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HUMAN CEREBRAL HEMISPHERIC DIFFERENCES

IN

ANXIETY REDUCTION

By

Lawrence John Eimers

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ABSTRACT

HUMAN CEREBRAL HEMISPHERIC DIFFERENCES
WITH RESPECT TO ANXIETY REDUCTION

By

Lawrence John Eimers

The study was designed to explore the relationship, with respect to anxiety reduction, between students engaged in either normally right or left-brain focused academic activity and right or left-brain treatments. Physiological hemispheric lateralization for either verbal or visuo-spatial functions was not determined for individual subjects.

Ninety-six juniors and seniors from Michigan State University were sampled. The sample was halved according to the dominant hemispheric activity required by each student's academic major. Art and theatre majors composed the right-brain focused group. Computer science and accounting majors composed the left-brain focused group.

Subjects were randomly assigned to eight groups of 12 students. Each group had an equal mix of right and left-brain focused students. A session of distracting music and difficult problems induced subject anxiety. Subject "tension" was then measured on a Likert-type scale for "tension", ranging from 1 (completely relaxed) to 7 (very tense). Next, each group received one of eight distinct treatments. Four treatments accessed normal left-brain function and four treatments accessed normal right-brain functions. Subjects then completed a duplicate of the initial Likert-type scale of "tension" and finally completed the "state anxiety" form of the State Trait Anxiety Index.

Analysis of variance was the method used to analyse the data from the "state anxiety" portion of the STAI, while an analysis of co-variance was used to analyse the data from the Likert-type scale of "tension". F-tests of statistical significance were made at the .05 level.

Hypotheses for the study and results of the hypotheses testing were:

1. There is no difference in anxiety, as measured by the STAI "state anxiety" form, between right-brain focused subjects and left-brain focused subjects. (Null rejected - p less than .006).

2. There is no difference in "tension" as measured by the Likert-type scale of "tension", between right-brain focused subjects and left-brain focused subjects. (Null accepted - p less than .19).

3. There is no difference in anxiety, as measured by the STAI "state anxiety" form, between left-brain treatment and right-brain treatment. (Null rejected - p less than .001).

4. There is no difference in "tension", as measured by the Likert-type scale of "tension", between left-brain treatment and right-brain treatment. (Null rejected - p less than .003).

5. There is no difference in anxiety level, as measured by the STAI "state anxiety" form, caused by the interaction of subject-type with treatment-type. (Null rejected - p less than .02).

6. There is no difference in "tension" as measured by the Likert-type scale of "tension", caused by the interaction of subject-type and treatment-type. (Null accepted - p less than .20).

Right-brain treatment was superior to left-brain treatment in reducing both anxiety and "tension".

Differences in anxiety were recorded for subject-type and the interaction of subject-type with treatment-type. Both effects were largely due to the single combination of right-brain focused subjects with left-brain treatment. When compared with the other combinations, anxiety was not effectively reduced in this case.

No difference in "tension" was recorded for subject-type, nor was a "tension" difference recorded for subject-type/treatment-type interaction. However, as with anxiety, the left-brain treatment was relatively ineffective in reducing the "tension" of right-brain focused subjects. A Type II error might have occurred in assessing significance for the subject-type/treatment-type interaction according to "tension".

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TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

LIST OF FIGURES

Figure Page

LIST OF APPENDICES

CHAPTER I

THE PROBLEM

Over the past 100 years there has been considerable research on the functional differences between the right and left hemispheres of the human brain. Within the past thirty years, these differences have been better understood and articulated. The cerebral hemispheres exist cooperatively, each with its own primary functions. These functions have been explored in persons who have suffered brain damage to a particular cerebral hemisphere. Studying such brain-injured patients enables researchers to isolate specific functions formerly processed in the damaged hemisphere. Research has also been performed on severe epileptics who have undergone cerebral commissurotomy in order to control their seizures. This operation completely severs the corpus callosum, the main nerve pathway connecting the cerebral hemispheres. The independent function of each cerebral hemisphere has been studied in these patients. Finally, researchers have developed methods for studying some hemispheric differences in the normally intact human brain. The right and left-brain differences established by these various methods of research are addressed in this study.

Need for the Study

Cerebral hemispheric research on humans has progressed considerably since 1865, when Paul Broca discovered that his left-brain damaged patients consistently showed aphasic disorders, disruption of speech and language functions. Consequently, research on left-brain functions grew rapidly. However, because no apparent behavior disorders were noted in right-brain damaged patients, the right hemisphere drew little attention and remained a mystery. Further research and more sophisticated measures of cerebral functioning have since revealed distinct right-brain functions. Today, each cerebral hemisphere commands considerable research. Dominant right and left-brain functions are described in the "theory" section of this chapter.

Most of the current cerebral hemispheric research suggests that discrete right and left brain functions do exist and that the cerebral hemispheres perform cooperatively in managing human behavior. If distinct and cooperative cerebral hemispheric function does exist, it needs further experimental validation. If it does not exist, then the notion needs to be abandoned as a viable construct. If it is established that people communicate, learn, or physically respond better by accessing a particular cerebral hemispheric mode, then the implications for interpersonal relationships, education, work and leisure activity are indeed important. The focus of this study is to investigate cerebral hemispheric differences and to determine if these differences impact daily human behavior.

Purpose of the Study

The purpose of this study is to determine whether the anxiety level of students doing academic activities requiring the predomint focus of a particular cerebral hemispheric mode is more greatly reduced by a treatment activity matching that particular hemispheric mode than by a treatment activity representing its counterpart mode.

It is important to note that in this study no claim is made to reflect information regarding actual right or left-brain dominance for individual subjects. More than 90 percent of this country's population is normally left-brain dominant for verbal/analytic functions and right-brain dominant for visuo-spatial perception. It is assumed that the subjects used in this study reflect the trends of the general population. The left-brain is commonly termed the dominant hemisphere due to its predominant use in everyday behavior. The label is somewhat misleading. If a person is reading a book, then the left-brain (assuming normal lateralization) is normally dominant for that activity. If a person is recognizing a face, then the right-brain is normally dominant for that activity. Hemispheric dominance is determined by situational context.

The intent in this study is to reflect information about individual subjects whose academic majors require that they spend considerable time doing either predominantly right-brain <u>focused</u> or left-brain <u>focused</u> activity. The term "focused" denotes the activation of a particular hemisphere. It does not denote or imply overall right or left-brain dominance. Throughout the remainder of this study, subjects are referred to as either right-brain focused or left-brain focused, depending on their major academic activity.

The assumption is made that there are discernable differences between the brain's hemispheres and that these differences may have some influence upon communication. Therefore, if positive results are found, some verification of cerebral hemispheric differences is established. If positive results are not found, then the question remains as to whether the problem is in hemispheric theory or in the design of the study.

Hypotheses

Six main hypotheses are considered in this study. The hypotheses are:

1. There is no difference in anxiety level between left-brain focused subjects and right-brain focused subjects.
2. There is no difference in "tension" level between left brain focused subjects and right-brain focused subjects.
3. The right-brain treatment is more effective than the left-brain treatment in reducing the anxiety level of all subjects.
4. The right-brain treatment is more effective than the left-brain treatment in reducing the "tension" level of all subjects.
5. There is no difference in anxiety level caused by the interaction of left and right-brain treatments with left and right-brain focused subjects.
6. There is no difference in "tension" level caused by the interaction of left and right-brain treatments with left and right-brain focused subjects.

The hypotheses are restated in testable form in Chapter III.

Positive results to any of the preceeding hypotheses are applicable only to the population used in this study - junior and senior accounting, computer science, art, and theatre majors at Michigan State University. Inference to groups not tested is left to further research on cerebral hemispheric function.

Theory

While most of the research on discrete cerebral hemispheric function has occurred during the past thirty years, differences were first hypothesized midway through the nineteenth century. Marc Dax and Paul Broca discovered that injury to the left-hemisphere on an adult human brain is usually followed by aphasia, a disturbance in speech and language functions.[1] In 1874 Wernicke furthered the notion of cerebral dominance by showing that loss of certain verbal comprehension resulted specifically from damage to the left cerebral hemisphere.[2] The same speech and language disturbances are rarely seen after similar injury to the right cerebral hemisphere. The Wernicke findings suggest that, in right-handed persons, the left cerebral hemisphere controls verbal functions.

Research indicates that cerebral lateralization, that is distinct hemispheric function, is clearly indicated in all but a small percentage of right handed adults. The left hemisphere manages verbal and analytic functions while the right hemisphere manages spatial relations, recognition of certain non-verbal sounds, and perception of holistic patterns. Right handers comprise approximately

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[1] Geschwind, Norman, "The Anatomical Basis of Hemispheric Differentiation, "Hemispheric Function in the Human Brain, ed. Dimond and Beaumont, p. 8, Halstead Press, 1974.

[2] Ibid., pp. 9 - 12.

88% of Western society.[3] Cerebral lateralization in left handed persons is not so clear. The left hander is often less distinctly lateralized. Beaumont provides an analogy which articulates the difference between right handers and left handers, "The brain of the right hander is rather like a campus in which books and journals are kept in departmental libraries. These libraries are connected by well organized pathways, but are nevertheless some distance apart. The brain of the non-right hander is more like a campus which has one large central library in which all books and journals are stored, and which has a cataloguing system which makes even relatively related subjects somewhat diverse within the confines of the library building.[4] In this study, normal right handedness is assumed in the description of right or left-brain functions. For normal right handers, the left-brain is dominant for verbal tasks.

A large body of research has grown from the early findings of men such as Broca and Wenicke. Since the early 1950's, important new knowledge has been added to the classical concepts of cerebral hemispheric function. Previously, the right hemisphere was considered to be of little functional value. Today, research reveals that the right hemisphere is not a minor factor in brain function but rather retains certain distinct and dominant characteristics of its own.

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[3]Beaumont, Graham, "Handedness and Hemisphere Function," Hemispheric Function in the Human Brain, ed. Dimond and Beaumont. New York: Halsted Press, 1974.

[4]Ibid., p. 110.

Mastery of spatial relations, recognition of certain sounds and tonality, recognition of faces, visual imagery, and perception of gestalts have all been credited to right-brain function. An operational definition of cerebral dominance is offered by Stuart Dimond, "a reasonably adequate current definition of dominance might be that one hemisphere may be said to be dominant for a given function when it is more important for the performance of that function that the other hemisphere."[5]

Human cerebral hemispheres function according to the principle of contralaterality. Each cerebral hemisphere has primary control over the physical functioning of the opposite half of the body. For example, the left hemisphere moves the right arm. Eye function is an exception to the strict definition of contralaterality. Both the right eye and the left eye are equally connected to both hemispheres. However, the recorded visual field of each eye is divided in half. Contralaterality is essentially preserved as the left-brain records images in the right visual field while the right-brain records images in the left visual field.[6]

The left cerebral hemisphere is frequently called the analytic or verbal hemisphere. It functions by taking things apart and dealing with the separated parts one at a time.[7] Boundaries are

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[5]Geschwind, Norman, op. cit., p. 5.

[6]Ornstein, R.E., The Psychology of Consciousness. New York: Penguin Books, 1972.

[7]Galin, D., "Implications for Psychiatry of Left and Right Cerebral Specialization," Archives of General Psychiatry, v. 31, pp. 572-583, 1971.

key to understanding this particular cognitive mode. Boundaries separate things into parts. Words serve to make boundaries. Mathematics is concerned with the manipulation and relationship of parts and units. Logic is founded upon the necessary separation implied by the relationship of cause and effect. Analysis is defined as the separation of a whole into its component parts. Sequential or temporal ordering is also an essential part of the analytic mode. Galin points out that, "this mode might emphasize concern with outcome and sequences of actions, focusing of the future, or the past, rather than focusing on processes and the present (what Gestalt therapists call 'staying in the now').[8]

The left-brain analytic style is very functional in dealing with everyday affairs. Without the left cerebral hemisphere, simple tasks like reading the paper or counting change would be prodigious.

While the left hemisphere manages parts, the right hemisphere manages perceptual wholes. Galin contrasts the right hemisphere to the left, describing the right-brain as more nonverbal, perceptual, spatial, pictorial, receptive, and emotional than the left-brain.[9] The right hemisphere records images through visual, tactile, kinesthetic and auditory sensation. The right hemisphere reasons by nonlinear association. Its solutions to problems are based on multiple converging determinants rather than a single causal chain.[10]

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[8]Ibid., pp. 28-49.

[9]Ibid., pp. 28-49.

[10]Ibid., pp. 28-49.

The right hemisphere is largely responsible for recognizing musical forms, melodies and environmental sounds other than speech. The right-brain provides objects with three dimensions, situating them in space. When one recognizes a face, the right-brain is responsible. When one recognizes a melody, the right brain is likely at work. Once considered a minor partner to the left hemisphere, the right hemisphere is now considered an integrally essential part of the human brain's overall performance. Jerre Levy-Agresti and R.W. Sperry state that, "the right hemisphere is specialized for Gestalt perception, being primarily a synthesist in dealing with information input. The speaking (left) hemisphere, in contrast, seems to operate in a more logical, analytic, computer-like fashion. Its language is not suitable for the rapid complex syntheses achieved by the right hemisphere."[11] Galin suggests that such rapid complex synthesis might indeed be intuition.[11a]

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[11] Galin, D., "Implications for Psychiatry of Left and Right Cerebral Specialization," Arch. of Gen. Psychiatry, pp. 574-577, Vol. 31:1975.

[11a] Ibid., pp. 574-577.

The chart presented in table 1.1 was developed by Bogen to display an historic progression of perceived dichotomous brain function.[12]

Table 1.1: Dichotomies with Lateralization Suggested

Suggested By:	Left Hemisphere	Right Hemisphere
Jackson (1864)	Expression	Perception
Jackson (1874)	Audito-articular	Retino-ocular
Jackson (1876)	Propositionizing	Visual imagery
Weisenberg & McBride(1935)	Linguistic	Visual or Kinesthetic
Anderson (1951)	Storage	Executive
Humphrey and Zangwill (1951)	Symbolic or Propositional	Visual or Imaginative
McFie and Piercy (1952)	Education of Relations	Education of correlates
Milner (1958)	Verbal	Perceptual or non-verbal
Semmes, Weinstein, Ghent, and Teuber (1960)	Discrete	Diffuse
Zangwill (1961)	Symbolic	Visuospatial
Hecaen, Ajuriaguerra, and Angelergues (1963)	Linguistic	Preverbal
Bogen and Gazzinaga (1965)	Verbal	Visuospatial
Levy-Agresti and Sperry (1968)	Logical or Analytic	Synthetic Perceptual
Bogen (1969)	Propositional	Appositional

[12] Bogen, J.E., "The Other Side of the Brain II: An Appositional Mind," Bulletin of the Los Angeles Neurological Society, v. 34, pp. 135-162, 1969.

