 Jeeves, M.A., and N.F. Dixon, "Hemisphere Differences in Response Rates to Visual Stimuli", in Psychonomic Science, Vol. 20, 1970, p. 249-251.

6 Filbey, R.A., and M.S. Gazzaniga, "Splitting the Normal Brain with Reaction Time", in Psychonomic Science, Vol. 17, 1969, p. 335-336.

7 Klatzky, Roberta L., and Richard C. Atkinson, "Specialization of the Cerebral Hemispheres in Scanning for Information in Short-Term Memory", in Perception and Psychophysics, Vol. 10, 1971, p. 335-338.

neural pathways from the left sides of both retinas to the visual cortex of the left hemisphere. It is important that during the presentation of stimuli the subject fixate at a given point if one is to insure that the stimuli reach the desired hemisphere. Therefore, the following instructions were given to the subjects:

> Before we begin, I would like you to become familiar with the way in which this experiment operates. A series of common words and pictures of objects will appear on the screen for a very short period of time. An important part of your task will be to look directly ahead at the black dot on the screen. The words and pictures will be shown to the right (or the left) of the dot. They are presented in this position so that the image of the word or picture will fall on the left or right side of the retina. Therefore, it is very important that you always look straight ahead at the dot. Try to resist the tendency to look directly at the word or picture.
>
> We shall now have a short trial run. If there is anything that you do not understand, do not worry, for we shall go over everything before we start the experiment.

When the subject was ready, the 8 trial slides were presented in the same manner as the other slides were to appear in the actual experiment. The slide exposure duration was set at 700 msec., because it proved to be the best compromise. Although a 700 msec. exposure time does not prohibit subjects from making eye movements which could expose the test stimulus to both hemispheres, the pilot testing indicated that at shorter intervals many subjects could not identify the pictures or words on a large number of trials.

Once the subject had understood the task, she was asked to rest for a few seconds to allow the experimenter to change the slide tray. The target tray was then inserted, and the experimenter would seat himself three feet in front and at an angle to the left of the subject. This provided him the opportunity to look at the subject's eyes during the target presentation phase of the experiment.

The subject was then informed:

> When you are ready, I shall start presenting the slides to you at the same speed as in the trial run. Try to remember as many pictures and words as you can, and try not to move your eyes. Feel free to stop me any time when you feel that you have to move your eyes, or that you are not ready for the next slide.

The subject was then shown the 140 target slides, with the same exposure time of 700 msec. as in the trial run. The interstimulus interval was controlled manually and on the average lasted about 3 seconds. With the completion of the presentation of the target tray, the first part of the recognition memory experiment was concluded, and the subject was informed that she may sit back in her chair and relax. This first part of the experiment generally lasted between 10 and 15 minutes.

During the period when the subject was resting, the target tray was removed and was replaced with the first of the recognition trays. Also the experimenter's chair was moved forward so that he could see the presentation of slides on the front of the screen and the worksheet was made ready.

When the necessary rearrangements were done, the following information was supplied to the subject:

> This time I am going to show you more slides. You no longer have to look at the black dot and you may if you wish move your eyes. Some of the slides you will recognize as having seen them in the first presentation. What I want you to do is first to <u>think</u> whether you saw on the first presentation the <u>item or thing</u> that the picture or word shown by the slide are going to represent. Then tell me whether you saw it before or not, and how sure you are that you saw it before or not. If you are positively sure that you saw it before, say "yes positive"; if you are less sure, say "yes fairly sure"; if you are guessing that you saw it before, say "yes guess". Use "no positive" if you are positive that you did not see it before; "no fairly sure" if you are less than positive; and "no guess" if you are guessing that you did not see it before. After you have told me that you did see the item or thing before, I want you to tell me how do you think you saw it before: whether you think you saw it as a picture or as a word before and again tell me how confident are you that you saw it as a picture or as a word. For example, if you are positive that you saw the item as a picture before, say "picture positive"; if you are only fairly sure say "picture fairly sure"; and if you are guessing, say "picture guess". And the same for words: "word positive","word fairly sure" and "word guess".

The subject was then introduced to the first slide. Once the subject had mastered the answering technique, which generally was around the tenth to fifteenth slide, she was encouraged to proceed at her most comfortable yet fastest speed. All her responses were entered by the experimenter on the prepared worksheet. On the whole this second phase of the recognition memory experiment lasted approximately 45 minutes. When the subject had answered to all of the slides the experiment was complete. The total duration of the experiment was around one hour to an hour and fifteen minutes.

6. Method of Analysis of Recognition Memory Data.

In the context of the theory of signal detection there were two stimulus situations in the item recognition experiment: (1) the new picture and word stimuli which had not been shown to the subject in the first phase of the recognition memory experiment, known as the distractor stimuli (noise), and (2) the old picture and word stimuli which had been shown to the subject in the first phase of the recognition memory experiment, known as target stimuli (signal plus noise). After each stimulus presentation, the subject answered either "yes" or "no". The two types of stimulus conditions, old (targets) and new (distractors), and the two response categories, yes or no, resulted in four possible stimulus-response combinations.[8] These four stimulus-response combinations are illustrated in the stimulus and response alternative matrix in Figure 1. The probability that the subject would judge the item as old (as having been seen before) when in fact it was old was the hit rate P(JiO/io); i.e., judged item old, stimulus item old. The probability that the subject would judge the item as old when in fact it was new (as not having been shown before) was the false alarm rate P(JiO/in), that is, judged item old, stimulus item new.

---

8 Green and Swets, Op. Cit., p. 337-346.

STIMULUS ALTERNATIVE

RESPONSE ALTERNATIVE	Item Old	Item New
Yes	P(JiO/io) Judged Item Old/ Stimulus Item Old Hit	P(JiO/in) Judged Item Old/ Stimulus Item New False Alarm
No	P(JiN/io) Judged Item New/ Stimulus Item Old Miss	P(JiN/in) Judged Item New/ Stimulus Item New Correct Rejection

Figure 1.- Stimulus and Response Alternative Matrix for Item Signal Detection Analysis.

In the item recognition study the rating procedure was used.[9,10] Therefore, each decision - i.e., old or new - was taken according to a response criterion (positive, fairly sure, guess) adopted by the subject. In fact, the subject answered in six categories that portrayed a continuum of her various decision criteria, attitude or motivation that she adopted during the recognition memory experiment.

In all there were twenty-four individual entries per subject for the item recognition task: six for target picture stimuli, six for distractor picture stimuli, six for target word stimuli and six for distractor word stimuli. The twelve picture values and the twelve word values were entered on different IBM data cards for analysis with an IBM 7094 Fortran IV computer programme developed by Ogilvie and Creelman[11]. This procedure was used for all eighty subjects.

The computer programme gave for each subject her discrimination indices or d' values for picture and word stimuli. These were the subject's indices of her recognition memory capacity as determined by her hit and false alarm scores over

---

9 Egan and Clarke, Op. Cit.

10 Pollack, Irwin, and Louis R. Decker, "Confidence Ratings, Message Reception, and the Receiver Operating Characteristic", in John A. Swets (ed.), Signal Detection and Recognition by Human Observers, New York, Wiley, 1964, p. 592-608.

11 Ogilvie, J.C., and C.D. Creelman, "Maximum Likelihood Estimation of Receiver Operating Characteristic Curve Parameters", in the Journal of Mathematical Psychology, Vol. 5, 1968, p. 387.

the six rating categories. The variations in the hit and false alarm proportions for the six rating categories reflected the effect of different personal or criterial standards. In general, the higher the hit score as determined by recognition factors and the lower the false alarm score as determined by nonrecognition attitudinal differences, the greater was the recognition memory and thereby the greater was the d'.

The signal detection procedure was also used for the coding data, but the binary, not the rating, method was employed to compute the discrimination indices. The calculations were performed manually. The subject's responses, as is the case in signal detection, yielded four stimulus-response alternatives, and they are represented in Figure 2. It is important to note that where a single binary yes-no procedure is used the results, unlike in the case of the rating scale, are not free of personal or guessing criteria.

7. Statistical Design.

The statistical design followed the three-factor analysis of variance model with repeated measures on one factor[12]. The three factors were imagery, hemisphere and stimulus. Each factor had two levels: high and low imagers,

---

12 Winer, B.J., Statistical Principles in Experimental Design, New York, McGraw-Hill, 1971, p. 559.

STIMULUS ALTERNATIVE

RESPONSE ALTERNATIVE

	Picture Old	Picture New
Picture Old	P(JpO/po) Judged Picture Old/ Stimulus Picture Old Hit	P(JpO/pn) Judged Picture Old/ Stimulus Picture New False Alarm
Picture New	P(JpN/po) Judged Picture New/ Stimulus Picture Old Miss	P(JpN/pn) Judged Picture New/ Stimulus Picture New Correct Rejection

STIMULUS ALTERNATIVE

RESPONSE ALTERNATIVE

	Word Old	Word New
Word Old	P(wO/wo) Judged Word Old/ Stimulus Word Old Hit	P(wO/wn) Judged Word Old/ Stimulus Word New False Alarm
Word New	P(wN/wo) Judged Word New/ Stimulus Word Old Miss	P(wN/pn) Judged Word New/ Stimulus Word New Correct Rejection

Figure 2.- Stimulus and Response Alternative Matrices for the Coding Signal Detection Analysis.

right and left hemispheres, picture and word stimuli. Repeated measures were taken on the stimulus factor. This general design was employed in two experiments. The dependent measures were: (1) item recognition memory (d'), and (2) the coding recognition memory (d') for pictures and words.

Simple main effects were calculated for the AB interaction of the coding data.

The results of this study are presented and discussed in the following chapter.

CHAPTER III

PRESENTATION AND DISCUSSION OF RESULTS

The first part of this chapter presents the results of the statistical analyses of the data and the second part looks at them in the light of the theoretical framework and of the hypotheses delineated in Chapter I.

1. Presentation of Results.

A. Classificatory Data for High and Low Imagers, and Right and Left Hemisphere.

Two groups of forty high imagers and forty low imagers were selected from a group of ninety-seven first year student nurses on the basis of combined scores obtained on the MPFB and SR tests. The mean of the combined MPFB and SR scores for the total sample was 38.60, and 44.41 for the high imagery group and 32.80 for the low imagery group. The degree of correlation between the MPFB and SR was .44($p<.01$) as calculated by the Pearson "r" method. The means of the hemisphere variable were 38.71 for the right hemisphere, and 38.50 for the left. These results are shown in Table 1. It is clear that the high and low groups differed considerably in terms of imagery ability, but the right and left hemisphere groups did not differ much.

Table I.-

Mean Combined MPFB and SR Scores for High and Low Imagers and Right and Left Hemisphere Groups.

Group	N	Right Hemisphere	Left Hemisphere	Average
High Imagers	40	44.71	44.05	44.41
Low Imagers	40	32.65	32.95	32.80
Average	80	38.71	38.50	38.60

Note: The MPFB and SR combined standard scores for subjects by imagery and hemisphere groups are given in Appendix II.

B. Analysis of Coding Data.

The mean coding scores (d') of subjects for the two imagery groups of high and low imagers were 1.44 and 1.35, respectively. The mean values for the two hemisphere groups were 1.41 for the right hemisphere and 1.38 for the left hemisphere. The stimulus means were 1.79 for picture coding and .99 for word coding The overall mean was 1.39. These results are presented in Table II. For the coding task, "d'" indicates the degree of facility for correctly detecting that a picture or a word previously presented was in fact a picture or a word: implying that the picture or word was coded as a picture or word. The false alarms in this case were the expressed recognitions of a new picture or word, suggesting that the new picture or word was coded as picture or word, respectively. This of course was impossible and thereby served as indices of guessing or noise in the picture or word coding process. The a priori probabilities of signal plus noise and noise conditions were equal. The high imagers performed better in picture coding than low imagers and all subjects coded more pictures as pictures than words as words.

A three-way analysis of variance with repeated measures on one factor was performed on the coding data. The results

showed a significant difference between picture and word stimuli, $F_{1,76} = 273.53$, $p<.001$, and there was a significant interaction between imagery and hemisphere groups, $F_{1,76} = 5.66$, $p<.05$.

An analysis of simple main effects was calculated for the AB interaction. Its results are presented together with those of the main analysis of variance in Table III. A graphic representation of the AB interaction is given in Figure 3. These results are discussed in the proceeding section.

Table II.-

Mean Coding Recognition Memory Scores (d') for Pictures and Words, for High and Low Imagers and Right and Left Hemisphere Presentations.

Group	N	Picture	Word	Average
High Imager-Right Hemisphere	20	1.93	1.25	1.59
High Imager-Left Hemisphere	20	1.72	0.87	1.29
Low Imager-Right Hemisphere	20	1.62	0.85	1.23
Low Imager-Left Hemisphere	20	1.91	1.01	1.46
Average	80	1.79	0.99	1.39

Table III.-

Analysis of Variance of Coding Recognition Memory Scores (d') for Pictures and Words for High and Low Imagers and Right and Left Hemisphere Presentations.

Source of Variance	SS	df	MS	F Ratio
Between subjects	40.06	79		
A (Imagery)	0.36	1	0.36	0.74
B (Hemisphere)	0.04	1	0.04	0.08
Between A at b_1	2.55	1	2.55	5.26*
Between A at b_2	0.56	1	0.56	1.15
Between B at a_1	1.73	1	1.73	3.56
Between B at a_2	1.06	1	1.06	2.18
AB	2.75	1	2.75	5.66*
Subjects within groups	36.91	76	0.48	
Within subjects	33.01	80		
C (Stimulus)	25.63	1	25.63	273.53*
AC	0.04	1	0.04	0.45
BC	0.21	1	0.21	2.22
ABC	0.01	1	0.01	0.09
C x Subjects within groups	7.12	76	0.09	

* $p<.05$ $\quad F_{.95}(1,76) = 3.97$

Note: The coding recognition memory values employed in this analysis of variance are given in Appendix IV.

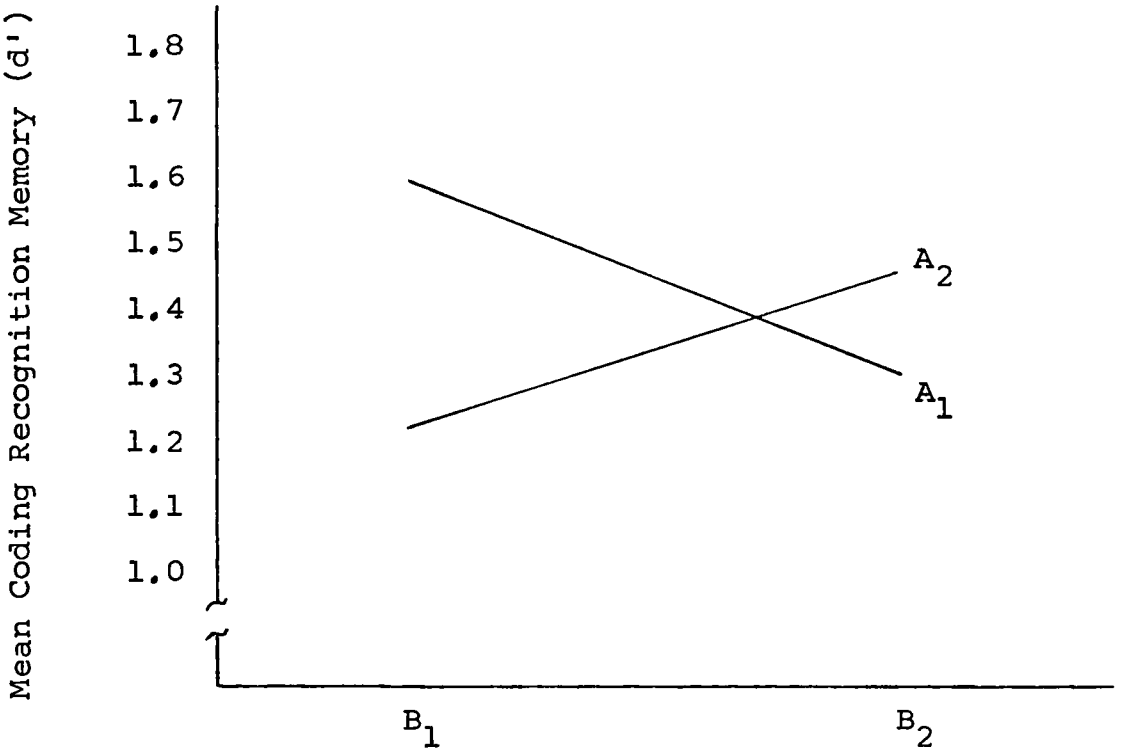


Figure 3.- Means for High (A_1) and Low (A_2) Imagery Groups and Right (B_1) and Left (B_2) Hemisphere Groups.

C. Analysis of Item Recognition Data.

The mean item recognition memory (d') scores for the two imagery groups, high and low, were 2.14 and 1.74 respectively. The mean values for the two hemisphere groups, right and left, were 1.74 and 2.14 respectively. The stimulus means were 2.42 for picture items and 1.46 for word items. The overall mean was 1.94. The results of the imagery variable and those of the hemisphere variable are shown in Table IV. First, the high imagery group performed best in item recognition, especially in the picture item condition. Second, performance in the picture item condition was superior to the word item condition for both imagery groups. Third, the left hemisphere condition proved superior to the right in picture item recognition as well as for word item recognition.

A three-way analysis of variance of the item recognition (d') values revealed a significant difference between high and low imagery groups, $F_{1,76} = 5.51$, $p<.05$; between right and left hemisphere groups, $F_{1,76} = 5.64$, $p<.05$; and between picture and word stimuli groups, $F_{1,76} = 163.18$, $p<.001$. There was also a significant interaction between imagery and stimulus variables, $F_{1,76} = 5.29$, $p<.05$. The results of this analysis of variance are shown in Table V. The significant imagery-interaction is graphically represented in Figure 4.

Table IV.-

Mean Item Recognition Memory Scores (d') for Pictures and Words, for High and Low Imagers and Right and Left Hemisphere Presentations.