The following chart was developed by Ornstein (1972) to represent contrasting modes of consciousness which might suggest dichotomous right and left-brain function:

Table 1.2: Two Modes of Consciousness: A Tentative Dichotomy[13]

Who Proposed It?		
Many Sources	Day	Night
Blackburn	Intellectual	Sensuous
Oppenheimer	Time, History	Eternity, Timelessness
Deikman	Active	Receptive
Polanyi	Explicit	Tacit
Levy, Sperry	Analytic	Gestalt
Many Sources	Lelf Hemisphere	Right Hemisphere
Domhoff	Right (side of body)	Left (side of body)
Bogen	Propositional	Appositional
Lee	Lineal	Non-lineal
Luria	Sequential	Simultaneous
Semmes	Focal	Diffuse
I. Ching	The Creative, Heaven	The Receptive, Earth
I. Ching	Masculine, Yang	Feminine, Yin
I. Ching	Light	Dark
I. Ching	Time	Space
Many Sources	Verbal	Spatial
Many Sources	Intellectual	Infinitive
Jung	Causal	Acausal
Bacon	Argument	Experience

[13]Ornstein, R.E. The Psychology of Consciousness. New York: Penguin Books, 1972.

The hemispheres of the brain are connected by the great cerebral commissure, the corpus callosum. It is through this nerve pathway that hemispheric information is exchanged. Sperry describes the results of severing the corpus callosum,

> "The most remarkable effect of sectioning the cerebral commissure continues to be the apparent lack of change with respect to ordinary behavior. The patients exhibit no gross alterations of personality, intellect, or overt behavior two years after operation. Individual mannerisms, conversation and bearing, temperament, strength, vigor, and coordination are all largely in tact and seem much as before surgery. Despite this outward appearance of general normality in ordinary behavior. . . specific tests indicate functional disengagement of the right and left hemispheres with respect to nearly all cognitive and other psychic activities. Learning and memory are found to proceed quite independently in each separated hemisphere. Each hemisphere seems to have its own conscious sphere for sensation, perception, ideation, and other mental activities and the whole inner realm of gnostic experience of the one is cut off from the corresponding experiences of the other hemisphere. . .[14]

When the corpus callosum is normally intact, the cerebral hemispheres somehow cooperate with one another by establishing dominance in certain situations. Exactly how this happens remains a mystery. Galin suggests that the hemispheres take turns according to situational demands. While one hemisphere functions, the other is either inhibited or at rest. On the other hand, Bogen considers healthy creativity to be the result of both hemispheres being simultaneously active and integrated.[15]

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[14]Sperry, R.W., "Neurology and the Mind-Brain Problem," American Scientist, v. 40, pp. 291-312, 1951.

[15]Galin, D., "The Two Modes of Consciousness and the Two Halves of the Brain," Symposium on Consciousness, ed., Lee, Ornstein, Galin, Deikman, Tart. New York: Penguin Books, 1976.

If it is true that hemispheric dominance is open to situational demands, then exactly what does determine the dominant hemisphere? Most situations provide ample stimuli to elicit either right or left-brain activity. What decides which hemisphere takes charge?

Galin and Gazzaniga each offer different hypotheses to the question of situational hemispheric dominance. Galin suggests that there is "resolution by speed."[16] The hemisphere that solves the problem or processes the stimuli first gets to the output channel first. For example, a simple conversation would trigger left-brain dominance because the left-brain processes verbal input faster than the right-brain processes verbal input. Gazzaniga proposes that "resolution by motivation" might determine situational hemispheric dominance. He discovered that situational hemispheric dominance in monkeys could be reversed by reinforcement of the nondominant hemisphere. This hypothesis suggests that the reason people are generally left-brain dominant in their behavior is because verbal and logical behavior is rewarded more than behavior requiring spatial perception, intuition or visual imagery. The issue of situational dominance is one of many areas in cerebral hemispheric function open to further study.

Research on human cerebral hemispheric difference is difficult due to the complexity and fragility of the brain. Consequently, most of the research to date has been performed on cats, monkeys,

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[16]Galin, D., op. cit., p. 7.

humans with clearly lateralized brain damage or epileptics who have undergone cerebral commissurotomy to control violent seizures. In this study, the operational definitions for right and left-brain functions are based upon the results of such research.

Any positive results recorded by this study provide support to the theory of discrete cerebral hemispheric function, despite the fact that physiological hemispheric lateralization was not assessed for individual subjects. The determination of which particular hemisphere managed verbal functions and which particular hemisphere managed visuo-spatial functions was not necessary for the subjects in the study. Only the discrete accessing of primarily verbal or primarily visuospatial functions was important to the study.

Overview

A review of the pertinent literature concerning differences in hemispheric function is provided in Chapter II.

Included in Chapter III are: a description of the sample, a description of the measure used to test subject anxiety, the research hypotheses in testable form, the design of the study, and the strategy for data analysis.

The results of the data analysis are presented in Chapter IV. Findings are recorded in tabular form and discussed according to the research hypotheses.

Chapter V is the integration and discussion of conclusions drawn from the study. Also, implications for further research are considered.

CHAPTER II

A REVIEW OF THE LITERATURE

The object of this chapter is to review the literature, pertinent to this study, on the differences in hemispheric brain function. Dominant right and left-brain functions are described. Also, in support of the study's subject groupings, job descriptions and personal qualifications of accountants, computer scientists, artists, and thespians are reviewed.

Introduction

Most of the research done on cerebral hemispheric differences has been done since 1950. However, differences were first noted midway through the nineteenth century. The left-brain gained primary recognition as the seat of all consciousness while the functional nature of the right-brain remained a mystery.[17]

Research over the last thirty years has demonstrated that the right hemisphere is, in fact, dominant for certain cerebral functions. Most of this research has been done on brain-bisected cats and monkeys, humans exhibiting clearly lateralized brain damage, and on epileptics who have undergone cerebral commissurotomy to control violent seizures. Cerebral commissurotomy includes severing the corpus callosum, the primary nerve pathway connecting the

[17] Geschwind, Norman, op. cit., p. 5.

cerebral hemispheres. Differences in cerebral hemispheric functions are the main concern of this study. These differences are reviewed with respect to the following categories: brain-bisected animals, handedness and hemispheric function, EEG studies of hemispheric activity, eye movement and hemispheric function, dominant functions of the cerebral hemispheres, and cognition and speech in the cerebral hemispheres. Furthermore, literature on the nature of right or left-brain focus in accounting, computer science, art, and theatre is reviewed.

Research on Brain-Bisected Animals

In mammals, the two halves of the brain are connected by discrete nerve bundles called commissures. The largest and most important of these connectors is the great cerebral commissure, technically called the corpus callosum. R.W. Sperry surgically severed the corpus callosum of cats and monkeys in order to study the independent functions of each cerebral hemisphere.

As previously stated, cerebral hemispheric function operates according to the principle of contralaterality. The right-brain primarily controls the motor functions of the left side of the body and the left-brain primarily controls the motor functions of the right side.

In a study of brain-bisected cats, Sperry and Stamm used a pedalpress type of learning apparatus to show that the hemispheres learn separately when the corpus callosum is severed.[18]

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[18]Gazzaniaga, M.S., "The Split Brain in Man," Scientific American, v. 217, pp. 24-29, 1967.

Pedal pressing techniques learned by one paw had to be relearned entirely anew by the other paw. One hemisphere had remained oblivious to learning what had occurred in the other. Sperry reported similar findings in split brain monkeys, "each of the divided hemispheres had its own independent mental sphere or cognition system - that is, its own independent perceptual, learning, memory, and other mental processes. It is as if each of the separated hemispheres is unaware of what is experienced in the other. It is as if the animals had two separate brains."[19]

Research by Gazzaniga and Young suggests that split cerebral hemispheres in monkeys are capable of processing more information than is possible for connected hemispheres. Increasing amounts of visual information were flashed to two normal and two split-brain monkeys. All four monkeys had been previously trained to respond in certain ways to the stimuli. The split-brain monkeys responded correctly to more information than the normal monkeys.[20]

Gazzaniga showed that cerebral hemispheric dominance in split-brain monkeys could be changed by behavioral reinforcement. Split-brain monkeys were trained to do certain tasks. Each hemisphere was taught independently. When problems were simultaneously given to both hemispheres, contralateral performance indicated that the right hemisphere was preferred. By increasing reinforce-

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[19]Zangwill, O., "Consciousness and the Cerebral Hemispheres," Hemispheric Function in the Human Brain, ed. Dimond and Beaumont. New York: Halsted Press, 1974.

[20]Gazzaniga, M.S., and Young, E.D., "Effects of Commissurotomy on the Processing of Increasing Visual Information," Experimental Research, v.3, pp. 368-371, 1967.

ment (food) of left-hemispheric performance, the left-brain soon became the preferred side and remained so thereafter.[21]

Trevarthen simultaneously presented contradictory visual tasks to the separate hemispheres of split-brain monkeys. Results were that one hemisphere was able to learn a certain visual discrimination while the other side learned a completely different visual discrimination. Trevarthen concluded that there were "two relatively independent perceiving and attending processes sustained simultaneously in the separated hemispheres of the split-brain monkey.[22]

Results from research on split-brain animals inspired Sperry, Bogen, and Gazzaniga to study the effects of cerebral commissurotomy on epileptics who had undergone the surgery to control their seizures. The operation has few visible effects on the patients' daily behavior. Bogen reports that these patients show a remarkable absence of functional impairment and that overall intelligence is minimally affected.[23] The greatest difference between commissurotomized human subjects and commissurotomized animals is in speech related deficits. Cats and monkeys simply don't demonstrate speech functions and consequently don't demonstrate speech deficits. In humans the left-brain is generally dominant for speech function.

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[21] Gazzaniga, M.S., "Changing Hemisphere Dominance by Changing Reward Probability in Split Brain Monkeys," Experimental Neurology, v. 33, pp. 412-419, 1971.

[22] Trevarthen, C.B., "Functional Interactions Between the Cerebral Hemispheres of the Split-Brain Monkey," Functions of the Corpus Callosum, ed. Ettlinger. London: Churchill, 1965.

[23] Gazzaniga, M.S., Bogen, J.E., and Sperry, R.W., "Some Functional Effects of Sectioning the Cerebral Commissures in Man," Proc. Nat. Acad. Sci. U.S., v. 48, pp. 1765-1769, 1962.

The left-hemisphere also governs the generally dominant right hand. For this reason, dominant right handedness and left-brain dominance for speech are often considered to be related.[24]

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[24]Gazzaniga, M.S., and Sperry, R.W., "Language After Section of the Cerebral Commissures," Brain, v. 90(1), pp. 131-148, 1967.

Handedness and Cerebral Hemisphere Dominance

J. Levy and M. Reid studied the relation between handedness and cerebral dominance. They report that approximately nine out of ten people in this country are right hand dominant and that 98% of all right handers have speech dominant left cerebral hemispheres.

Levy suggests that "the linguistically dominant left hemisphere and the dominant right hand seems to derive from the fact that the left side of the brain is organized not only for language integration but also for the programming of sequential manual movements."[25] Further, it was reported that approximately 60 percent of left handers retain left-brain dominance for speech. The remaining 40% have speech dominance reversed in the right-brain. Consequently, more than 90 percent of this country's population has language dominance in the left cerebral hemisphere. Levy and Reid also noted that lateralization is not as distinct for left,handers as it is for right handers. For example, considerable speech function may exist in both hemispheres of the left hander.[26]

EEG Studies of Cerebral Hemispheric Function

Monitoring alpha waves is another method for assessing cerebral function. Galin and Ornstein studied the EEG assymmetry of normal subjects during verbal and spatial tasks. The verbal activities included writing a letter, arithemetic, and making up a list of verbs. The spatial activities include the Seashore Tonal

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[25] Levy, J. and Reid, M., "Variations in Writing Posture and Cerebral Organization," Science, v. 194, pp. 337-339, 1976.

[26] Ibid., pp. 337-339.

Memory Test and construction of multi-colored blocks. Results were that, during left-brain activity, alpha wave activity is greater in the right hemisphere relative to the left. During spatial tasks, the alpha activity of the left hemisphere is greater relative to the right. The hemisphere being accessed does not generate as much alpha wave power as the hemisphere not being accessed. The alpha power is decreased by performance of the particular hemispheric function. Ornstein states that, "the appearance of alpha rhythms indicates a turning off of information processing in the area involved."[27]

Brown studied the identification of feeling states which matched greater alpha activity, an indicator of relaxation. She found that greater alpha activity appeared to be related to the narrowing of perceptual awareness and pleasant feeling states.[28] Researchers at the Langley Porter Neuropsychiatric Institute compared the brain activities of subjects reading technical literature to subjects' brain activity while reading fiction full of vivid imagery. Results were that primarily left-brain accessing occurred during both types of reading and that right-brain activity was greater during the fiction reading than during the technical reading.[29]

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[27] Galin, D., and Ornstein, R.E., "Lateral Specialization of Cognitive Mode: An EEG Study," Psychophysiology, v. 9, pp. 412-418, 1972.

[28] Brown, B.B., "Recognition of Aspects of Consciousness through Association with EEG Alpha Activity Represented By a Light Signal," Psychophysiology, v. 6, pp. 442-452, 1970.

[29] Schmeck, H., "Two Brains of Man: Complex Teamwork," New York Times, pp. C1-C4, January 30, 1980.

Lateral Eye Movement and Hemispheric Function

Lateral eye movement is related to cerebral hemispheric function. Kinsbourne found that, during verbal thought, subjects most often looked to the right. During spatial or imagery-laden thought, subjects most often looked to the left. Kinsbourne learned that the effect was weakened by the presence of the experimenter or the sound of his voice.[30] In a similar study, Galin and Ornstein asked ceramicists and lawyers questions requiring either verbal thought or spatial thought. They found that the questions requiring verbal thought evoked significantly more right lateral eye movements than did spatial questions.[31] Schwartz found that subjects tended more often to look left when answering affective questions. This directional shift is accentuated when the questions involve spatial manipulation and lessened when the questions involved verbal manipulation. Schwartz concludes that, "this data supports the hypothesis that the right hemisphere has a special role for emotion in the intact brain."[32]

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[30] Kinsbourne, M., "Direction of Gaze and Distribution of Cerebral Thought Processes," Neuropsychologia, v. 12, pp. 279-281, 1973.

[31] Galin, D., and Ornstein, R.E., "Individual Differences in Cognitive Style: Reflective Eye Movements," Neuropsychologia, v. 12, pp. 367-376, 1973.

[32] Schwartz, G., "Right Hemisphere Lateralization for Emotion in the Human Brain", Science, v. 190, pp. 286-288, 1975.

Visual and Auditory Studies of Dominant Right and Left-Brain Functions

Gazzaniga, Bogen, and Sperry collaborated in a study of visual perception in commissurotomized humans, Visual stimuli were tachistoscopically presented to each visual half-field. Half-field presentation ensures select attention in either the right or the left hemisphere. The tachistoscope provides half-field visual presentation. Results were that when instructional information was presented to only one hemisphere, the contralateral manual functions responded normally while ipsalateral manual performance was markedly disrupted.[33]

In a study of memory scanning ability, Klatsky and Atkinson flashed pictures and letters to each visual half-field of split-brain patients. Results showed that the right hemisphere was faster at processing large memory sets of pictorial stimuli and the left-brain excelled in processing letter stimuli.[34]

Levy-Agresti and Sperry studied the different perceptual styles of the two cerebral hemispheres. Split-brain patients were shown diagrams of three blocks, each different in some fashion. Subjects were then asked to feel a single block without looking at it and then match the block with its duplicate, initially seen in the diagram. The pattern of scores led Levy-Agresti and Sperry to

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[33]Gazzaniga, M.S., Bogen, J.E., and Sperry, R.W., "Observations on Visual Perception After Disconnexion of Cerebral Hemispheres in Man," Brain, v. 88(2), pp. 221-236, 1965.

[34]Klatzky, R., and Atkinson, R., "Specialization of the Cerebral Hemispheres in Scanning for Information in Short-Term Memory," Perception and Psychophysics, v. 10, pp. 335-338, 1971.

suggest that each hemisphere used a different strategy in solving the problems given to it; "the speaking hemisphere consciously analyzes the details of each block while the mute hemisphere synthesizes the block Gestalt and visualizes it."[35]

Bogen and Gazzaniga studied the differences in eye-hand function of recently commissurotomized patients. Findings revealed that the right hand showed an inability to copy lines and shapes while the left hand largely lost its capacity to write. The left hand was found superior to the right in tasks of a constructive nature requiring assemblage of two and three dimensional forms.[36] Similarly, Nebes discovered that the left hand of commissurotomized patients is best at estimating the size of a circle by feeling a portion of its arc.[37] Regarding these studies, C. Trevarthen concludes that, "the right hemisphere (and left hand of a commissurotomy patient) is best equipped for spatial relations and best able to perceive wholes from partial information."[38]

Levy, Sperry, and Trevarthen did further study of visual-perceptual differences in split-brain patients. Chimeric images

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[35]Levy-Agresti, J., and Sperry, R.W., "Differential Perceptual Capacities in Major and Minor Hemispheres," Proc. Nat. Acad. Sci. U.S., v. 61, p. 1151, 1968.

[36]Bogen, J., and Gazzaniga, M., "Cerebral Commissurotomy in Man: Minor Hemisphere Dominance for Certain Visuo-spatial Functions," Journal of Neurosurgery, v. 23, pp. 394-399, 1964.

[37]Nebes, R., "Superiority of the Minor Hemisphere in Commissurotomized Man for the Perception of Part-Whole Relations," Cortex, v. 7, pp. 333-349, 1971

[38]Trevarthen, C., "Analysis of Cerebral Activities that Generate and Regulate Consciousness in Commissurotomy Patients," Hemispheric Function in the Human Brain, ed. Dimond and Beaumont. New York: Halsted Press, 1974.

(incomplete half-images) were tachistoscopically presented to both visual fields simultaneously. The chimeric half-images were similar, connected, but not alike as they combined to create one whole image. Subjects were required to match the image they saw with its duplicate located in a visual array of complete images. The results were:

> "1. When the subject is asked to make a direct visual match of what he saw in the tachistoscope with one of a group of alternative whole stimuli, this is done more strongly with the right hemisphere.
>
> 2. Any requirement to say what the object was or to think in words without speaking causes the left hemisphere to assume command of response."[39]

Milner and Taylor studied tactile pattern recognition in seven split-brain patients. In six of seven subjects, left hand performance was more accurate than right hand performance. In delayed matching tests, the left hand could delay across intervals lasting two minutes while the right hand could not.[40]

D. Kimura studied spatial localization in the visual half-fields. Single dots were flashed to either the left or the right visual field. Subjects were asked to recreate the placement of that dot on a card showing an entire set of dot locations. Kimura concluded that, "a point can be more accurately located when it has been presented to the left visual field than when it has been presented to

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[39] Levy, J., Trevarthen, C., and Sperry, R.W., "Perception of Bilateral Chimeric Figures Following Hemispheric Disconnection," Brain, v. 95, pp. 61-78, 1972.

[40] Milner, B., and Taylor, L., "Right-Hemisphere Superiority in Tactile Pattern-Recognition after Cerebral Commissurotomy: Evidence for Non-Verbal Memory," Neuropsychologia, v. 10, pp. 1-15, 1971

the corresponding position in the right visual field."[41]

In a similar study, Nebes measured the perception of spatial relationships in split-brain human subjects. Differing dot patterns were presented to the right and left visual fields. Patients were asked to use finger movement to mimic the dot pattern. Results were that the right hemisphere was superior to the left in perceiving the stimulus patterns.[42]

Kimura and Durnford studied depth perception in the two cerebral hemispheres. Series of dots and single rods were presented to each visual half-field. Subjects were asked to chose the closer rod or dot. Results were that right-brain perception is superior to that in the left-brain.[43]

Geffen, Bradshaw, and Wallace presented words and faces to each hemisphere of split-brain human subjects. Results were that the response time of the left-brain was faster than the right-brain in recognizing verbal stimuli. The right hemisphere was faster than the left in recognizing faces.[44] In a similar study, Levy and Trevarthen showed that the left-brain of split-brain subjects was superior to

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[41]Kimura, D., "Spatial Localization in Left and Right Visual Fields," Canadian Journal of Psychology, v. 23, pp. 443-458, 1969.

[42]Nebes, R., "Perception of Spatial Relationships by the Right and Left Hemispheres in Commissurotomized Man," Neuropsychologia, v. 11, pp. 285-289, 1972.

[43]Kimura, D., and Durnford, M., "Right Hemisphere Specialization for Depth Perception Reflected in Visual Field Differences," Nature, v. 231, pp. 393-396, 1971

[44]Geffen, G., Bradshaw, J., and Wallace, G., "Interhemispheric Effects on Reaction Time to Verbal and Non-Verbal Visual Stimuli," Journal of Experimental Psychology, v. 87, pp. 415-422, 1971.

the right brain in tachistoscopic tests of verbal meaning (matching tests) and conceptual categorization.[45]

Arrigoni and DeRenzi studied spatial perception in subjects having clearly lateralized right or left-brain lesions. The left-lesioned patients were poorer than the right-lesioned patients on the Raven Progressive Matrices of form and spatial perception. Similarly, Aaron Smith tested subjects who had undergone cerebral hemispherectomy. Patients with right cerebral hemispherectomy scored markedly lower than normals on the Raven Progressive Matrices. The scores of the left-hemispherectomy subjects were comparable to subjects without brain damage.[46]

Kimura contrasted the cerebral processing of verbal sounds with non-verbal environmental sounds. Kimura reports that, "when different stimuli are presented simultaneously to the two ears (dichotic presentation), normal adults do not identify the sounds presented to the two ears with equal proficiency."[47] Results showed that:

1. verbal stimuli such as digits or words are more often correctly identified by the right ear than the left.

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[45]Levy, J., and Trevarthen, "Hemispheric Specialization Tested by Simultaneous Rivalry for Mental Associations." (in preparation). from Hemispheric Function in the Human Brain, ed. Dimond and Beaumont. New York: Halsted Press, 1974.

[46]Arrigone, G., and DeRenzi, E., "Constructional Apraxia and Hemispheric Locus of Lesion," Cortex, v. 1, pp. 170-197, 1964.

[47]Kimura, D., "Left-Right Differences in the Perception of Melodies," Quarterly Journal of Experimental Psychology, v. 16, pp. 355-358, 1964.

2. non-verbal stimuli such as melodic patterns or environmental sounds are more often correctly identified by the left ear than the right.

Kimura concludes that language functions are the specialization of the left-brain and non-verbal functions are specialized in the right brain.[48] Kimura and Knox did a similar study where 5 - 8 year olds were assessed to see if lateralization was present in persons of these ages. They found that lateralization does exist in children by the age of five years.[49]

Milner studied the auditory perception of right and left lobectomy patients. He found that scores on the Timbre and Tonal Memory subtests of the Seashores Measure of Musical talents were depressed by right temporal lobectomy but not by left temporal lobectomy.[50]

Cognition and Speech in the Cerebral Hemispheres

In a study designed to evaluate cerebral hemispheric capacity to maintain and use the sequential aspects of verbal acoustic input, Albert demonstrated differences between brain damaged and normal subjects. Brain-damaged subjects did not perform as well as normals. It was further shown that right-brain damaged subjects did more poorly

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[49] Kimura, D., and Knox, "Cerebral Processing of Non-Verbal Sounds in Boys and Girls," Neuropsychologia, v. 8, pp. 227-237, 1969.

[50] Milner, B., "interhemispheric Differences in the Localization of Psychological Processes in Man," Brit. Med. Bull. v. 27(3), pp. 272-277, 1961

than left-brain damaged subjects. These results suggest the dominance of the left-cerebral hemisphere for verbal-sequential analysis.[51]

Semmes, Weinstein, Ghent, and Teuber studied the perceptual capacities of brain damaged subjects and suggest two contrasting modes of neural organization linked along hemispheric lines. Semmes claims that the focal representation of elementary functions in the left hemisphere favors integration of similar units for behavior such as speech while the diffuse representation of elementary functions in the right hemisphere may lead to integration of dissimilar units in behavior requiring multimodal coordination and spatial ability.[52]

Hall, Hall, and LaVoie studied the ideational processes of fifty subjects, all having clearly lateralized brain lesions. Seven selected Rorschach variables were used to differentiate the right hemisphere lesioned subjects from left hemisphere lesioned subjects. Results were that left hemisphere ideation was limited and constricted. Right hemisphere ideation was expansive and uncritically innovative.[53]

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[51] Albert, M., "Auditory Sequencing and Left Cerebral Dominance for Language," Neuropsychologia, v. 10, pp. 245-248, 1962.

[52] Semmes, J., Weinstein, S., Ghent, I., and Teuber, H., Spatial Orientation in Man after Cerebral Injury," J. of Psychology, v. 39, pp. 227-244, 1955.

[53] Hall, M., Hall, G., and LaVoie, P., "Ideation in Patients with Unilateral or Bilateral Midline Brain Lesions," J. of Abnormal Psychology, v. 73, pp. 526-531, 1968.

Dimond and Beaumont used the Kent Rosanoff Word Association Test to study response time differences between intact human cerebral hemispheres. No differences in response time were found. However, word associations were markedly different along hemispheric lines. The left-brain produced very common associations while the right hemisphere associations were less common and more creative.[54]

Seamon did cerebral hemispheric research contrasting the mental coding and retrieval of both verbal and pictorial imagery Results were that the right-brain is faster than the left-brain in retrieving visuo-spatial patterns while the left hemisphere is faster in retrieving verbal material. Seamon suggests that, "retrieval processes and cerebral laterality effects are functionally related to coding strategies and that there are separate processing systems for verbally and visually coded information."[55]

Goodglass and Calderon studied the parallel processing of verbal and tonal stimuli in the cerebral hemispheres of normal subjects. Concurrent or parallel processing was achieved by dichotic presentation of spoken numbers superimposed on piano notes. Subjects were tested for recall of both tonal and digital patterns. Results showed right ear superiority for the tonal component. Goodglass and Calderon suggest that, "the two hemispheres concurrently and indepen-

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[54]Dimond, S.J., and Beaumont, J.G., "Different Personality Patterns of the Human Cerebral Hemispheres." (in preparation). from Hemispheric Function in the Human Brain, ed. Dimond and Beaumont. New York: Halsted Press, 1974.

[55]Seamon, J., "Imagery Codes and Human Information Retrieval," J. of Experimental Psychology, v. 96, pp. 468-470, 1972.

ently process that component of a complex stimulus for which each is dominant."[56]

Gazzaniga and Hillegard studied right hemisphere speech capacities in split-brain subjects. They discovered that, "little or no syntactic capability exists independently in the right-brain. The only syntactic dimension comprehended in a series of pictorial-verbal matching tests was the affirmative-negative."[57]

In a similar study of language capacities in split-brain subjects, Gazzaniga and Sperry found that the left-brain retained all language functions while the right-brain could neither write nor comprehend language.[58]

In the case of a 39 year old male whose right cerebral hemisphere was removed because of a tumor, Bruell and Albee tested the remaining left-hemisphere for language function. The patient showed a "perfect retention of language and had no difficulty in forming abstract concepts."[59]

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[56] Goodglass, H., and Calderon, M., "Parallel Processing of Verbal and Musical Stimuli in Right and Left Hemispheres," Neuropsychologia, v. 15, pp. 377-407, 1976.