Group	N	Picture	Word	Average
High Imager-Right Hemisphere	20	2.36	1.36	1.86
High Imager-Left Hemisphere	20	3.05	1.80	2.42
Low Imager-Right Hemisphere	20	2.04	1.20	1.62
Low Imager-Left Hemisphere	20	2.23	1.50	1.86
Average	80	2.42	1.46	1.94

Table V.-

Analysis of Variance of Item Recognition Memory Scores (d') for Pictures and Words, for High and Low Imagers and Right and Left Hemisphere Presentations.

Source of Variation	SS	df	MS	F Ratio
Between subjects	100.93	79		
A (Imagery)	6.32	1	6.32	5.50*
B (Hemisphere)	6.47	1	6.47	5.63*
AB	1.02	1	1.02	0.89
Subjects within groups	87.12	76	1.15	
Within subjects	55.17	80		
C (Stimulus)	36.55	1	36.55	162.44*
AC	1.18	1	1.18	5.24*
BC	0.04	1	0.04	0.17
ABC	0.32	1	0.32	1.42
C x Subjects within groups	17.08	76	0.23	

* $p<.05$ $\quad F_{.95}(1,76) = 3.97$

Note: The item recognition memory values employed in this analysis of variance are given in Appendix V.

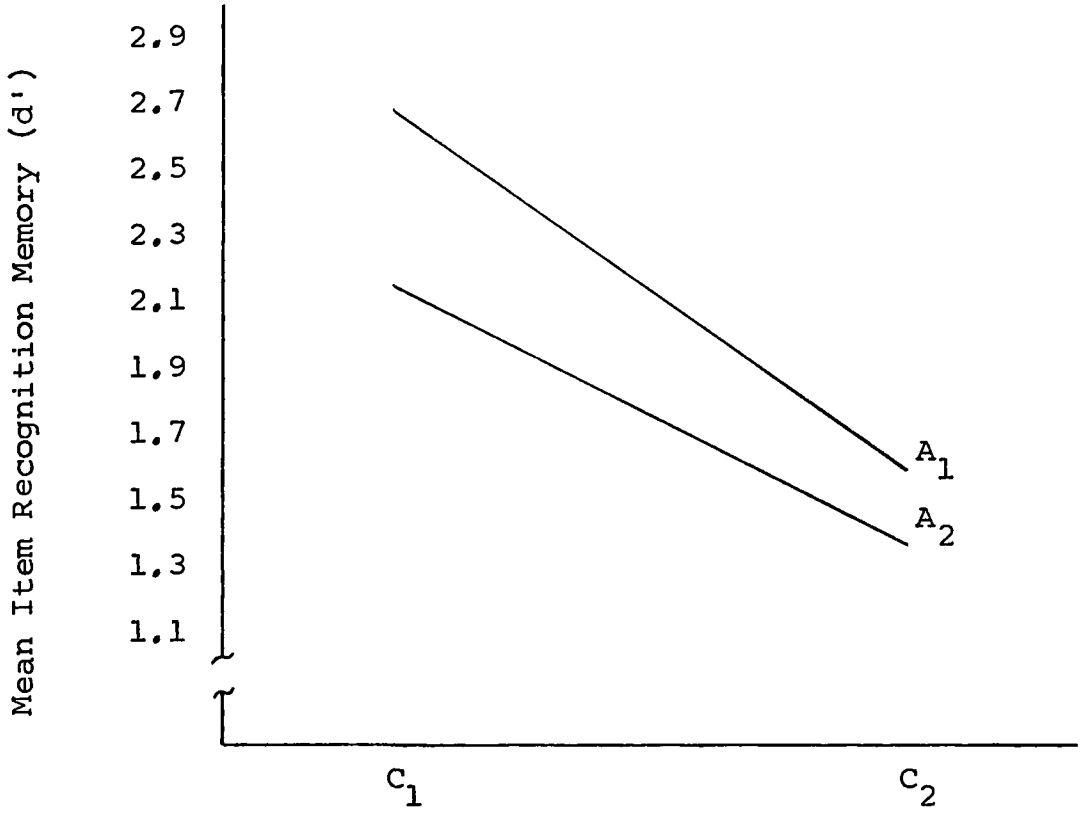


Figure 4.- Means for High (A_1) and Low (A_2) Imagery Groups and Picture (C_1) and Word (C_2) Stimuli.

2. Discussion of Results.

In the discussion of results first the imagery and hemisphere differences will be presented and then the imagery and stimulus findings.

A. Imagery and Hemisphere Differences.

The main purpose of this research was to study whether imagery differences were founded in hemisphere differences. It was decided to investigate this issue under two different experimental sets: (1) in which the subjects were asked to tell the experimenter how did they think they saw the item before; and (2) in which the subjects were instructed to say whether they saw before the item or thing that the picture or word shown by the slide was to represent. In the first condition the success of the subject depended on her being able to identify the mode through which the conceptual form came into being. In the second condition her success was dependent on her having retained a conceptual form of the picture or word stimulus. In one coding was being tapped; in the other conceptual memory.

The results of this research suggest that these two issues are separate, but not completely independent; and that joint treatment of them offers interesting insights into the question of imagery and hemisphere differences.

The coding recognition memory experiment yielded a significant interaction well within the .05 level for the imagery and hemisphere variables. This interaction has been presented graphically in Figure 3 and the analysis of variance for simple main effects in Table III. The results indicated that high imagers coded more pictures and words correctly that were presented to the right hemisphere than were presented to the left hemisphere; and that the low imagers, although the difference was not significant at the .05 level, showed a tendency to code more pictures and words correctly that were presented to the left hemisphere than to the right. In view of these findings and those on hemispheric specialization[1,2], that in the right hemisphere dominance generally exists for spatial and practic functions and in the left hemisphere for verbal functions, it is proposed that high imagers coded the pictorial and concrete verbal data in spatial form when it was presented to the right hemisphere, and low imagers on the other hand coded pictorial and concrete verbal stimuli mainly in language form.

The question now arises how do high imagers handle tasks that are primarily dependent on the left hemisphere?

---

1 Mountcastle, Op. Cit.

2 Kimura, 1966, Op. Cit.

To answer this it is necessary to turn to the item recognition memory experiment. Its findings are expressed in Table V.

In this experiment the hemisphere main effect was significant well within the .05 level showing that there were significant differences between right and left hemisphere groups. The difference was in favour of the left hemisphere, thus supporting the assumption that the item recognition memory experiment was a left hemispheric operation. This is in agreement with Kimura's[3] findings on visual perception that led her to conclude that the left posterior part of the brain plays an important role in the identification of verbal conceptual forms while the corresponding area on the right had functions in the registration of non-verbal stimuli. Further, the high imagers were superior to the low imagers in the item recognition memory experiment. This suggested that the high imagers were successful in switching over from one hemisphere to the other depending on the experimentally induced sets. Further, their superiority over the low imagers indicates that they probably brought to bear their imagery skills on the recognition memory of conceptual forms. This demands qualification of the coding statement that high imagers coded their pictorial and concrete verbal data in spatial form when it was presented to the right hemisphere,

---

3 Kimura, 1966, Op. Cit.

with the follow-up statement that they immediately reinforced it in a verbal cast.

An unpublished experiment described by Paivio[4] and conducted under his supervision, tackled an issue very similar to that of this study, but yielded findings considerably different from those presented above. It involved tachistoscopic presentation of verbal and non-verbal stimuli to the right or left visual field at exposure durations of 10 to 20 msec. The interactions were not significant, but high imagers were superior to low imagers in their overall accuracy. Although Paivio's study was in some respects different from this one in that incidental recall rather than recognition memory was under investigation, the difference in findings was surprisingly great.

It is proposed that a large portion of the discrepancy between the results of these two studies is the effect of the fast speed at which the stimuli were presented in the incidental memory research, that is, between 10 and 20 msec. Apart from the question of likelihood of identifying a picture or a word stimulus at such a fast exposure[5], Haber[6] has reported "that both fast and slow readers need about a quarter

---

4 Paivio, Op. Cit., p. 498.

5 Stelmack, R.M., personal communication, 1973.

6 Haber, Op. Cit., p. 110.

of a second to perceive and extract the information contained in any word /. . ./ and /that this/ interval constitutes the adequate minimum processing time for encoding linguistic material into the memory". Clearly, this requirement was not adhered to in the incidental recall experiment.

In conclusion to this section, the coding experiment supported the supposition that imagery differences are linked with hemispheric specialization, and that high imagers show significant differences in performance from low imagers in coding when stimuli are presented to the right hemisphere. There was also a trend for low imagers to perform better in the left hemisphere condition. The item recognition experiment extended these observations to include the finding that high imagers were also superior on a task requiring them to involve the left hemisphere. This was interpreted to mean that high imagers were successful in switching over from one hemisphere to the other depending on the experimentally induced attentional sets, and therefore had at their disposal more equipment to tackle the task than low imagers who had to rely primarily on their verbal reserve.

The results suggest that visual imagery is a function of the appositional brain.

B. Imagery Differences and Recognition Memory for Pictures and Words.

The results of the item recognition memory experiment showed that pictures were recognized more easily than were words ($p<.001$), and that they were recognized more easily than words by both high and low imagers ($p<.02$). There were also significant differences between high and low imagers ($p<.05$) and further, both pictures and words in the item recognition memory experiment were recognized better by high imagers than by low imagers.