[57] Gazzaniga, M.S., and Hillegard, S., "Language and Speech Capacity of the Right Hemisphere," Neuropsychologia, v. 9, pp. 273-280, 1971

[58] Gazzaniga, M.S., and Sperry, R.W., "Language after Section of the Cerebral Commisures," Brain, v. 90(1), pp. 131-148, 1967.

[59] Bruell, J., and Albee, G., "Higher Intellectual Functions in a Patient with Hemispherectomy for Tumors," J. of Consulting Psychologist, v. 26, pp. 90 - 98, 1962.

Occupational Cerebral Hemispheric Focus

The preceeding study concludes the review of the cerebral hemispheric research pertinent to this study. Literature describing the personal characteristics and job descriptions of computer scientists, accountants, artists, and thespians is reviewed in the following section. The particular right or left-brain functions required by participation in these occupations are detailed.

Accountants

The Dictionary of Occupational Titles (1977) describes the worker requirements for an accountant: "Ability to concentrate for long periods; good vocabulary and verbal expression; organization ability; speed and accuracy in making numerical determinations; and a memory for detail."[60]

The Michigan Job Brief (1974) reports that to have success as an accountant, "it is necessary to have an interest and ability for analyzing and solving problems by breaking them down to their essential parts, as well as an ability to separate important and unimportant facts. Accountants must also be able to communicate well in speech and writing.

Accountants need particular skill in verbal, analytical and logical functions. These are left-brain functions.

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[60]Dictionary of Occupational Titles, "Accountant," 4th Edition, U.S. Dept. Labor, p. 252, 1977.

The Canadian Occupations job brief (1975) reports that computer programmers must be able to "write programs in logical sequence by applying knowledge of computers' capabilities, subject matter, and symbolic logic. They write detailed logical flow charts in symbolic form to represent work order of data to be processed. They describe input, output, and arithemetic and logical operation involved".[62]

The Dictionary of Occupational Titles (1977) reports that, "the most important qualification for a programmer is a logical, analytical mind. They must be able to give attention to a mass of detail. They must be accurate. A tiny error may require time-consuming corrections in a program. Painstaking concentration and attention to detail are vital."[63]

The Michigan Job Brief (1975) states that, "Programming requires an aptitude for logical thinking and exact analysis. Ingenuity, patience, persistence, and ability to work with extreme accuracy are important."[64]

Skill in logic and analysis is required of persons entering into the field of computer science. Such skills normally represent left-brain functions.

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[62] Canadian Occupations, "Computer Scientist", Manpower and Immigration Dept., April, 1975.

[63] The Dictionary of Occupational Titles, "Computer Scientist," 4th edition, U.S. Dept. Labor, p. 020., 1977.

[64] "Computer Science," Michigan Job Brief, Bureau of Employment Service, December, 1975.

Artists

The Dictionary of Occupational Titles reports that artists need a significant combination of, "aesthetic appreciation, creative imagination, artistic judgment concerning harmony of color and line, eye hand coordination and finger and manual dexterity to paint or draw and to use handtools when working with plaster, clay, stone and other materials; perception of form and design; color discrimination to perceive differences in hue, shade, and value; and spatial aptitude to visualize and depict three dimensional objects and arrangements on two dimensional surfaces."[65]

Kenneth Lansing (1969) in Art, Artists and Art Education, says that, "artists must be able to perceive a good Gestalt. A good Gestalt is a percept that is meaningful, complete, and simple as the conditions of the stimulus field will allow." He later defines intuition as not a supersensational faculty of the mind, but the apprehension of abstract quantities and relations (size, shape, distance, volume, and surface area)."[66]

Artists must posess skill in spatial relations, the perception of gestalts, and fine motor coordination. Creativity is another asset for art. All of these functions are normally dominant in the right-brain.

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[65] "Artist," Dictionary of Occupational Titles, 4th ed., U.S. Department of Labor, p. 232, 1977.

[66] Lansing, K., Art, Artists, and Art Education, pp. 98-104, Chicago: McGraw Hill, 1969.

Theatre Persons

The Canadian Occupational Information Monograph (1978) reports that "an actor must have vitality, stamina, and good coordination. If actors are to create an understanding of character within an audience, it is also important that they like and be genuinely interested in other people. Imaginative and creative ability far outweighs other apparent assets. Special aptitudes required by the actor not only include a highly developed imagination but also a keen awareness of life. This should be guided by a keen eye for physical movement and grouping and by a good ear for all the variety of meaning and feeling conveyed by voice tones."[67]

Careers (1979) lists various qualities of an actor: "An actor must be able to create a positive image. Distinctive voice quality is important. A special talent for projecting the human body in motion is helpful. Successful actors are good at expressing emotions. An actor must have a keen sense of timing, enthusiasm, spontaneity, and flexibility."[68]

Acting requires imagination, creative thought, sensitivity to affect and a keen sense of form within spatial relations. These qualities are normally right-brain dominant.

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[67]"Actors and Actresses," *Canadian Occupational Information Monograph*, University of Toronto, Nov. 1978.

[68]"Actors and Actresses," *Careers*, research no. 158, Chicago: Institute for Research, 1979.

Summary

In this chapter the pertinent literature on differences in cerebral hemispheric function was reviewed. An historical perspective of hemispheric research was presented. Studies dating back to the mid-nineteenth century record left hemisphere dominance for certain language functions. Studies on cats and monkeys reveal that the hemispheres of the brain can be surgically separated and each hemisphere will retain independent functioning with no deleterious effects on the animal.

It is then shown that severing the corpus callosum controls seizures of severe epileptics without markedly altering the everyday behavior of the patient. Nevertheless, differences in cerebral hemispheric function are recorded. Studies of commissurotomized patients, patients with clearly lateralized cerebral lesions, hemispherectomy patients, and normals suggest discrete differences in cerebral hemispheric function. The research reveals that:

Handedness and Cerebral Dominance

1. In normal right handed persons, language function is dominant in the left hemisphere. Right handers include approximately 90% of this country's total population. In left handers, approximately 60 percent retain left-brain dominance for speech while the remaining 40 percent demonstrate speech dominance in the right-brain. Overall, left-handers are less distinctly lateralized than right handers.

Eye Movement

2. Lateral eye movement is related to hemispheric activation. Accessing of the right hemisphere most often includes left lateral eye movement. Accessing to the left hemisphere most often includes right lateral eye movement.

3. Contralaterality

   The principle of contralaterality states that the right side of the body is controlled primarily by the left cerebral hemisphere and that the left side of the body is controlled primarily by the right cerebral hemisphere. In humans, both the right and left eye access both cerebral hemispheres. However, for each eye, the right visual field is recorded by the left hemisphere while the left visual field is recorded by the right hemisphere.

4. EEG Studies

   Increased alpha wave activity is a measure of relaxation in the brain. Alpha wave activity is greater in the cerebral hemisphere not being accessed than it is in the hemisphere being accessed.

5. Dominant Cerebral Hemispheric Functions

   While both hemispheres are to some extent capable of most functions, each hemisphere retains clear dominance in certain functions. These are listed below:

Dominant Right-Brain functions (assuming normal right handedness) include:

1. Depth perception.
2. Spatial relations on two and three dimensional levels.
3. Tonal recognition, recognition of certain melodies, and certain other musical abilities.
4. Recognition of faces.
5. Perception of wholes or "gestalts".
6. Visual imagery.
7. Creative, divergent ideation

Dominant Left-Brain functions (assuming normal right handedness) include:

1. Speech and language.
2. Reading comprehension.
3. Writing.
4. Logic, sequential analysis, digital analysis, and certain calculation.
5. Convergent ideation.

6. <u>Description of Subject Groups</u>

Finally, worker characteristics and various personality variables of accountants, computer programmers, artists and theatre persons are described. Job descriptions indicate that accounting and computer programming require predominantly left-brain focused activity while art and theatre require a greater proportion of right-brain focused activity.

CHAPTER III

METHODOLOGY OF THE STUDY

Included in Chapter III are: a description of the sample, the operational measured used, the design of the study, a restatement of research hypotheses in testable form, and the procedures for the analysis of the data.

The Sample

The sample of the study included 96 persons, all students at Michigan State University. The number ninety-six was used because it was the largest number, divisible by eight, that the resources of this study could sustain. Forty-four percent of the subjects were male; fifty-six percent were female. The subjects were selected by random recruiting from four specific academic majors: accounting, computer science, art, and theatre. Also, to better ensure student committment to their particular majors, only juniors and seniors were chosen for the study. The subjects' ages ranged from 19 to 27 years. The mean age of the sample was 20.6 years. The modal age of the group was 20 years.

The subjects were divided into two groups. One group consisted of accounting and computer science majors. The other group consisted of art and theatre majors. The two groups were chosen according to the predominant cerebral hemispheric activity required by the individual academic majors. Accounting and computer science majors were the left-brain focused group. Their academic work largely includes mastery of verbal, digital, analytical and logical functions. Art and theatre majors represented the right-brain focused group. Their academic work largely includes mastery of visuospatial skills, perception of gestalts, and creativity.

As previously stated, particular cerebral hemispheric dominance for verbal or visuospatial functions was not physiologically established for each student in this study.

Job-task descriptions indicate that art and theatre majors do academic work requiring more right-brain focus than accounting and computer science majors. Conversely, job-task descriptions indicate that accounting and computer science majors do academic work requiring more left-brain focus than art and theatre majors.

Pilot Study

A pilot study was done in order to detect any potential procedural problems in the final study. The procedures for the final study matched the procedures used in the pilot study except for three alterations.

First, the word "tension" was used instead of "anxiety" on the Likert-type scale. The subjects were better able to gauge their "tension" level than their "anxiety" level. Second, it was determined that <u>reading</u> the instructions rather than saying them extemporaneously was most effective in creating a test-like atmosphere conduscive to anxiety. Third, it was decided that the use of testing cubicles would best prevent inter-subject communication which might prematurely relieve subject anxiety.

Twelve subjects were used in the pilot study. The group consisted of an equal share of right and left-brain focused subjects. It was initially hypothesized that anxiety would be reduced best by the treatment-type which matched the subject-type according to hemispheric bias. Right-brain treatment would best relax right-brain focused subjects while left-brain treatment would best relax left-brain focused subjects. The hypothesis was not supported by the pilot study. Results indicated that in all 12 cases, the right-brain treatment was more effective in reducing anxiety and tension than the left-brain treatment. The initial hypothesis was consequently dropped and replaced by the hypothesis that right-brain treatment was most effective in reducing anxiety and tension in both left and right-brain focused subjects.

Procedures

The 96 subjects were studied in eight groups, 12 subjects per group. Within each group of 12 subjects, six had left-brain focused academic activity and six had right-brain focused academic activity. For convenience, the two subject groups were called simply right or left-brain focused. The eight groups were tested on consecutive Mondays and Wednesdays over a two week period. Testing times remained constant for all four days. Two sites were used for testing. One half of the subjects were tested in each site.

The subjects entered the testing room and were advised of their rights. Confidentiality of individual results was ensured.

The subjects then signed a release form stating that they were aware of their rights. Next, the subjects were seated in cubicles constructed to prevent inter-subject communication. The general nature of the study was explained. Detailed directions to the study were read to the subjects and they were asked to begin.

The first ten minutes of the experiment were designed to induce anxiety in each of the subjects. Subjects were told that they had 10 minutes to solve three problems normally completed by high school seniors in eight minutes. The problems were actually very difficult and solving even one of them in a 10 minute period was difficult. The problems' simple word form belied their true complexity. Also, high school seniors had never been tested on the problems. In addition to the essential unsolvability of the problems within the time constraint, distracting music was played during the problem session. The musical piece was called, "Threnody for the Victims of Hiroshima" by Penderecki.[69] The music was an unstructured mixture of high-pitched stringed instruments designed to characterize the fears and horror at the bombing of Hiroshima. The combination of analytical problems and unstructured music was designed to simultaneously access both cerebral hemispheres and disrupt competent problem-solving. Subjects were reminded of time remaining at three-minute intervals. Failure to complete the problems and the stressful music were the designed sources of subject anxiety.

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[69] Penderecki, K., "Threnody for the Victims of Hiroshima," RCA Victor, VICS - 1239, 1967.

Following the anxiety induction, subjects completed the first of two matching Likert-type tests. The subjects ranked their subjective "tension" level on a scale ranging from 1 to 7. Seven meant "very tense" while 1 meant "completely relaxed." This procedure took approximately 30 seconds to complete. Each of the eight testing groups was then given one of eight distinct treatments. Four of the treatments were designed to access right-brain activity and four treatments were designed to access left-brain activity. The treatments were as follows:

Right-Brain Treatments

1. Raven Progressive Matrices[70] - spatial design puzzles used to detect right cerebral hemispheric damage.
2. Environmental Sounds[71] - ocean, rain, bird, fog, wind. thunder, and forest sounds.
3. Movie - "Imagery in Space,"[72] - eight minutes of free-floating forms superimposed on other forms in a surreal fashion. The sound track was unstructured music with no lyrics or melody.

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[70]Raven, J., "Raven Progressive Matrices," pub. H. Lewis Co., London, Cambridge: University Press 1938.

[71]"Environments I," Syntonic Research Inc., SD-66001, New York, N.Y., 1979.

[72]Burnford, P., "Imagery in Space," ACI films, 16 mm, color, 1961.

4. Music of John Cage - "introductions I & II,"[73] - unstructured electrical music accompanying the melodic voice of John Cage telling Zen-like and humorous stories of peculiar life experiences.

Left-Brain Treatments

1. Map Reading[74] - subjects were required to answer 10 questions about a Forest and Form Cover Map of Bayfield County, Wisconsin.*
2. Political Tape[75] - An eight minute tape in which Lewis Anthony describes reasons why the government and the press need to remain separate. The discussion is monotonic, logical, detailed, and demonstrates little affect.
3. Scientific Article[76] - subjects were required to read an article entitled "The Role of Fire-Retardant Treated Wood in the Protection of Life and Property." by B. Shunk. The article is descriptive, logical, and full of detail.

*Map reading is normally considered a right-brain activity, however in this treatment the left-brain is primarily accessed due to the logical-sequential questions asked of the subjects. (See appendix).

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[73]Cage, J., "Introductions I and II," Everest Records, SDBR-3132, 1966 - 1968.

[74]"Geographical Maps of Wisconsin," Department of Land Resources, Madison, Wisconsin, 1952.

[75]Anthony, L., "Behind the Lines," PBS, May 6, 1976.

[76]Shunk, B., "The Role of Fire-Retardant Treated Wood in the Protection of Life and Property," Wood and Fiber, v. 9, pp. 89-95, 1977.

4. Miller Analogies Test[77] - subjects were asked to complete five practice tests from the Miller Analogy Tests. The logical and analytical nature of this exercise is self-evident in the title of the test.

For the entire sample, one half of the left-brain focused subjects received left-brain treatments and the other half received right-brain treatments. One half of the right-brain focused subjects received right-brain treatments and the other half received left-brain treatments. Each treatment lasted eight minutes.

After the treatment, the 12 subjects were required to complete a matching form of the initial Likert-type test which scaled "tension" from 1 to 7. Next, the subjects completed the "state anxiety" portion of the "State Trait Anxiety Index."[78] This form included twenty questions concerning the subjects' feelings at the moment.

The "state anxiety" questionaire ended the experiment. The subjects were debriefed about the true difficulty of the initial problem set and its purpose. This was followed by a period when the subjects could ask questions about the study. The subjects were then asked not to discuss the experiment with anyone until all the subjects had been tested. Finally, pizza and coke were served as reward for participation in the study.

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[77]Miller, "Miller Analogies Test," Psych. Corp., 304 E. 45th St., NY, NY, 1970.

[78]Spielberger, C., Gorsuch, R., and Lushene, R., "State Trait Anxiety Index." Palo Alto, California: Counsulting Psychologist Press, pp. 7 - 16, 1970.

Measures Used

The primary anxiety index for this study was the "state anxiety" portion of the "State Trait Anxiety Index," developed by Spielberger, Gorsuch, and Lushene in 1964. The "state anxiety" portion of the STAI consists of twenty questions designed to measure a person's anxiety level at the moment. The "trait" anxiety section of the test measures anxiety level in general. An example of the "state anxiety" format is:

	1. Not at all
I feel at ease	2. Somewhat
	3. Moderately so
	4. Very much so

Over 3,300 high school and college students were tested in the development and standardization of this form. The test has been revised twice and is used extensively as a research instrument.[79]

Reliability

Given the transitory nature of anxiety states, test-retest reliability measures were not useful in establishing the reliability of the STAI "state" section. Internal consistency was measured as an alternative and was found to range from .83 to .92 in previous studies. It was further shown that alpha reliability coefficients were typically higher when the "state" anxiety form was given under stressful conditions. For example, the alpha reliability of the scale

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[79]Ibid., pp. 7-16.

was .94 when it was given after a distressing film and, for the same subjects, it was .89 when given following a brief period of relaxation training.[80]

The internal consistency of this study's sample was measured according to Cronback's modification of formula K-R 20.[81] The reliability coefficient was recorded as alpha = .91. This coefficient falls within the reliability range recorded by the STAI authors and well beyond the generally acceptable .80 level.

Evidence toward the construct validity of the STAI "state" test is provided by a sample of 977 undergraduates at Florida State University. These students were given the STAI "state" form with standard instructions. Then they were given the same form and asked to respond according to how they believed they would feel just prior to a final examination. There was a considerable difference in mean score between the normal and exam conditions, the exam score being higher.[82]

Construct validity was further tested in a group of subjects, under stressful and non-stressful conditions. The results are shown in Table 3.1:[83]

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[80] Ibid., pp. 7 - 16.

[81] Cronbach, L., "Coefficient Alpha and the Internal Structure of Tests," <u>Psychometrika</u>, v. 16, pp. 297-334, 1951.

[82] Spielberger, C., Gorsuch, R., and Lushene, R., op. cit., p. 40.

[83] Ibid., pp. 7 - 16.

Table 3.1

Means, Standard Deviation and Alpha Reliability for the Anxiety "State" Scales Under Stressful and Non-stressful Conditions

	males(n=109)			females(n=88)		
Conditions	Mean	SD	Alpha	Mean	SD	Alpha
Violent Movie	50.03	12.48	.94	60.94	11.99	.93
Exam	43.01	11.23	.92	43.69	11.59	.93
Normal	36.99	9.57	.89	37.24	10.27	.91
Relaxation Training	32.70	9.02	.89	29.60	6.91	.83

As further evidence of construct validity, the STAI -"state" form has been shown positively correlated with the D. Pt, and Sc scales of the Minnesota Multiphasic Personality Inventory: D=57, Pt-.79, Sc=.71.[84] Elevation on these three MMPI scales normally reflects high levels of anxiety.

Other Research Using the STAI - "State" Form

Hodges (1967) found that the scores of undergraduate students at Vanderbilt University increased from a rest period to a stress period. The stress situations measured included failure-threat and shock - threat conditions.[85]

Gorsuch (1969) tested Vanderbilt University undergraduates enrolled in a personality course. He tested their "state" anxiety

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[84]Ibid., pp. 7 - 16.

[85]Ibid., pp. 7 - 16.

at the beginning of the term in the middle of the term and at the end of the term. Results showed increasing "state" anxiety as the term progressed to finals week.[86]

Lamb (1969) tested speech students for "state" anxiety just prior to giving a speech and again during the speech. Heart rate and "state" anxiety both rose markedly during the speech and then decreased again after the speech.[87]

Likert-Type Scale of Tension

This tension scale was created solely for the purposes of this test. There is no normative data. It is stricly an experimental instrument. The scale was constructed to serve two purposes. First, using the pre and post format, it could be used as an indicator of what happened to the subjects' "state anxiety" and/or "tension" between the end of the problem set and the end of treatment. Second, analysis of covariance would help to control for any initial differences in "tension" due, for example, to a group effect. The format of the measure required that subject rank his current "tension" level on a scale ranging from 1 - 7, where 1 meant "completely relaxed" and 7 meant "very tense."

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[86] Ibid., pp. 7 - 16.

[87] Ibid., pp. 7 - 16.

Design

The STAI "state anxiety" measure was this study's primary dependent variable. Any results from study were interpreted in light of scores on the STAI. The STAI "state" test was administered once, following the treatments. Therefore, the design of this study is a post-test only type (Campbell and Stanley, 1966).[88] It is a 2(4) X 2 factorial design with two treatment types, four treatment methods nested within treatment-type and both treatment-type and treatment method are crossed with subject type. Four of the treatment methods nested within treatment-type were designed specifically to access verbal/analytical brain function. These four methods constituted the left-brain treatment-type. Four of the treatment methods were designed specifically to access visuo-spatial brain function. These four methods constituted the right-brain treatment-type. Subject-type and treatment-type are fixed variables. Treatment method is a random variable. The design may be represented visually as follows in Table 3.2.

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[88] Campbell, D., and Stanley, J., Experimental and Quasi-Experimental Designs for Research, Chicago: Rand McNally, 1963.

Table 3.2

Treatment Type	Treatment Method No.	S_1	S_2
T_1	1	6 subjects	6
	2	6	6
	3	6	6
	4	6	6
T_2	1	6	6
	2	6	6
	3	6	6
	4	6	6

The post-test only design does not need a pre-test measure because subjects have been randomly assigned to the eight different treatment groups. The design controls for all eight of the Campbell and Stanley threats to internal validity of the design.[89] The fact that the Likert-type "tension" scale included a pre-test and a post-test does not diminish control of the eight Campbell and Stanley threats to internal validity. Random assignment of subjects to cells controls for these variables, just as it does for the post-test only design.

Key to Table 3.2

S = Left-Brain Focused Subjects

S = Right-Brain Focused Subjects

T = Left-Brain Treatment

T = Right-Brain Treatment

Treatment Methods (1-4) = distinct treatment styles-all designed to access left-brain functions.
Treatment Methods (1-4) = distinct treatment styles-all designed to access right-brain functions.

[89] Ibid.

Testable Hypothesis

Six primary hypotheses were tested within the design of this study:

1. H_0: There is no difference in anxiety level, as measured by the STAI "state anxiety" form, between left-brain focused subjects (junior and senior accounting and computer science majors at M.S.U.) and right-brain focused subjects (junior and senior art and theatre majors at M.S.U.).

   H_1: There is a difference in anxiety level, as measured by the STAI "state anxiety" form, between left-brain focused subjects (junior and senior accounting and computer science majors at M.S.U.) and right-brain focused subjects (junior and senior art and theatre majors at M.S.U.)

2. H_0: There is no difference in "tension," as measured by the Likert-type scale for "tension," between left-brain focused subjects (junior and senior accounting and computer science majors at M.S.U.) and right-brain focused subjects (junior and senior art and theatre majors at M.S.U.).

   H_1: There is a difference in "tension," as measured by the Likert-type scale for "tension," between left-brain focused subjects (junior and senior accounting and computer science majors at M.S.U.) and right-brain focused subjects (junior and senior art and theatre majors at M.S.U.).

3. H_0: There is no difference in anxiety, as measured by the STAI "state anxiety" form, between left-brain treatment (activity requiring verbal, logical, or analytical brain processing)and right-brain treatment (activity requiring brain processing of spatial relations, visual imagery, gestalts and certain musical-tonal qualities).

   H_1: Right-brain treatment (activity requiring brain processing of spatial relations, visual imagery, gestalts and certain musical-tonal qualities) is more effective than left-brain treatment (activity requiring verbal, logical, or analytical brain processing) in reducing anxiety, as measured by the STAI "state anxiety" form.

4. H_0: There is no difference in "tension," as measured by the Likert-type scale for "tension," between left-brain treatment (activity requiring verbal, logical, or analytical brain processing and right-brain treatment (activity requiring brain processing of spatial relations, visual imagery, gestalts and certain musical-tonal qualities).

H_1: Right-brain treatment (activity requiring brain processing of spatial relations, visual imagery, gestalts and certain musical-tonal qualities) is more effective than left-brain treatment (activity requiring verbal, logical, or analytical brain processing) in reducing "tension" as measured by the Likert-type scale for "tension".

5. H_0: There is no difference in anxiety level, as measured by the STAI "state anxiety" form, caused by the interaction of left and right-brain treatments (as described in H_0: #3) with left and right-brain focused subjects (as described in H_0: #1).

   H_1: There is a difference in anxiety level, as measured by the STAI "state anxiety" form, caused by the interaction of left and right-brain treatments (as described in H_0: #3) with left and right-brain focused subjects (as described in H_0: #1).

6. H_0: There is no difference in "tension" as measured by the Likert-type scale for "tension" caused by the interaction of left and right-brain treatments (as described in H_0: #3) with left and right-brain focused subjects (as described in H_0: #1).

H_1: There is a difference in "tension" as measured by the Likert-type scale for "tension" caused by the <u>interaction</u> of left and right-brain treatments (as described in H_0: #3) with left and right-brain focused subjects (as described in H_0: #1).

Analysis

The data from the STAI "state" form were coded and analyzed by an analysis of variance. The data from the Likert-type "tension" scales were coded and analyzed by analysis of covariance. Results were tested at the .05 level of significance, using the F test. Assumptions for using the F test in this situation are:

1. Normal distribution.
2. Equality of variance within groups (homoscedosticity).
3. Independence of observations.

According to Kerlinger and Pedhauzer, the F test remains quite robust with respect to violation of these assumptions.[90] The data of this study were assumed to be well within the limits of the assumptions for the F-test model.

Summary

In order to test the hypotheses about the relationship between students engaged in either right or left-brain focused academic activity and right or left-brain treatments, with respect to anxiety reduction, ninety-six students were randomly recruited from the Accounting, Computer Science, Art, and Theatre departments. In eight groups of 12 persons, these subjects had their anxiety raised, measured, treated and finally measured again.

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[90] Kerlinger, F., and Pedhauzer, E., Multiple Regression in Behavioral Research. New York: Holt, Rinehart, and Winston, 1975.

The pre and post test measure was a Likert-type scale of "tension" constructed specifically for use in this study. It has no normative data. The post-test measure was the "state anxiety" form of the State Trait Anxiety Index. The previously established reliability of the measure ranged between .83 and .92. The STAI "state anxiety" form was the study's primary measure; the Likert-type "tension" scale provided a contrast to the STAI "state anxiety" form.

The design used was a 2(4) X 2 factorial design, where treatment-type and treatment method were crossed with subject-type and treatment method was nested within treatment-type. Four groups were compared according to mean scores. They were:

1. Right-brain focused students who received right-brain treatment
2. Right-brain focused students who received left-brain treatment
3. Left-brain focused students who received left-brain treatment
4. Left-brain focused students who received right-brain treatment

Analysis of variance was the decision model used to assess the differences in the four group mean scores of anxiety, as measured by the "state anxiety" form of the STAI.

Analysis of covariance was used to assess the differences in group mean scores of "tension," as measured by the Likert-type "tension" scale.

F-Tests for significance were performed at the .05 level. Assumptions for using the F-test were:

1. Normal distribution.
2. Equality of variance within groups (homoscedasticity).
3. Independence of observations.

CHAPTER IV

RESULTS

The results of the study are reported in the following chapter. Each hypothesis is presented in researchable form with its corresponding level of statistical significance. Two decisions are recorded for each hypothesis. One decision reflects results obtained from the "state anxiety" section of the State Trait Anxiety Index. The other decision reflects results obtained by the Likert-type scale of "tension".

The results of the analysis of variance for "state anxiety" are recorded in table 4.1. The analysis of covariance results for "tension" are recorded in table 4.2. The Pre and Post-test "tension" mean scores are listed in table 4.3 according to both treatment-type and the four treatment-type by subject-type combinations. Graphs representing results of the analysis of variance and covariance are plotted in figures 4.1 and 4.2.

The results are further explained in a discussion section. All results are summarized in table 4.4.

The following research hypotheses were tested.

1. There is no difference in anxiety level as measured by the STAI "state anxiety" form between left-brain focused <u>subjects</u> (junior and senior accounting and computer science majors at M.S.U.) and right-brain focused <u>subjects</u> (junior and senior art and theatre majors at M.S.U.)