In consideration of the fact that Paivio had dedicated five pages to the presentation and discussion of Stewart's research, and that hers has been the main work in the study of individual differences in imagery and recognition memory for pictures and words, and that the findings of this research are not in agreement in some important aspects with her findings, what follows is a relatively lengthy analysis of the different results.

Stewart's findings that pictures were recognized more easily than words, and that they were recognized more easily than words by both high and low imagers, are compatible with the results of this work. However, in this study it was observed that pictures and words in the item recognition memory experiment were recognized better by high imagers than

by low imagers. This is contrary to Stewart's[7] statement that high imagers were superior to low imagers in picture recognition but inferior in word recognition.

It seems that this disharmony arises from the fact that Stewart's conclusion was based on the results of the "compound" analysis of variance. What occurred was as follows. Three sets of data were collected. First there were "associate errors": errors which the subjects had made when they said they had seen an item as a word on the presentation trial when they had actually seen it as a picture and vice versa. Second, there were "N-type errors": errors made when the subjects said they had never seen an item when actually it had been presented as a picture or as a word on the presentation trial. And third, there was a set of data on items not seen on presentation trial. Four separate analyses of variance were computed - one on the associate errors, one on the N-type errors, one on the data not seen on presentation trial, and one "compound" analysis where the associate errors and N-type errors were added together to give the fourth dependent variable. The assertion that high imagers were superior to low imagers in picture recognition but inferior in word recognition was based on the findings of the "compound" analysis. The major contribution to the "compound" analysis of variance for that given interaction came from the associate error

---

7 Stewart, Op. Cit., p. 55-75.

analysis. In the associate error analysis of variance the results were significant at .001 level, but in the N-type analysis they were non-significant. By compounding the dependent data the outcome was a significant imagery-stimulus interaction at .001 level, but this significance was mainly contributed by the associate errors. Therefore it was erroneous on Stewart's part to generalize that high imagers were superior to low imagers in picture recognition but inferior in word recognition, when in fact this was only the case for associate error dependent variable but nor for the N-type error dependent variable. Further, when an attempt is made to translate Stewart's scores into a signal detection matrix, one notices that different types of data were handled as same. The N-type errors are analogous to the false alarm condition of the recognition item signal detection matrix of this study; and the associate errors are analogous to the false alarm condition of the coding signal detection matrix of this research. So in fact two completely different sets of scores were grouped together.

The analysis of variance presented in Table V showed significant differences between high and low imagery groups. Stewart found no such differences. It seems that this lack of agreement stems from similar reasons as reported above, that the analysis was performed on the number of errors rather than on the correct responses - what in this study would have

been the false alarms (associate errors) and misses (N-type errors); and the fact that the recognition data, namely N-type errors, were grouped together with the coding scores, that is the associate errors. This latter is particularly important in view of the fact that in our analysis of coding data the main imagery effect was non-significant.

With reference to the coding analysis of this study and the imagery and stimulus variables, the only significant result was the main effect of the stimulus factor. This should be interpreted that subjects coded pictures better than words. There was no significant imagery-stimulus interaction. Similar results were obtained by Paivio, Rogers and Smythe[8] in their experiment on free recall. Could it be that coding and free recall are related?

The results of this section suggest that imagery ability may predict short-term item recognition memory in tasks involving pictorial (non-verbal) and concrete verbal material. This generalization is consistent with Davis'[9] findings which expressed positive relations between individual differences in imagery as measured by subjective reports

---

8 Paivio, A., T.B. Rogers and P.C. Smythe, "Why are Pictures Easier to Recall Than Words?", in Psychonomic Science, Vol. 11, 1968, p. 137-138.

9 Davis, F.C., "The Functional Significance of Imagery Differences", in the Journal of Experimental Psychology, Vol. 15, 1932, p. 630-661.

and recall; and more recently with those of Sheehan[10] who found accuracy of visual memory to be related to individual differences as measured by the shortened version of the Betts questionnaire on imagery.

These results do not agree in some important aspects with Stewart's findings in that in the coding task there was no evidence that low imagers coded words better than pictures, or that in the item recognition task low imagers were superior to high imagers in recognizing words. On the contrary in this latter experiment high imagers performed better than low imagers in both picture and word conditions.

Further what is clear is that item recognition memory tasks are different from coding memory tasks and therefore should be kept distinct.

It is important to keep in mind that the imagery and stimulus study was concerned first, with visual imagery; second, with imagery as defined by perceptual or figural ability tests; third, that the word "stimulus" referred to picture or concrete words, and not to abstract words; and fourth, that it was conducted on subjects of good average intelligence. It is within this framework that the above results have been discussed.

---

10 Sheehan, P.W., "Accuracy and Vividness of Visual Images", in Perceptual and Motor Skills, Vol. 23, 1966, p. 391-398.

Finally, the issue may be raised that both the hemisphere and imagery stimulus findings are the result of superior intelligence of high imagers. This question is a complex one, for much depends on the significance of the word "intelligence". If by intelligence is meant that which is measured by intelligence tests then hitherto no significant relationships have been found between imagery performance and intelligence scores. Davis[11] reported positive relations between recall and individual differences in imagery as measured by subjective reports but no significant relation between imagery and intelligence. Brower[12] found no significant relations between imagery scores and intelligence as measured by the Otis. Stewart[13] employed the Vocabulary subtest of the Wechsler Adult Intelligence Scale as one estimate of intelligence and reported that the average score was 67.67 for low imagers and 67.42 for high imagers - again nonsignificant. If by intelligence is understood the scholastic achievement of subjects, then again the results suggest no significant relationship between imagery and intelligence. Kuhlman[14] had observed differences in school achievement between high and

---

11 David, F.C., Op. Cit.

12 Brower, D., "The Experimental Study of Imagery: I. The Relation of Imagery to Intelligence", in the Journal of General Psychology, Vol. 36, 1947, p. 229-231.

13 Stewart, Op. Cit.

14 Kuhlman, Op. Cit.

low imagery children in the early grades but reported that these differences disappeared at later ages and in higher grades. Stewart in addition to the Vocabulary subtest of the WAIS used subjects' averaged Grade 13 final examination marks and found no significant differences in their attainments. She reported that the averaged Grade 13 marks were 74.71 for low imagers and 75.96 for high imagers. If, however, intelligence is defined in terms of hemisphere maturations and their most favourable synchronization, and this is a major and as yet unverified supposition, then the results of this study suggest that indeed high imagers' biological intelligence is superior to that of low imagers. But this is a post facto statement.

It seems that the reason why imagery and intelligence as measured by either intelligence tests or scholastic achievements are not related is that many tasks can be approached and tackled from different perspectives. Although individuals differ in their abilities, they have learnt how to break down and reassemble different problems into schemata which they can handle best. This accounts for why Kuhlman observed significant differences between high and low imagery children in the lower grades, but not in the higher. Children that were poor in imagery had not yet developed alternative methods of handling information. With age these differences "disappear" on intelligence tests, not because they are no

longer there, but because the correct solutions of the tasks can be reached in different ways. It is not simply the solution, but how the solution was reached that is important in the study of individual differences.

CONCLUSION

The results of this research supported the main premise that imagery differences were reflected in hemispheric specialization. This was borne out by the findings that high imagers performed best on the coding recognition memory task when the stimuli were presented to the right hemisphere, and that low imagers expressed a preference for the left hemisphere. Further, the success of the high imagers was not restricted to the coding task and the right hemisphere, because in the item recognition memory experiment where significant differences were observed in favour of the left hemisphere, high imagers accomplished more than low imagers. This was interpreted to mean that high imagers were not impoverished in their left hemisphere operations, and were able to supplement their left hemispheric facilities with their right hemispheric skills - i.e., with imagery. The low imagers, on the other hand, had to rely predominantly on their left hemisphere.

With reference to imagery differences and stimulus types the results supported the findings that pictures are recognized more easily than words by both high and low imagers. They further suggested that, contrary to previous observations, there are significant differences between high and low imagers and second, that both pictures and words in an item recognition experiment are better recognized by high imagers than

by low imagers. Third, no significant interaction between imagery and stimulus factors was obtained in the coding experiment.

The fact that imagery differences were reflected in hemisphere differences opens a new vista in imagery research. New questions arise. How much or how little do high and low imagers respectively rely on the right hemisphere in coding? The question of whether imagery ability contributes anything to item recognition memory of highly abstract words remains unanswered. Also an important question is the effect of attentional set on imagers when stimuli are presented to opposite hemispheres. Answers to questions like these can only but offer better closure in the understanding of imagery functions.

BIBLIOGRAPHY

Bogen, Joseph E., "The Other Side of the Brain II: An Appositional Mind" Bulletin of the Los Angeles Neurological Societies, Vol. 34, 1969, p. 135-162.

The article, second in a series of four, offers a historical review and a synthesis of the subject on the specialization of the right hemisphere and proposes two distinct modes of thought as related to the appositional and propositional hemispheres.

Egan, James P., and Frank R. Clarke, "Psychophysics and Signal Detection", in Joseph B. Sidowski (ed.), Experimental Methods and Instrumentation in Psychology, New York, McGraw-Hill, 1966, p. 211-246.