3. There is no difference in anxiety as measured by the STAI "state anxiety" form between left-brain <u>treatment</u> (activity requiring verbal, logical, or analytical brain function) and right-brain <u>treatment</u> (activity requiring brain processing of spatial relations, visual imagery, gestalts, and certain musical-tonal qualities).

$$H_0 : T_1 = T_2$$

P .05

$$H_0 : T_1 \neq T_2$$

The results of the analysis of variance for anxiety indicate a statistically significant main effect (significance = .001) for treatment-type, therefore the null hypothesis was rejected. The right-brain treatment was more effective than the left-brain treatment in reducing anxiety.

4. There is no difference in "tension" as measured by the Likert-type scale for "tension" between left-brain <u>treatment</u> (activity requiring verbal, logical or analytical brain function) and right-brain <u>treatment</u> (activity requiring brain processing of spatial relations, visual imagery, gestalts, and certain musical-tonal qualities).

$$H_0 : T_1 = T_2$$

P .05

$$H_0 : T_1 \neq T_2$$

The results of the analysis of covariance for "tension" indicate a statistically significant main effect (significance = .003) for treatment-type. Therefore, the null hypothesis was rejected. The right-brain treatment was more effective than the left-brain treatment in reducing "tension".

5. There is no difference as measured by the STAI "state anxiety" form, caused by the interaction of subject-type (as described in H_0: #1) and treatment-type (as described in H_0: #3).

   The results of the analysis of variance for anxiety indicate a statistically significant interaction effect (significance = .01) between subject-type and treatment-type, therefore the null hypothesis was rejected.

6. There is no difference in "tension," as measured by the Likert-type scale for "tension," caused by the interaction of treatment-type (as described in H_0: #3) and subject-type (as described in H_0: #1).

   The results of the analysis of covariance for "tension" indicate no statistically significant interaction effect (significance = .20) between subject-type and treatment-type, therefore the null hypothesis was accepted.

   The interaction effect is described in the discussion section of this chapter.

Table 4.1

ANOVA SUMMARY TABLE FOR SUBJECT ANXIETY
as Measured by the STAI
"State Anxiety" Form.

Source	df	MS	F	P less than
Treatment Type	1	3243.38	33.46	.001
Subject Type	1	504.17	4.93	.060
Method: Treatment Type	6	96.94	1.56	.160
Subject Type by Treatment Type	1	1107.04	10.83	.010
Subject Type by Method: Treatment Type	6	102.22	1.65	.140
Within Groups	80	62.61		
Total	95	4961		

Table 4.2

ANCOVA TABLE FOR POST-TENSION
with Pre-Tension as a Covariate

Source	Adjusted df	Adjusted MS	F	p less than
Subject Type by Method: Treatment Type	6	1.46	1.67	.13
Method: Treatment	6	.77	.88	.51
Within Groups	79	.87		
			$r_{pre, post} = .47$	
Subject Type by Treatment Type	1	3.51	2.13	.20
Subject Type	1	3.67	2.23	.19
Subject Type by Method: Treatment Type	5	1.64		
			$r_{pre,post} = .54$	
Treatment	1	24.51	28.06	.003
Method: Treatment	5	.87		
			$r_{pre, post} = .15$	

Discussion

A statistically significant difference in "state anxiety" (significance .06) was found between treatment groups. No significant treatment group difference was recorded on the "tension" scale (significance = .19). The difference in "anxiety" is largely attributable to the combination of right-brain focused subjects and left-brain treatment. The right-brain focused subjects demonstrated far greater anxiety than the left-brain focused subjects in response to left-brain treatment. This point is illustrated in figures 4.1 and 4.2. However, when given right-brain treatment, both the right and left-brain focused subjects were nearly equal with respect to anxiety level. Therefore, any suggestion of true differences between treatment groups alone is not intended. The interaction effect is further explained in the discussion of hypothesis # 3.

A statistically significant difference in both "state anxiety" and "tension" was found between treatment types. The significance level for anxiety was .001, while the significance level for "tension" was .003. The right-brain treatment was more effective than the left-brain treatment in reducing the "state anxiety" and "tension" of both treatment groups. In figures 4.1 and 4.2, the combinations are diagrammed.

A statistically significant difference in "state anxiety" was recorded for the interaction of subject-type with treatment-type (significance = .01). No significant difference in "tension" was recorded for the subject-type/treatment-type <u>interaction</u> (significance = .20). The interaction effect was attributable to one subject-type/treatment-type combination in particular. Matching right-brain focused subjects with left-brain treatment was not very effective in reducing subject anxiety or "tension" when compared to the other three possible subject-type/treatment-type combinations. The point is best illustrated in figures 4.1 and 4.2.

Figure 4.1

Interaction Between Subject Type and Treatment Type According to Level of State Anxiety

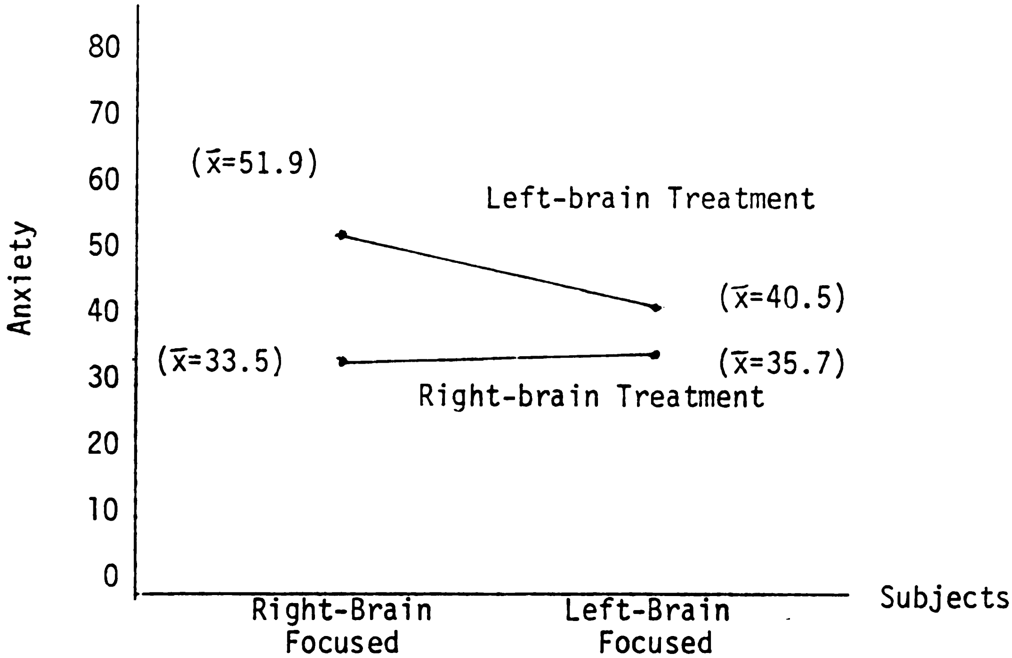

Figure 4.2

Interaction Between Subject Type and Treatment Type According to Level of "Tension" (Adjusted Means)

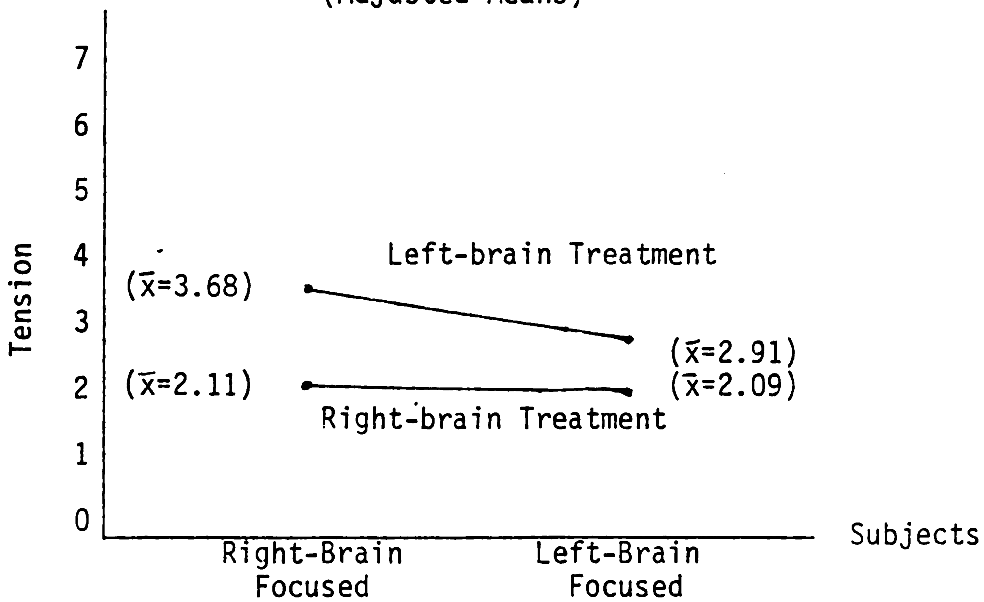

Table 4.3

Means for "Tension" Pre-Test and Post-Test

Subject Type X Treatment Type	Pre-Test	Post-Test
1. Left-Brain Subject X Left-Brain Treatment	5.16	3.08
2. Left-Brain Subject X Right-Brain Treatment	4.67	1.96
3. Right-Brain Subject X Left-Brain Treatment	5.12	3.83
4. Right-Brain Subject X Right-Brain Treatment	4.58	1.92
Treatment Type		
1. Left-Brain Treatment	5.15	3.46
2. Right-Brain Treatment	4.63	1.94

Table 4.4

Summary of Results of the Study

Hypotheses ("state anxiety" and "tension")	STATE ANXIETY significance of F	TENSION significance of F	DECISION (P .05) STATE ANXIETY	TENSION
I. Subject type # 1 equals subject type # 2 $H_0 : S_1 = S_2$	.06	.19	reject	accept
II. Treatment type # 1 equals treatment Type # 2 $H_0 : T_1 = T_2$	.001	.003	reject	reject
III. There is no interaction effect between subject type and treatment type	.01	.20	reject	accept

CHAPTER V

SUMMARY AND CONCLUSIONS

In Chapter V the research is summarized and conclusions are presented. The results of the study are discussed and implications for further research are suggested.

Summary

The study evolved from an interest in how the various differences in cerebral hemispheric function impact daily human behavior. The study was designed to explore the relationship, with respect to anxiety reduction, between students engaged in either normally right or left-brain focused academic activity and right or left-brain treatments.

Pilot Study Design

Particular physiological hemispheric dominance for either verbal or visuo-spatial functions was not established for individual subjects, nor was it implied. However, the predominant activity required by each of the four academic majors used in the study was classified as either normally right or left-brain focused.

A pilot study was performed to test for precedural problems and evaluate tentative hypotheses. Twelve subjects were tested. The sample consisted of six right-brain focused subjects and six left-brain focused subjects. Three procedural changes were made as a result of the pilot. First, the word "tension" was used instead of "anxiety" on the Likert-type scale. Second, it was determined that reading the directions would create more anxiety than simply saying them. Third, it was decided that testing cubicles would best inhibit inter-subject communication which might prematurely relieve subject anxiety. Finally, a tentative hypothesis was changed. It was initially hypothesized that right-brain treatment would best relax right-brain focused subjects and left-brain treatment would best relax right-brain focused subjects. Results of the pilot did not support the hypothesis. In all twelve cases, right-brain treatment reduced anxiety best. Therefore, the initial hypothesis was dropped and replaced by the hypothesis that right-brain treatment was most effective in reducing anxiety and "tension" in both left and right-brain focused subjects.

Design of the Study

The subjects were 96 junior and senior students from Michigan State University. Forty-four percent of the subjects were male and 56% were female. The mean age of the subjects was 20.6 years. The sample was divided in half according to the dominant cerebral hemispheric activity required by each student's particular academic major. One half of the sample consisted of accounting and computer science majors while the other half consisted of art and theatre majors. Accounting and computer science majors represented the left-brain focused group. Their academic work largely included mastery of verbal and analytical functions. Art and theatre majors were the right-brain focused group. Their academic work largely included mastery of visuo-spatial skills, perception of gestalts, and creativity.

The subjects were tested in groups of 12, each group having an equal mix of right and left-brain focused subjects. The subjects sat in cubicles to prevent inter-subject communication. The first ten minutes of the experiment were designed to induce anxiety in the subjects. They were given ten minutes to complete three word problems while listening to disturbing high-pitched string music entitled, "Threnody for the Victims of Hiroshima," by Penderecki. Subjects were told that high school seniors normally completed the problems in eight minutes. Actually, high school students were never tested on these problems and completion of even one problem within the ten minute limit was difficult. The problems' simple word form belied their true complexity. The combination of analytical problems and unstructured music was designed to simultaneously access both cerebral hemispheres and disrupt competent problem solving. Failure to complete the problems and the stressful music were the designed sources of subject anxiety.

Following the anxiety induction, subjects were measured for "tension" on a Likert-type scale of tension ranging from 1 to 7. This measure was constructed specifically for the study and has no normative data. Seven meant "very tense" while 1 meant "completely relaxed." Next, each of the eight groups of 12 subjects was given one of eight distinct treatments. Four of the treatments were designed to access normal right-brain functions and four were designed to access normal left-brain functions. Each treatment lasted eight minutes. After the treatment, subjects completed a matching form of the initial Likert-type scale of "tension". Subjects then completed the "state anxiety" portion of the State Trait Anxiety Index. A debriefing session concluded the experiment.

An analysis of variance was used to analyse the data from the "state anxiety" portion of the STAI. An analysis of covariance was used to analyse the data from the Likert-type scale of "tension". F-Tests of statistical significance were made at the .05 level on data from the following four groups:

1. Right-brain focused students who received right-brain treatment.
2. Right-brain focused students who received left-brain treatment.
3. Left-brain focused students who received left-brain treatment.
4. Left-brain focused students who received right-brain treatment.

Hypothesis

Six main hypotheses were tested in the study. These are stated in the null form along with the results of statistical analysis.

1. H_0: There is no difference in anxiety level, as measured by the STAI "state anxiety" form, between left-brain focused <u>subjects</u> (junior and senior accounting and computer science majors at M.S.U.) and right-brain focused <u>subjects</u> (junior and senior art and theatre majors at M.S.U.).

The null hypothesis was rejected (p less than .06).

2. H_0: There is no difference in level of "tension," as measured by the Likert-type scale of "tension," between left-brain focused subjects (junior and senior accounting majors at M.S.U.) and right-brain focused subjects (juniors and senior art and theatre majors at M.S.U.).

   The null hypothesis was accepted (p less than .19).

3. There is no difference in anxiety, as measured by the "state form" of the STAI, between left-brain treatment (activity requiring verbal, logical and analytical brain processing) and right-brain treatment (activity requiring brain processing of spatial relations, visual imagery, gestalts, and certain musical-tonal qualities).

   The null hypothesis was rejected (p less than .001).

4. There is no difference in "tension", as measured by the Likert-type scale of "tension", between left-brain treatment (activity requiring verbal, logical and analytical brain processing) and right-brain treatment (activity requiring brain processing of spatial relations, visual imagery, gestalt, and certain musical-tonal qualities).

   The null hypothesis was rejected (p less than .003).

5. There is no difference in anxiety level, as measured by the "state anxiety" form of the STAI, caused by the interaction of subject-type (described in H_0: #1) with treatment-type (described in H_0: #3).

   The null hypothesis was rejected (p less than .01).

6. There is no difference in "tension," as measured by the Likert-type scale of "tension," caused by the interaction of subject-type (described in H_0: #1) and treatment-type (described in H_0: #3).

   The null hypothesis was accepted (p less than .20).

Conclusions

1. Subject Groups

There was a difference in anxiety recorded by the main effect of treatment grouping. The right-brain focused group exhibited more overall anxiety than the left-brain focused group. However, caution is advised in interpreting this effect. The group difference was largely attributable to the single combination of left-brain treatment and right-brain focused subjects. Also, subject group difference was not supported by the Likert-type "tension" data. There was no significant difference in "tension" recorded by the main effect of subject grouping.

2. Treatment Groups

There was a difference in anxiety caused by the main effect of treatment grouping. The right-brain treatment was more effective in reducing both right and left-brain focused subject anxiety than the left-brain treatment. There was also a difference in "tension" caused by the main effect of treatment grouping. The right-brain treatment was more effective in reducing both right and left-brain focused subject "tension" than the left-brain treatment.

3. Interaction of Treatment-Type with Subject-Type

There was a difference in anxiety caused by the interaction of treatment-type with subject-type. The effect was most dramatically evidenced by the combination of right-brain focused subjects with left-brain treatment. Anxiety was not effectively reduced for this particular subject-type/treatment-type combination. Little evidence of the interaction effect for anxiety was recorded for the three remaining subject-type/treatment-type combinations. There was no difference in "tension" caused by the interaction of treatment-type with subject-type. However, as with anxiety, a dramatic effect was caused by the particular combination of right-brain focused subjects with left-brain treatment. "Tension" level was not markedly reduced when right-brain focused subjects were given left-brain treatment. A type II error might have occurred in assessing the significance of subject-type/treatment-type interaction for "tension." The similarity of the graphs for anxiety and "tension" (Figures 4.1 and 4.2) indicates the possibility of a significant interaction for "tension" despite the lack of statistical support.

Discussion

The methodology of the study was different than that of most previous research on cerebral hemispheric functions in three ways.

First, the assessment of subjects' hemispheric lateralization is often an integral part of research on differences in hemispheric functions. The present study did not require that individual subjects be tested to determine hemispheric lateralization. Only the discrete accessing of primarily verbal/analytical or primarily visuo-spatial functions was important to the study. The question of which particular cerebral hemisphere possessed the verbal/analytical or the visuo-spatial functions remained unimportant.

Second, most of the previous cerebral hemispheric research has explored individual hemispheric brain functions such as depth perception or reading comprehension or the ability to recognize melodies. The examination and/or articulation of specific individual hemispheric functions was not the purpose of the study. The various individual hemispheric functions, based on the findings of previous research, were simply assumed to exist and manifest certain distinct characteristics. The distinct hemispheric functions were collectively studied as two groups: the group of verbal/analytical functions and the group of visuo-spatial functions. The hemispheric lateralization of the two groups of functions was not determined for subjects in the study, nor was it necessary.

Thirdly, no previous research has employed the technique of clustering various hemispheric treatment methods in order to represent a particular hemispheric treatment mode. The design required four normally left-brain focused treatment methods to represent the left-brain treatment mode and four normally right-brain focused treatment methods to represent the right-brain treatment mode. The technique was successful in that, with respect to anxiety reduction, the four right-brain methods were basically similar in impact and the four left-brain methods were also basically similar in impact. That is, no significant differences were found among the four left-brain treatment methods, nor were any significant differences found among the four right-brain treatment methods. The consistency of the results suggests that accessing a particular hemispheric mode by using a cluster of either distinctly verbal/analytical or distinctly visuo-spatial focused activities is a viable means of exploring general differences in cerebral hemispheric function.

Differences in Anxiety/"Tension" due to Treatment Effect

As predicted, right-brain treatment was more effective than left-brain treatment in reducing subject anxiety and "tension". The results are in accordance with other findings recorded by cerebral hemispheric research. Ornstein suggests that greater alpha activity in a particular cerebral hemisphere indicated, to varying degrees, the "turning off" of the functions dominant in that hemisphere.[91] Therefore, since the left-brain (verbal/analytic functions) is normally dominant for most everyday behavior, the "turning off" of the much

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[91] Ornstein, R.E., The Psychology of Consciousness. New York: Penguin Books, 1972.

used left hemisphere is consequently a relaxing experience. Brown's research supports the notion, reporting that increased alpha activity is associated with pleasant feelings states.[92] The initial subject anxiety in the present study was probably generated by left-brain stress. Despite the attempt to simultaneously access both hemispheres (disturbing music and difficult math problems), the left-brain was likely dominant in the problem solving activity. Consequently, the right-brain treatment best reduced subject anxiety and "tension" by "turning off" the stressed left-brain functions.

That normal right-brain activity is more relaxing than normal left-brain activity makes intuitive sense considering the ways that most people choose to relax. Going to the movies, watching television, listening to music, going to the country, playing sports, having sex, and using alcohol or drugs are some of the more popular ways that people relax. They all include a greater amount of right-brain focused activity than is normally found in school or job activites. The right-brain activity likely relieves the stress that is normally placed upon the left brain (verbal/analytical) functions.

Transcendental Meditation has become a popular technique for relieving stress. The process requires the silent rhythmic repitition of a mantra in order to inhibit the flow of a persons' thoughts and inner dialogue. Sitting comfortably in the dark with eyes closed encourages visual imagery, a normal right-brain function. EEG studies report that alpha activity is increased during TM.[93]

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[92]Brown, B.B., op. cit. p. 20.

[93]Bloomfield, H., Cain, M., and Jaffe, D., TM - <u>Discovering Inner Energy and Overcoming Stress</u>, Delacorte Press, New York; 1975.

The results suggest left-brain functions are being "turned off" and stress is relieved by the right-brain activity.

There is other research which suggests an alternative explanation for right-brain treatment superiority in reducing subject anxiety and "tension". Schwartz, Davidson, and Maer reported that subjects' lateral eye movement went predominantly to the left when asked emotional questions, whether verbal or visuo-spatial in content.[94] Their findings suggest right-brain lateralization for emotion. Their results were supported by a similar study by Tucker, Roth, Arneson and Buckingham.[95] If, in fact, emotion is based in the right-brain, then relaxed feeling states may only occur when the right-brain is being accessed, regardless of what is happening in the left-brain.

The question of which theory best explains the right-brain treatment's superiority in reducing subject anxiety or "tension" might be clarified by further research. If anxiety could be induced by stressing normal right-brain functions, would left-brain treatment then be superior to right-brain treatment in reducing anxiety or "tension"? If it were, then the theory which credits relaxation to the "turning off" of the stressed hemisphere would gain credence. If it were not, then the theory which places emotion in the right-brain would gain credence.

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[94] Schwartz, G., Davidson, R., and Maer, F., "Right Hemisphere Lateralization for Emotion in the Human Brain", Science, Vol. 190, pp. 286-288, 1975.

[95] Tucker, D., Roth, R., Arneson, B., and Buckingham, V., "Right Hemispheric Activation During Stress," Neuropsychologia, vol. 15, pp. 697-700, 1977.

Anxiety and "Tension" Differences for Subject-Type and the Interaction of Subject-Type with Treatment-Type

Anxiety and tension differences recorded for both subject-type and the interaction of subject-type with treatment type were largely due to the single combination of right-brain focused subjects with left-brain treatment. Right-brain focused subjects simply did not relax much, compared to left-brain focused subjects when given left-brain treatment. The reason that this one combination was different from the other three interactions remains unclear. Compared to the daily left-brain activity required by accounting and computer science, the amount of left-brain activity required by left-brain treatment may have seemed rather small to the left-brain focused students. On the other hand, the amount of left-brain activity required by left-brain treatment perhaps seemed relatively large to the right-brain focused students. Consequently, the left-brain focused students relaxed somewhat in response to the left-brain treatment while the right-brain focused students relaxed very little.

Another possible explanation is that right-brain subjects simply were frightened by the prospect of doing mathematical problems. At the testing, many right-brain focused subjects made disparaging comments about their ability to do "math". Many right-brain focused subjects were anxious because they hadn't done "math" since grade school. Also, the right-brain focused group generally seemed competitive towards the left-brain focused group, particularly during the three initial problems and the left-brain treatments. The left-brain focused group generally seemed more interested in their own performance than any inter-group competition. Competitiveness might have increased the anxiety of the right-brain focused subjects during left-brain treatment. Competitiveness was not evident for either group during the right-brain treatments.

Problem Areas in the Study

1. While effects were recorded for both treatment-type and subject-type, it remains uncertain as to whether right or left-brainedness was actually the variable measured. The right and left-brain groups differed according to the hemispheric focus of their academic work. However, there might have been other variables creating the differences between the two groups. For example, personality style might also differentiate the groups. Consequently, it is possible that the anxiety differences between groups were due to personality style rather than academic hemispheric focus. The same problem exists for the treatment-type effects. Most of the right-brain treatment methods were passive while most of the left-brain treatment methods were active. Consequently, the spectrum of activity and passivity might have caused treatment differences rather than the right or left-brain accessing peculiar to the treatments. Caution is advised in assuming that subject and treatment hemisphericity were the only variables operating to create the anxiety differences. There is no certainty that hemispheric focus caused the difference between subject-types, nor is there certainty that hemispheric treatment method was the variable which created the differences recorded for treatment-type.

The results of the study support the notion of hemispheric differences in anxiety reduction, however a cause and effect relationship between hemispheric differences and anxiety differences is not established.

2. The right and left-brain focused groups were not as distinct as their titles suggest. Despite the fact that the right-brain focused group performed academic work requiring more right-brain activity than the left-brain focused group, research suggests that 90 percent of the entire sample was normally left-brain dominant in most everyday behavior. The hemispheric differences between the subject groups were relative rather than discrete. It would be interesting to study a group of people who use predominantly visuo-spatial functions in everyday activity, however finding such a group would present a prodigious task.

3. Group mood was seemingly affected by the experimenter's mood. There is a possibility that certain biases of the experimenter were unwittingly transmitted to the group. Effectiveness of the right-brain treatments might have profitted in this case. Left-brain treatments might have suffered.

Implications for Further Study

In the study, it was likely that the anxiety induced was primarily due to stress on left-brain functions, despite simultaneous accessing of both hemispheres. This assumption is grounded upon research which suggests that the left-brain is dominant in most everyday behavior. The disturbing music was designed to stress right-brain function while the word problems were designed to stress left-brain function. It is probable that the music actually placed more stress on left-brain function by causing the left-brain to work harder to concentrate on solving the problems.

Two questions are raised by this problem. First, can the right-brain be stressed separately and to a greater degree than the left-brain? Second, if the right-brain can be so stressed, would left-brain treatment then be superior to right-brain treatment in relieving the resultant anxiety on tension? Positive results to this question would support the notion that the brain works best and people feel best when both cerebral hemispheres are working together to share nearly equal portions of the functional responsibilities of daily behavior. Negative results would support the research which suggests that the right-brain is normally dominant for emotion.

While it is understood that the results of the study pertain only to the populations sampled, some basic questions are raised regarding work and leisure and stress. First, normal right-brain activity was more relaxing than normal left-brain activity for junior and senior accounting, computer science, art, and theatre majors at M.S.U. Does this trend reflect a trend for other populations? If so, could certain hemispheric functions be generally recommended for relaxation. Could work activity and leisure activity be assessed for stress according to the type and frequency of particular right or left-brain functions required by each?

The area of assessing human cerebral hemispheric function is relatively new and exhibits a growing body of research and interest. The present study and any ideas generated from it will hopefully further the understanding of discrete cerebral hemispheric function in humans.

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APPENDICES

APPENDIX A-1

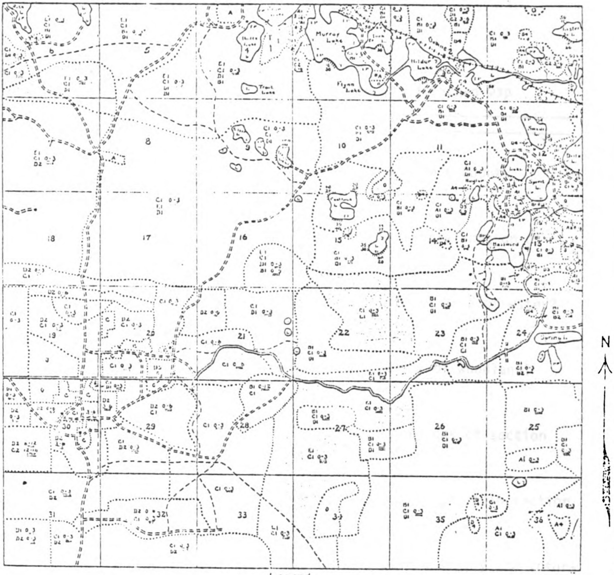
LEFT-BRAIN TREATMENTS

Treatment # 1

(Map Reading)

"Geographical Maps of Wisconsin"
Department of Land Resources,
Madison, Wisconsin, 1952.

LAND ECONOMIC INVENTORY — BAYFIELD CO., WISCONSIN.
FOREST AND FORM COVER MAP — T.46N. R.8W. — 1928.