The authors present the rationale and procedures for the single interval, the force choice and rating methods and for deriving the ROC curves.

Kimura, Doreen, "The Asymmetry of the Human Brain", Scientific American, Vol. 228, 1973, p. 70-78.

The author synopsises some important research on hemisphere differences and explains the procedures used in presenting stimuli to the right and left hemispheres.

Kinsbourne, Marcel, "The Cerebral Basis of Lateral Asymmetries in Attention", Acta Psychologica, Vol. 33, 1970, p. 193-201.

This article presents the "differential expectancy" hypothesis that suggests that effects of perceptual asymmetry are not necessarily the consequence of more efficient information transmission by the shorter pathways, but can be interpreted as a function of preparatory set.

Paivio, Alan, Imagery and Verbal Processes, New York, Holt, 1971, xi-596 p.

This text is a key work on imagery. It offers an extensive review of the research on imagery and verbal processes and discusses many of the theoretical issues arising from it.

Pollack, Irwin, and Louis R. Decker, "Confidence Ratings, Message Reception, and the Receiver Operating Characteristic", in John A. Swets (ed.), Signal Detection and Recognition by Human Observers, New York, Wiley, 1964, p. 592-608.

The article explains in detail the method of administering the rating procedure and the use of confidence ratings and ROC curves.

Richardson, Allan, Mental Imagery, New York, Springer, 1969, xii-180 p.

This text is a valuable source in the study of individual differences in imagery ability, especially in its treatment of inter-individual and intra-individual comparisons.

Semmes, Josephine, "Hemispheric Specialization: A Possible Clue to Mechanism", Neuropsychologia, Vol. 6, 1968, p. 11-26.

This article suggests that sensory and motor capacities are represented differently in the two hemispheres, tending to be focally represented in the left hemisphere but diffusely represented in the right hemisphere.

Stewart, John Chalmers, An Experimental Investigation of Imagery, unpublished Doctoral thesis, University of Toronto, 1965, 1-107 p.

This study investigated the question of relationship between individuals differing in imagery ability and the image-evoking characteristics of the material to be remembered.

APPENDIX 1

SAMPLE PROBLEMS FROM THE MINNESOTA PAPER FORM BOARD (MPFB) TEST - FORM AA, AND SPACE RELATIONS (SR) TEST OF DAT - FORM L

APPENDIX 1

REVISED MINNESOTA PAPER FORM BOARD TEST - SERIES AA
Prepared by R. Likert and Wm. H. Quasha

DIRECTIONS AND PRACTICE PROBLEMS

READ THE FOLLOWING DIRECTIONS VERY CAREFULLY WHILE THE EXAMINER READS THEM ALOUD

Look at the problems on the right side of this page. You will notice that there are eight of them, numbered from 1 to 8. Notice that the problems go DOWN the page.

First look at Problem 1. There are two parts in the upper left-hand corner. Now look at the five figures labelled A, B, C, D, E. You are to decide which figure shows how these parts can fit together. Let us first look at Figure A. You will notice that Figure A does **not** look like the parts in the upper left-hand would look when fitted together. Neither do Figures B, C, or D. Figure E **does** look like the parts in the upper left-hand corner would look when fitted together, so E is PRINTED in the square above [1] at the top of the page.

Now look at Problem 2. Decide which figure is the correct answer. As you will notice, Figure A is the correct answer, so A is printed in the square above [2] at the top of the page.

The answer to Problem 3 is B, so B is printed in the square above [3] at the top of the page.

In Problem 4, D is the correct answer, so D is printed in the square above [4] at the top of the page.

Now do Problems 5, 6, 7, and 8.

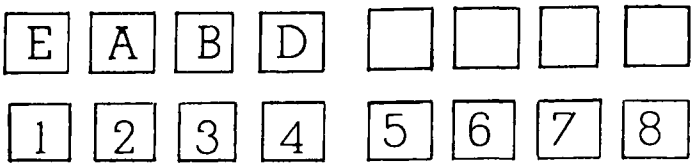
PRINT the letter of the correct answer in the square above the number of the example at the top of the page.

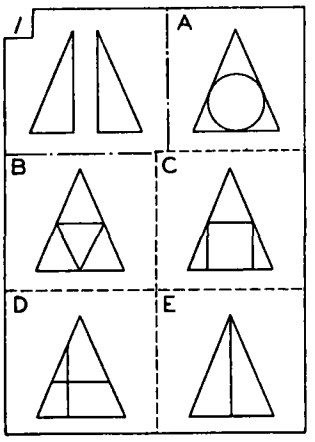
DO THESE PROBLEMS NOW.

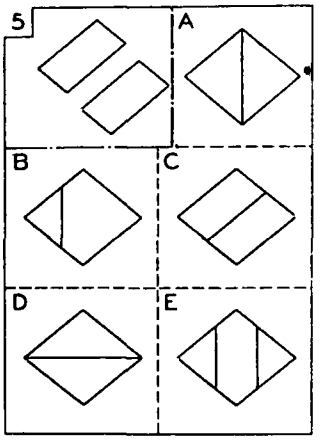
If your answers are not the same as those which the examiner reads to you, RAISE YOUR HAND.

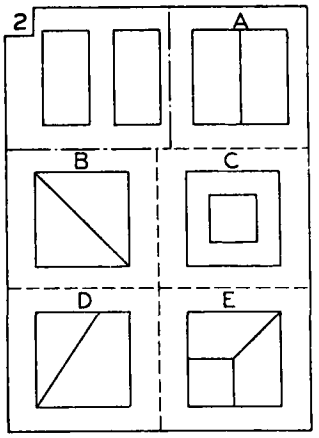
DO NOT OPEN THE BOOKLET UNTIL YOU ARE TOLD TO DO SO.

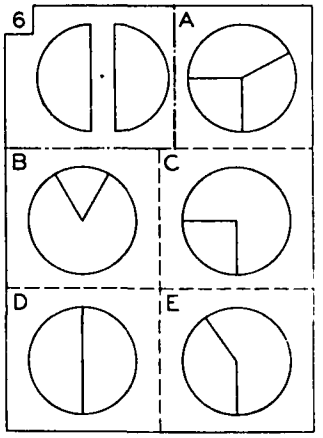
Some of the problems on the inside of this booklet are more difficult than those which you have already done, but the idea is exactly the same. In each problem you are to decide which figure shows the parts correctly fitted together. **Sometimes the parts have to be turned around, and sometimes they have to be turned over in order to make them fit.** In the square above [1] write the correct answer to Problem 1; in the square above [2] write the correct answer to Problem 2, and so on with the rest of the test. Start with Problem 1, and go DOWN the page. After you have finished one column, go right on with the next. **Be careful not to go so fast that you make mistakes. Do not spend too much time on any one problem.**

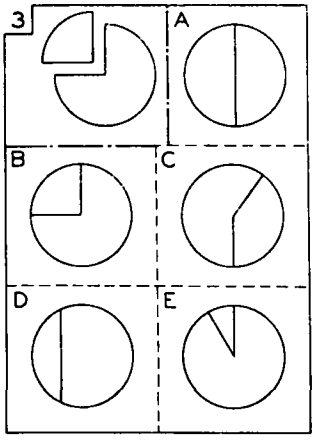


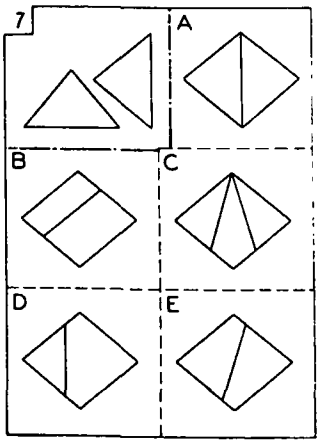












Do not make any marks in this booklet

SPACE RELATIONS

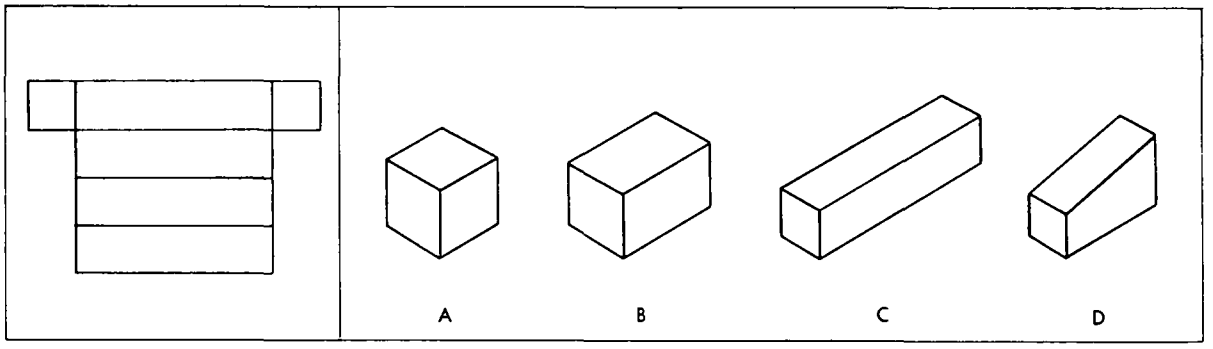
Mark your answers on the separate Answer Sheet

DIRECTIONS

Find the place for Space Relations on the Answer Sheet.

This test consists of 60 patterns which can be folded into figures. For each pattern, four figures are shown. You are to decide which **one** of these figures can be made from the pattern shown. The pattern always shows the **outside** of the figure. Here is an example:

Example X.



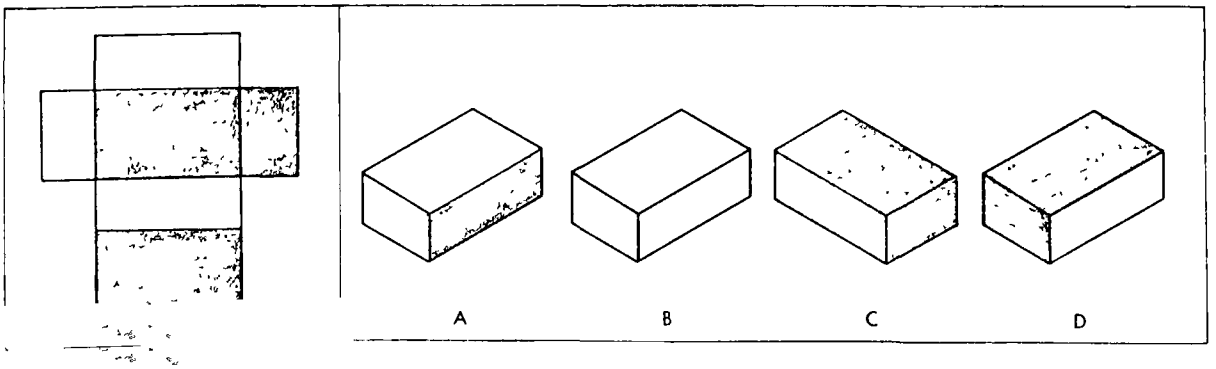
Which one of these four figures — A, B, C, D, — can be made from the pattern in Example X? A and B certainly cannot be made; they are not the right shape. C is correct both in shape and size. You cannot make D from this pattern. Therefore, on the Sample of the Answer Sheet on the next page, C has been marked for Example X.

— In the test there will always be a row of four figures following each pattern.

— In every row there is only one correct figure.

Now look at the pattern for Example Y and the four choices for it. Note that when the pattern is folded, the figure must have three gray surfaces. Two of these will be large surfaces either of which could be the top or the bottom of a box. The other is a small surface which would be one end of the box.

Example Y.



APPENDIX 1

Notice – all the figures made from this pattern are correct in **shape,** but the sides which you see are different. One of these figures can be made from this pattern while the others cannot. Look at the four choices:

— Figure A is wrong. The long, narrow side is not gray in the pattern and the large surface must be gray.

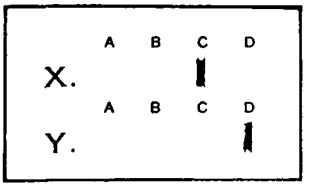
— Figure B is wrong. The large surface must be gray, although the gray end could be at the back.

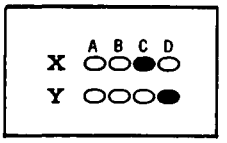
— Figure C is wrong. The gray top and end are all right, but there is no long gray side in the pattern.

— Figure D is correct. A large gray surface can be shown as the top, and the end surface of gray can be shown facing towards you.

So, you see, all four figures are correct in shape, but only one shows the gray surfaces correctly. Therefore, on the Sample of the Answer Sheet, D has been marked for Example Y.

SAMPLES OF ANSWER SHEETS





Remember that the surface you see in the pattern must always be the **outside** surface of the completed figure. In taking the test:

— Study each pattern.

— Decide which figure can be made from the pattern.

— Show your choice on the Answer Sheet by blackening in the space under the letter which is the same as that of the figure you have chosen in the booklet.

You will have 25 minutes for this test. Work as rapidly and as accurately as you can. If you are not sure of an answer, mark the choice which is your best guess.

DO NOT TURN THE PAGE UNTIL YOU ARE TOLD TO DO SO.

APPENDIX 2

RAW SCORES, STANDARD SCORES AND COMBINED STANDARD SCORES FOR THE MPFB - FORM AA, AND SR (DAT) - FORM L

Raw Scores, Standard Scores (z) and Combined Standard Scores for MPFB - Form AA and SR (DAT) - Form L Tests by Imagery and Hemisphere Groups.

Subject	MPFB - Raw Scores	MPFB - z-Scores	SR - Raw Scores	SR - z-Scores	MPFB+SR z-Scores
High Imagery - Right Hemisphere Group					
23	49	0.97	47	1.22	2.19
30	44	0.28	54	1.96	2.24
31	49	0.97	43	0.81	1.78
17	51	1.24	24	-1.18	0.06
7	44	0.28	44	0.91	1.20
5	47	0.70	42	0.70	1.40
43	47	0.70	44	0.91	1.61
32	44	0.28	39	0.39	0.67
10	39	-0.40	45	1.02	0.61
54	48	0.83	53	1.85	2.68
63	44	0.28	39	0.39	0.67
39	50	1.11	32	-0.34	0.76
57	45	0.42	37	0.18	0.60
50	53	1.52	35	-0.03	1.49
8	52	1.38	59	2.48	3.86
47	41	-0.13	43	0.81	0.68
29	46	0.56	48	1.33	1.89
60	46	0.56	45	1.02	1.57
56	53	1.52	46	1.12	2.64
64	46	0.56	35	-0.03	0.52
High Imagery - Left Hemisphere Group					
70	45	0.42	47	1.22	1.65
59	49	0.97	47	1.22	2.19
46	48	0.83	34	-0.13	0.70
58	45	0.42	31	-0.45	-0.02
78	47	0.70	48	1.33	2.02
75	44	0.28	34	-0.13	0.15
26	46	0.56	44	0.91	1.47
49	59	2.34	52	1.75	4.09
73	50	1.11	37	0.18	1.29
13	46	0.56	28	-0.76	-0.20
2	47	0.70	43	0.81	1.50
52	49	0.97	33	-0.24	0.73
3	47	0.70	51	1.64	2.34
34	51	1.24	38	0.28	1.53
21	47	0.70	40	0.49	1.19
71	38	-0.54	43	0.81	0.27
25	43	0.15	35	-0.03	0.12
68	51	1.24	50	1.54	2.78
80	52	1.38	37	0.18	1.56
76	49	0.97	37	0.18	1.15

Raw Scores, Standard Scores (z) and Combined Standard Scores for MPFB - Form AA and SR (DAT) - Form L Tests by Imagery and Hemisphere Groups (cont'd).

Subject	MPFB - Raw Scores	MPFB - z-Scores	SR - Raw Scores	SR - z-Scores	MPFB+SR z-Scores
Low Imagery - Right Hemisphere Group					
77	33	-1.22	34	-0.13	-1.36
53	34	-1.09	28	-0.76	-1.85
67	27	-2.05	44	0.91	-1.13
6	28	-1.91	19	-1.70	-3.61
40	42	0.01	34	-0.13	-0.12
12	35	-0.95	19	-1.70	-2.65
24	33	-1.22	31	-0.45	-1.67
38	39	-0.40	17	-1.91	-2.31
42	41	-0.13	30	-0.55	-0.68
61	38	-0.54	24	-1.18	-1.72
36	40	-0.26	31	-0.45	-0.71
51	37	-0.67	41	0.60	-0.07
9	36	-0.81	25	-1.08	-1.89
19	29	-1.77	23	-1.28	-3.06
28	33	-1.22	24	-1.18	-2.40
44	36	-0.81	41	0.60	-0.21
14	33	-1.22	34	-0.13	-1.36
22	42	0.01	31	-0.45	-0.44
79	37	-0.67	41	0.60	-0.07
55	39	-0.40	22	-1.39	-1.79
Low Imagery - Left Hemisphere Group					
16	39	-0.40	31	-0.45	-0.85
69	46	0.56	23	-1.28	-0.73
72	44	0.28	28	-0.76	-0.48
66	43	0.15	31	-0.45	-0.30
62	30	-1.63	31	-0.45	-2.08
4	40	-0.26	25	-1.08	-1.34
65	40	-0.26	31	-0.45	-0.71
1	46	-.56	24	-1.18	-0.62
18	31	-1.50	38	0.28	-1.21
27	36	-0.81	25	-1.08	-1.89
41	38	-0.54	36	0.07	-0.46
48	51	1.24	12	-2.44	-1.19
33	39	-0.40	26	-0.97	-1.37
35	26	-2.18	24	-1.18	-3.36
45	30	-1.63	29	-0.66	-2.29
37	40	-0.26	32	-0.34	-0.61
74	40	-0.26	33	-0.24	-0.50
15	34	-1.09	30	-0.55	-1.64
20	24	-2.46	31	-0.45	-2.91
11	34	-1.09	27	-0.87	-1.95

APPENDIX 3

LISTS OF PICTURE AND WORD TARGET STIMULI AND DISTRACTOR STIMULI IN ORDER OF PRESENTATIONS

Picture (P) and Word (W) Target Stimuli Listed in Order of Presentation.