Legend

Upland Forest	Lowland Forest	Popple	No Forest Cover	Open Swamp	Farm and Urban Land	Lakes and Ponds

0 Mile 1
½

— Land Cover —

- Cover Boundary
- A1-Hardwood with some Basswood
- B1-Hardwood with some Conifers
- C1-Popple with some White Birch
- D1-Scrub-oak (mostly Scarlet) and some Red Maple
- E1-Pin-cherry
- A2-Hemlock with Hardwoods
- B2-White Pine
- C2-Norway Pine
- D2-Jack Pine
- A3-Black Ash, Maple and Elm
- B3-White Cedar
- C3-Tamarack
- D3-Spruce (mostly black)
- A4-Tag Alder, Willow, Red Dogwood, etc.
- B4-Cat tail Marsh
- C4-Grass Meadow
- D4-Leather Leaf Bog
- D5-Recent Burn
- O-Open Land (No forest growth)
- C-Cleared Farm Crop Land
- CR-Farm Crop Land with stumps
- PP-Permanent Pasture
- SP-Stump Pasture
- CV-Urban Property
- Y-Commercial Orchard
- A-Idle or Abandoned Farm Land
- Density of Stand: Fair Medium Poor

— Roads and Improvements —

- Improved Gravel, or Crushed Stone Road
- Improved Dirt Road
- Unimproved Dirt Road
- Trail
- Occupied House
- Unoccupied House
- Summer Home
- Telephone Line
- Railroad
- Abandoned Railroad
- Fire Tower
- Rural Store
- Logging Camp
- School
- Rural Church
- Post Office
- Summer Hotel
- Power Line Along Road
- Saw Mill
- Creamery
- Cheese Factory

Diameter Classes of Forest Cover

0-3, 3-6, 6-12, Etc. — Average Diameter Class for Area, in Inches.

— Lake Mapping —

- Shore Line
- Bog Shore Line
- Strand 10ft. wide
- Bank 10ft. high
- Flat, due to water recession 75 ft. wide. Bank 10 ft. high.
- L-Lake
- BP-Beaver Pond
- Bathing Beach
- St-Shoal Bottom with Debris
- G-Shoal Bottom of Marl
- B-Shoal Bottom of Muck
- C-Shoal Bottom of Clay
- Y-Shoal Bottom of Sand
- b-Shoal Bottom, Gravelly
- R-Shoal Bottom, Stony

— Aquatic Vegetation —

- P-Plankton (Lake Blooming)
- SA-Submerged Algal Vegetation
- FP-Duckweed and like Plants
- SP-Submerged Pondweeds
- EP-Rooted Water Plants with floating or Emerged Stems and Leaves.

DIRECTIONS

Please answer the following questions concerning the attached map.

1. What is the total land area of the portion of Bayfield County represented by this map? ____________

2. What particular type of water body rests in the central region of section #1? ____________

3. Which section of the map contains the greatest total area of water?

   ____

4. Which section of the map indicates the least amount of woodland?

   ____

5. What type of vegetation is growing in the water regions of section #6? ____________

6. What is the average diameter of the popple and white birch in section #23? ____________

7. Regarding Murray Lake, located in section #3, please supply the information requested?

   a) what types of woods are present? ____________

   ____

   b) what types of transportation are available? ____________

   ____

   c) what is the physical nature of the southern bank of the lake?

   ____

Treatment # 2

(Political Tape)
excerpt . . .

Anthony, L., "Behind the Lines,"
PBS, May 6, 1976.

Excerpt from Lewis' Anthonyes discussion on the separation of government and the press. "Behind the Lines," P.B.S., May 6, 1976.

What makes the press special is that in our complicated society the ordinary citizen cannot know or have access to everybody and the press is sort of his delegate for getting the facts and expressing them; and it's that reason, not the Constitution, that makes the press different and requires for the public good that it be protected, that it be protected in its function. Is the press a delagate of the public or a surrogate of the public? Or is there a real difference? It's not a delegate in the sense that it is a representative -- that would be very dangerous. The notion of the constitution is that the paper represents only itself. Each paper speaks for itself and out of a multitude of voices we get hopefully the best. Let's get down to some of the great problems that bother the press alot and perhaps the public too. There is this great big omnibus bill in congress called S-1. What is S-1? It is an attempt to rewrite, in modern and logical form, all the federal and criminal laws that have been passed in this country since the year 1789. A number of previsions were in the original version which were oppressive to the press. This is a rather little known provision, but I think an extremely important one; there is an old statute which makes it a crime, I think quite naturally, to steal government property. This bill would redefine property to include ideas and information. You know the government can't copyright its works - the government has property interest in reports or documents. And yet this law would tend to make ideas property so that people who "stole" a piece of government information, whether copyrighted or not, might be committing a crime. That is a very far-reaching concept. In other words, a government employee might be assigned to write a report, a report considered secret, and then, if he were to speak that report, he would be guilty of a crime under this new law. But suppose that somebody in the government wrote a report that was not published - it was merely an internal report - about the water-works. Then I come along as a journalist and obtain this information and I xerox the report. I don't take away the pieces of paper - just the information. In this case, I might have committed a crime. And that is quite a far reaching and new notion. The better known example of what S-1 would do, is to make it a crime for any government employee to give away to anybody a classified piece of information. How that has never been a law in the United States. The law has made the giving away of secrets a crime for government employees only in very narrow categroies. 1) If it helps a foreign power or injures the United States. 2) If it relates to atomic secrets. 3) If it relates to cryptographic information.

Well, there are now two quite different questions here for me -- 1) one is the idea of judges generally messing with the press and on their own authority issuing orders to prevent publication. And the other one is the question of free press and fair trial. And I find the latter a much more difficult case . . .

Treatment #3

(Scientific Article)

The Role of Fire-Retardant Treated Wood
in the Protection of Life and Property

by

Bernard H. Shunk

Abstract

Fire retardant wood is discussed with two approaches to fire protection offered: fire hazard and fire resistance. Descriptive terms used by testing and regulatory agencies are defined. Several of the more commonly accepted test methods used to determine efficiency of fire-retardant treatments in retarding flame spread or resisting burn-through are examined. The roles played by two major impregnated fire-retardant treatments in this accomplishment are described. Sources of information for more detailed study are provided.

Keywords: Fire hazard; fire protection; fire resistance; fire-retardant treatment; test methods; pressure impregnation; waterborne retardants.

Shunk, B., "The Role of Fire-Retardant Treated Wood in the Protection of Life and Property," Wood and Fiber, v. 9, pp. 89-95, 1977.

Treatment # 4

(Miller Analogies Test)

Sample Problems Reprinted from
Study Guide for Miller Analogies Test,
C. 1976, with the permission of
Contemporary Books Inc. Chicago.

INSTRUCTIONS: Circle the best answer among the choices given in each of the following analogies given below.

1. CANARY : (a. red, b. blue, c. brown, d. yellow) :: POLAR BEAR: WHITE

2. SHIRT : WEAR :: BLOODY MARY : (a. kill, b. eat, c. dress, d. drink)

3. DAY : NIGHT :: DIURNAL : (a. nocturnal, b. eternal, c. vernal, d. external)

4. (a. Howard, b. Phineas, c. Ernest, d. Millard) : FILLMORE ::

   THOMAS : JEFFERSON

5. APRIL : 2 X 15 :: FEBRUARY : (a. 2 X 14, b. 2 X 15, c. 2 X 16, d. 2 X 17)

6. COMPARATIVE : (a. good, b. better, c. best, d. great) :: SUPERLATIVE : BEST

7. WINE : FRUIT :: BEER : (a. grape, b. hay, c. grain, d. lemon)

8. OTHELLO : JEALOUS :: HAMLET : (a. greedy, b. reflective, c. unintelligent, d. joyous)

9. (a. skirmish, b. war, c. disaster, d. truce) : BATTLE :: DRIZZLE : RAINFALL

10. SHETLAND : (a. monkey, b. lion, c. chicken, d. pony) :: HOLSTEIN : COW

11. (a. donkey, b. horse, c. bulldog, d. cougar) : DEMOCRAT :: ELEPHANT : REPUBLICAN

12. (a. green, b. red, c. blue, d. yellow) : CARDINAL :: ORANGE : ORIOLE

13. GERIATRICS ; (a. old age, b. childhood, c. adolescence, d. adulthood) :: PEDIATRICS : INFANCY

APPENDIX A-2

RIGHT-BRAIN TREATMENTS

Treatments 1, 2, 3, 4.

Note: Because of the audio and visual nature of treatments 2, 3, and 4, they are not suitable for an appendix format. Therefore, each treatment will be briefly described. Also, as copyright permission was not obtained for the Raven Progressive Matrices (treatment # 1), they will be described rather than illustrated.

Treatment # 1: Raven Progressive Matrices -

These matrices are spatial design puzzles designed specifically to detect right cerebral hemispheric damage. There are five sets of 12 designs per set. The designs in each set progress with increasing difficulty from design 1 to design 12.

Treatment # 2: Environmental Sounds -

These include the recorded sounds of the ocean, rain, birds, wind, thunder and a forest.

Treatment # 3: "Imagery in Space" -

This movie included free floating architecturally unusual forms superimposed on other forms to create an effect of surreal disorientation. The sound track which accompanied the movie consisted of unstructured music with no lyrics or melody.

Treatment # 4: "Introductions I & II"

The music by John Cage features unstructured electrical music accompanying the melodic voice of John Cage telling humorous Zen-like stories of peculiar life experiences. The content of the stories is subordinate to the rhythum of the voice in contrast with the electrical sounds.

---

1. Raven, J., "Raven Progressive Matrices," pub. H. Lewis Co., London, Cambridge University Press, 1938.

2. Environments I, "Syntonic Research Inc., SD-66001, New York, N.Y. 1979.

3. Burnford, P., "Amagery in Space," ACI films, 16 mm, color, 1961.

4. Cage, J., "Introductions I and II," Everest Records, SDBR-3132, 1966-1968.

APPENDIX B

WORD PROBLEMS

for

ANXIETY INDUCTION

***

Important - SHOW YOUR WORK
(use back if necessary)

Name______________________________

#1. Smith Jones and Robinson are the engineer, brakeman, and fireman on a train but not necessarily in that order. Riding the train are three passengers with the same surnames, to be identified in the following premises by a "Mr" before their names. . .

a) Mr. Robinson lives in Los Angeles
b) the brakeman lives in Omaha
c) Mr. Jones long ago forgot all his high school algebra
d) the passenger whose name is the same as the brakeman lives in Chicago
e) the brakeman and one passenger, a distinguished mathematical physicist, attend the same church
f) Smith beat the fireman at billiards

Question . . . who is the engineer???

#2. Three men play a game with the understanding that the loser is to double the money of each of the other two. After three games each has lost just once and each ends up with $24.00. With how much did each one start? Each player had to show $5.00 to get into the first game.

#3. Make me a crown weighing sixty minae, mixing gold and brass, and with them tin and much wrought iron. Let the gold and brass together form two thirds, the gold and tin together three fourths, and the gold and iron together three fifths. Tell me how much gold you must put in, how much brass, how much tin, and how much iron, so as to make the whole crown weigh sixty minae? Two minae in precious gems shall be added for adornment upon completion of the crown.

APPENDIX C

INSTRUCTIONS FOR PROBLEM SESSION

DIRECTIONS FOR PROBLEM SESSION

(Anxiety Induction)

This study is concerned with learning patterns. Each of you will be given three problems to solve. The problems were chosen from the California Inventory of High School Achievement. The problems require only a basic understanding of mathematics and are designed to test your powers of simple logic. The inventory's statistics show that the average student will complete the three problems in slightly over eight minutes. You will be allotted ten minutes and I will periodically inform you as to time remaining.

A tape of musical distraction will be played while you work. Try to ignore it and work quickly and efficiently. PLEASE SHOW ALL YOUR WORK.

Also, please utter no sounds which might suggest success or difficulty with a problem. Remain as silent as possible throughout your time in the room and communicate with no one.

When you have finished the problems, please wait quietly so as not to disturb others who may not have yet finished.

You may begin NOW . . . remember to work quickly and show your work.

PPlease remain quiet and complete the top sheet of the papers sitting on the desk next to your own.

TREATMENT . . . . . FIVE MINUTES . . .

Now please complete the final two sheets as quickly as you can. Thank You.

APPENDIX D

PARTICIPANT CONSENT FORM

V. Participant Consent Form

I understand that the study being conducted by Larry Eimers under the supervision of Dr. William Farquhar is for the purpose of exploring the general nature of intuitive versus rational functioning in college students pursuing study requiring predominance of either activity. I understand that participating in this study will not result in any direct benefit to me, nor will I be penalized in any fashion should I withdraw from participation. I understand that any confusion or questions resulting from the experiment will be fully clarified in a debriefing session immediately following the experiment. I also understand that the information I provide by completing the twenty question self-evaluation questionnaire will be kept strictly confidential. Only the researcher will have access to the original forms. General results will be reported, but none of these will identify individual participants' results. I know that I will, upon request, receive a report of this study's general results, within the restrictions of confidentiality as outlined above.

Signature	Date
Witness	Date

APPENDIX E

STATE TRAIT ANXIETY INDEX

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DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then blacken in the appropriate circle to the right of the statement to indicate how you feel right now, that is, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

	Not at all	Somewhat	Moderately So	Very Much So
1. I feel calm	1	2	3	4
2. I feel secure	1	2	3	4
3. I am tense	1	2	3	4
4. I am regretful	1	2	3	4
5. I feel at ease	1	2	3	4
6. I feel upset	1	2	3	4
7. I am presently worrying over possible misfortunes	1	2	3	4
8. I feel rested	1	2	3	4
9. I feel anxious	1	2	3	4
10. I feel comfortable	1	2	3	4
11. I feel self-confident	1	2	3	4
12. I feel nervous	1	2	3	4
13. I am jittery	1	2	3	4
14. I feel "high strung"	1	2	3	4
15. I am relaxed	1	2	3	4
16. I feel content	1	2	3	4
17. I am worried	1	2	3	4
18. I feel over-excited and "rattled"	1	2	3	4
19. I feel joyful	1	2	3	4
20. I feel pleasant	1	2	3	4