No.	Item	Type	No.	Item	Type
1.	Teepee	P	36.	Glass	P
2.	Mushroom	P	37.	Stump	W
3.	Pillow	W	38.	Anchor	P
4.	Glove	P	39.	Jug	W
5.	Stool	W	40.	Nest	P
6.	Radio	W	41.	Arrow	W
7.	Carrot	P	42.	Wrench	P
8.	Hook	P	43.	Squirrel	W
9.	Grapes	W	44.	Cup	P
10.	Birdhouse	P	45.	Bowl	P
11.	Ghost	P	46.	Penguin	P
12.	Glasses	P	47.	Airship	P
13.	Telephone	P	48.	Violin	W
14.	Dice	W	49.	Truck	W
15.	Ear	W	50.	Trumpet	P
16.	House	W	51.	Turkey	W
17.	Pumpkin	P	52.	Shell	W
18.	Paw	P	53.	Cat	P
19.	Star	W	54.	Gun	P
20.	Skate	P	55.	Racoon	P
21.	Cow	W	56.	Fence	W
22.	Purse	W	57.	Tap	W
23.	Sailboat	P	58.	Stairs	W
24.	Ball	P	59.	Hat	W
25.	Goat	W	60.	Clown	P
26.	Butterfly	P	61.	Sled	W
27.	Igloo	W	62.	Eight	P
28.	Diver	P	63.	Sun	P
29.	Ring	W	64.	Arm	W
30.	Apple	P	65.	Whale	W
31.	Bell	W	66.	Sponge	W
32.	Pear	W	67.	Book	W
33.	Jacket	W	68.	Barrel	P
34.	One	W	69.	Basket	P
35.	Ashtray	P	70.	Owl	W

Picture (P) and Word (W) Target Stimuli Listed in Order of Presentation (cont'd).

No.	Item	Type	No.	Item	Type
71.	Kite	W	106.	Crib	W
72.	Flag	W	107.	Lion	P
73.	Piano	W	108.	Tie	W
74.	Boy	P	109.	Compass	P
75.	Bathtub	P	110.	Horse	P
76.	Volcano	W	111.	Umbrella	P
77.	Feather	W	112.	Gate	P
78.	Mask	W	113.	Zipper	W
79.	Key	W	114.	Sweater	W
80.	Crown	P	115.	Doghouse	P
81.	Dress	P	116.	Sandal	W
82.	Tree	P	117.	Girl	W
83.	Lamb	P	118.	Foot	W
84.	Whip	W	119.	Window	P
85.	Watch	P	120.	Wig	P
86.	Hotdog	P	121.	Airplane	P
87.	Television	P	122.	Flower	P
88.	Lamp	W	123.	Castle	P
89.	Spoon	W	124.	Chair	W
90.	Circle	W	125.	Skirt	W
91.	Crocodile	P	126.	Candle	W
92.	Match	W	127.	Turtle	P
93.	Camera	W	128.	Rooster	P
94.	Cactus	P	129.	Cap	P
95.	Pie	W	130.	Four	W
96.	Dog	W	131.	Fan	P
97.	Suitcase	P	132.	Moon	W
98.	Net	W	133.	Shirt	W
99.	Wagon	P	134.	Fly	W
100.	Monkey	W	135.	Pipe	W
101.	Pelikan	P	136.	Zebra	P
102.	Octopus	W	137.	Bucket	P
103.	Kettle	P	138.	Bird	W
104.	Camel	P	139.	Button	W
105.	Fingers	P	140.	Six	P

Picture (P) and Word (W) Target (*) and Distractor Stimuli Listed in Order of Presentation.

No.	Item	Type	No.	Item	Type
1.	Magnet	P	* 36.	Spoon	W
2.	Tent	W	37.	Clover	P
3.	Rocket	P	38.	Five	W
4.	Bear	W	39.	Bulb	W
5.	Duck	P	40.	Cigar	W
* 6.	Igloo	W	41.	Socks	P
7.	Brush	P	* 42.	One	W
8.	Pen	P	* 43.	Ear	W
* 9.	Moon	W	44.	Seven	W
* 10.	Sled	W	* 45.	Tie	W
11.	Bicycle	W	* 46.	Barrel	P
* 12.	Feather	W	47.	Spur	W
13.	Whistle	W	* 48.	Wig	P
* 14.	Anchor	P	49.	Needle	P
15.	Wheel	W	50.	Door	W
16.	Rabbit	W	51.	Banana	P
17.	Bat	P	* 52.	Crib	W
18.	Elephant	P	* 53.	Paw	P
19.	Shovel	W	* 54.	Bucket	P
20.	Toothbrush	W	* 55.	Shirt	W
21.	Nail	P	56.	Statue	W
22.	Toboggan	P	57.	Tulips	P
23.	Lobster	P	* 58.	Apple	P
* 24.	Lamp	W	59.	Clock	P
25.	Guitar	P	60.	Trombone	P
* 26.	Fan	P	61.	Vase	W
* 27.	Piano	W	62.	Ship	P
* 28.	Ring	W	63.	Mouth	W
* 29.	Zebra	P	* 64.	Hotdog	P
30.	Mouse	P	65.	Poodle	W
* 31.	Flag	W	66.	Belt	W
* 32.	Shell	W	67.	Balloon	P
* 33.	Stump	W	68.	Saw	P
* 34.	Basket	P	69.	Pencil	W
* 35.	Glass	P	* 70.	Foot	W

APPENDIX 3

Picture (P) and Word (W) Target (*) and Distractor Stimuli Listed in Order of Presentation (cont'd).

	No.	Item	Type		No.	Item	Type
	71.	Tricycle	P		106.	Heart	W
	72.	Car	W	*	107.	Cow	W
	73.	Train	W	*	108.	Book	W
	74.	Nine	P		109.	Slide	P
*	75.	Telephone	P	*	110.	Net	W
*	76.	Radio	W		111.	Acorn	P
	77.	Tunnel	P		112.	Spool	W
	78.	Windmill	W	*	113.	Match	W
	79.	Axe	W	*	114.	Ball	P
	80.	Mitten	P	*	115.	Hat	W
	81.	Cheese	P	*	116.	Wagon	P
*	82.	Volcano	W		117.	Cane	W
	83.	Fish	W	*	118.	Suitcase	P
	84.	Parachute	P	*	119.	Pillow	W
*	85.	Pear	W	*	120.	Skate	P
	86.	Bed	W	*	121.	Lion	P
	87.	Sword	W	*	122.	Crocodile	P
	88.	Chain	P		123.	Triangle	W
*	89.	Bowl	P	*	124.	Button	W
	90.	Snowman	W	*	125.	Jug	W
	91.	Clothesline	P		126.	Cabbage	W
*	92.	Umbrella	P	*	127.	Pie	W
	93.	Scissors	W		128.	Bow	P
	94.	Shield	W		129.	Screw	P
	95.	Two	W	*	130.	Television	P
*	96.	Castle	P		131.	Sofa	W
*	97.	Pumpkin	P		132.	Cherry	W
*	98.	Fingers	P	*	133.	Boy	P
	99.	Lock	P		134.	Ruler	P
*	100.	Octopus	W		135.	Giraffe	P
*	101.	Whip	W		136.	Nose	W
*	102.	Compass	P		137.	Spear	P
	103.	Hammer	W	*	138.	Gate	P
*	104.	House	W	*	139.	Stool	W
*	105.	Ghost	P	*	140.	Carrot	P

Picture (P) and Word (W) Target (*) and Distractor Stimuli Listed in Order of Presentation (cont'd).

No.	Item	Type	No.	Item	Type
141.	Thermometer	P	176.	Kangaroo	P
142.	Pig	P	177.	Knife	P
143.	Comb	W	* 178.	Glasses	P
* 144.	Key	W	179.	Square	W
145.	Tank	W	180.	Three	P
146.	Well	P	* 181.	Camera	W
147.	Ladder	W	* 182.	Sandal	W
* 148.	Trumpet	P	* 183.	Clown	P
149.	Chimney	W	* 184.	Sailboat	P
* 150.	Rooster	P	185.	Egg	W
* 151.	Teepee	P	* 186.	Zipper	W
* 152.	Pipe	W	187.	Canoe	P
* 153.	Jacket	W	* 188.	Sweater	W
* 154.	Butterfly	P	189.	Diamond	W
* 155.	Wrench	P	* 190.	Cat	P
156.	Mermaid	W	191.	Boot	P
* 157.	Flower	P	* 192.	Bird	W
* 158.	Watch	P	193.	Snake	W
* 159.	Doghouse	P	* 194.	Racoon	P
* 160.	Circle	W	* 195.	Horse	P
* 161.	Truck	W	* 196.	Dog	W
* 162.	Squirrel	W	* 197.	Airplane	P
163.	Granny	W	* 198.	Gun	P
164.	Rope	P	* 199.	Goat	W
* 165.	Nest	P	* 200.	Star	W
166.	Cassette	W	201.	Cigarette	P
167.	Table	P	* 202.	Fence	W
168.	Bridge	W	* 203.	Grapes	W
169.	Hand	W	* 204.	Lamb	P
170.	Skeleton	W	* 205.	Monkey	W
171.	Rake	P	206.	Eye	W
* 172.	Eight	P	* 207.	Cup	P
173.	Cake	P	* 208.	Chair	W
174.	Football	P	* 209.	Arm	W
175.	Hanger	P	210.	Cross	W

Picture (P) and Word (W) Target (*) and Distractor Stimuli Listed in Order of Presentation (cont'd).

No.	Item	Type	No.	Item	Type
211.	Frog	P	246.	Mop	W
212.	Saddle	W	* 247.	Bathtub	P
* 213.	Dress	P	* 248.	Glove	P
214.	Bottle	P	* 249.	Pelikan	P
215.	Trunk	P	250.	Bus	P
* 216.	Kettle	P	251.	Lipstick	W
217.	Drum	P	* 252.	Penguin	P
218.	Cage	W	* 253.	Stairs	W
* 219.	Girl	W	* 254.	Hook	P
220.	Chainsaw	P	* 255.	Mushroom	P
* 221.	Diver	P	* 256.	Skirt	W
* 222.	Cactus	P	257.	Apron	W
* 223.	Ashtray	P	* 258.	Dice	W
* 224.	Whale	W	* 259.	Turkey	W
* 225.	Tap	W	260.	Thumb	P
226.	Club	P	261.	Walnut	W
227.	Snowshoe	P	* 262.	Arrow	W
* 228.	Owl	W	263.	Radar	W
* 229.	Birdhouse	P	264.	Stamp	W
* 230.	Crown	P	* 265.	Sun	P
* 231.	Candle	W	266.	Leaf	W
232.	Horn	P	267.	Stapler	W
* 233.	Bell	W	* 268.	Camel	P
234.	Cannon	P	* 269.	Mask	W
235.	Fork	W	* 270.	Purse	W
236.	Harp	P	* 271.	Airship	P
237.	Jar	W	* 272.	Tree	P
* 238.	Fly	W	* 273.	Kite	W
239.	Skis	P	* 274.	Six	P
* 240.	Sponge	W	* 275.	Violin	W
241.	Toaster	P	* 276.	Four	W
* 242.	Cap	P	* 277.	Window	P
243.	Parrot	P	* 278.	Turtle	P
244.	Tractor	P	279.	Snail	W
245.	Film	W	280.	Shoe	P

APPENDIX 4

CODING RECOGNITION MEMORY SCORES (d')

APPENDIX 4

Coding Recognition Memory Scores (d') for Pictures and Words by Imagery and Hemisphere Groups.

Subject	Pictures	Words	Subject	Pictures	Words
High Imagers-Right Hemisphere			High Imagers-Left Hemisphere		
23	1.26	1.36	70	1.31	0.56
30	1.87	1.24	59	2.56	1.73
31	2.27	1.35	46	1.87	1.25
17	2.84	1.09	58	2.06	0.63
7	1.81	1.61	78	1.33	0.90
5	2.47	1.55	75	2.59	1.86
43	1.68	1.24	26	1.18	0.63
32	1.41	0.79	49	1.31	0.87
10	2.29	1.08	73	1.58	0.66
54	1.63	0.84	13	1.40	0.33
63	0.92	0.83	2	2.29	1.36
39	1.54	0.85	52	1.63	0.49
57	3.44	2.90	3	2.06	0.99
50	1.26	0.97	34	1.45	0.84
8	3.63	2.33	21	1.47	0.73
47	1.79	0.99	71	1.27	0.73
29	1.70	1.49	25	2.19	1.27
60	1.73	0.60	68	1.48	0.56
56	1.33	0.72	80	1.93	0.62
64	1.78	1.21	76	1.55	0.40
Low Imagers-Right Hemisphere			Low Imagers-Left Hemisphere		
77	1.57	1.14	16	1.77	0.50
53	1.87	1.63	69	1.64	0.84
67	2.84	1.11	72	3.01	1.33
6	2.21	1.22	66	3.31	1.13
40	1.10	0.84	62	2.32	1.11
12	1.54	1.03	4	1.92	0.91
24	1.79	1.07	65	1.06	0.07
38	1.65	0.89	1	2.96	2.30
42	1.22	0.94	18	1.92	1.09
61	1.57	0.34	27	1.93	1.24
36	0.69	0.20	41	0.83	0.52
51	1.89	0.91	48	1.80	0.86
9	1.72	0.71	33	2.83	1.21
19	0.29	0.00	35	2.00	1.73
28	2.24	0.76	45	1.64	1.10
44	1.25	0.70	37	1.31	0.78
14	2.19	0.82	74	1.64	1.14
22	1.71	1.23	15	1.25	0.99
79	1.67	0.51	20	1.99	0.78
55	1.45	0.89	11	1.08	0.77

APPENDIX 5

ITEM RECOGNITION MEMORY SCORES (d')

APPENDIX 5

Item Recognition Memory Scores (d') for Pictures and Words by Imagery and Hemisphere Groups.

Subject	Pictures	Words	Subject	Pictures	Words
High Imagers-Right Hemisphere			High Imagers-Left Hemisphere		
23	4.40	3.09	70	2.29	1.55
30	2.60	1.62	59	5.63	3.50
31	2.27	1.81	46	2.64	1.84
17	3.05	1.60	58	2.35	1.25
7	2.89	0.85	78	4.01	1.90
5	2.17	1.39	75	2.67	1.91
43	1.79	1.10	26	1.61	1.04
32	1.48	1.74	49	1.77	1.78
10	1.97	0.80	73	2.41	0.35
54	1.72	0.68	13	3.03	1.09
63	2.83	2.12	2	4.31	2.59
39	1.81	0.93	52	2.13	1.67
57	3.02	1.85	3	3.27	1.83
50	2.25	0.99	34	1.97	1.71
8	4.16	3.20	21	2.66	1.48
47	2.57	0.19	71	3.28	2.08
29	0.78	0.66	25	2.62	1.61
60	1.58	0.99	68	1.89	0.21
56	2.46	0.88	80	6.10	4.62
64	1.49	0.67	76	4.30	1.96
Low Imagers-Right Hemisphere			Low Imagers-Left Hemisphere		
77	0.87	0.95	16	1.98	1.98
53	1.81	1.39	69	1.36	1.93
67	2.21	0.46	72	2.75	1.76
6	1.21	1.53	66	2.78	2.59
40	0.40	0.16	62	1.98	1.09
12	2.85	1.13	4	2.98	2.00
24	1.99	1.29	65	2.74	2.14
38	2.62	2.55	1	2.10	1.65
42	2.46	1.19	18	2.63	1.55
61	1.46	0.88	27	2.59	1.40
36	1.92	1.21	41	1.90	1.27
51	2.54	1.54	48	0.97	0.29
9	2.83	1.28	33	1.95	1.62
19	3.08	1.19	35	2.10	1.70
28	2.01	1.35	45	2.06	1.26
44	2.76	1.24	37	1.37	0.62
14	1.16	1.10	74	1.64	0.93
22	2.39	1.22	15	1.54	1.51
79	2.34	1.00	20	4.51	1.30
55	2.01	1.35	11	2.62	1.50

APPENDIX 6

ABSTRACT OF

High and Low Imagers and Hemisphere Differences in Recognition Memory Performance for Picture and Word Stimuli

APPENDIX 6

ABSTRACT OF

High and Low Imagers and Hemisphere Differences in Recognition Memory Performance for Picture and Word Stimuli[1]

This research undertook to investigate whether imagery differences were dependent on hemispheric specialization. More specifically, whether imagery ability was a function of the right hemisphere. The question was suggested by findings in hemispheric studies that the right hemisphere was dominant in spatial and practic functions, and by repeated observations in imagery research that high imagers were superior to low imagers in recognition memory or paired-associate learning of picture stimuli.

It was further reasoned that if the locus of imagery ability is the right hemisphere, and if an appropriate task is given to subjects that is known to involve primarily the left hemisphere, then those with high imagery ability should do better on it for they should be able to involve both hemispheres in tackling the issue. Low imagers, on the other hand, would have to depend mainly on their left hemispheric operations.

These questions were investigated in a recognition memory paradigm.

---

1 Wolodymyr Dacko, doctoral thesis presented to the School of Graduate Studies of the University of Ottawa, 1973, x-104 p.

Four groups of twenty female subjects selected on the basis of their combined performance on the Minnesota Paper Form Board Test - Form AA and the Space Relations Test - Form L and designated as high imagery-right hemisphere, high imagery-left hemisphere, low imagery-right hemisphere, low imagery-left hemisphere groups were presented with picture and word slides in a recognition memory experiment. Two dependent measures were obtained: coding recognition memory (d') and item recognition memory (d') scores.

The results supported that imagery differences were dependent on hemispheric specialization. High imagers coded pictorial and concrete verbal information better with the right hemisphere, and low imagers showed a tendency to code more pictures and words correctly with the left hemisphere. The superiority of high imagers was not restricted to the right hemisphere, for they also proved to be more successful in the item recognition memory task, that is known to be a left hemispheric operation.

With reference to the imagery and stimulus question the results showed significant differences between high and low imagers; and pictures and words in the item recognition memory task were better recognized by high imagers than by low imagers.