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EXPLORATION IN MALE AND FEMALE MODES OF CONSCIOUSNESS

by

KODYN HERMAN VANDONSELAAR

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ABSTRACT

In essence, the thesis consists of an in depth exploration and evaluation of Ornstein's (1972) proposal for the existence of two modes of consciousness, which he identifies with the left and right brain hemispheres respectively, and associates with sex differences.

An extensive review of relevant neuropsychological and physiological research literature, published since Ornstein's proposal in 1972, provides little support for his conceptualizations. Also, a detailed investigation of a number of "psycho-philosophical" concepts and functions proposed prior to 1972 and used by Ornstein in support of his concept, brings incongruencies and contradictions to light, putting its validity in doubt.

It is concluded, that the concept of two modes of consciousness in relation with brain hemispheric and sex differences, as formulated by Ornstein, is ill-conceived, superficially researched and presented in an oversimplified manner.

Within the context of the title of the thesis, discussions take place concerning the hazards involved in research in cognitive processes and related to this, different forms of explanations on the basis of sex differences. Similarly, the importance of the body-mind issue, the centrality of the concept of dichotomy in view of qualitative and quantitative differences, and the complementarity of psychological functions, are presented and dealt with.

Finally, "masculinity" and "femininity" and the problems related to "psychological androgynyny" within the context of the nature-nuture aspects of human learning experiences, are also discussed.

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CHAPTER I

INTRODUCTION

In essence, this thesis consists of an in depth exploration of Ornstein's (1972) proposal for the existence of two modes of consciousness, which he identifies with the left and right brain hemispheres respectively, and associates with sex differences.

All human beings belong to the same biological species and function in an environment which is dominated by the presence of other humans. On the basis of biological sex, humans can be categorized as females and males. As a result of biological differences, reaction to and interaction with the environment is different for the members of each category.

The differences between women and men in terms of their nature, their behaviour, and their specific sex roles are a rich source for ideas in the annals of religion, philosophy and literature. The ideas have been represented through in-depth descriptions by ancient and contemporary philosophers, clergy, novelists and playwrights. These presentations have facilitated the development of female and male stereotypes.

Recently, the subject matter involved in comparisons between females and males has become part of the domains of Biology, Anthropology, Sociology and Psychology. As a result, scientific investigations have produced a body of materials which deals with the similarities, but more frequently, with the differences between women and men. Most contemporary researchers use scientific methods for

these inquiries. They tend to be interested primarily in the comparative biological, sociological and psychological aspects of female and male behaviors and roles. These investigations involve the measuring of isolated traits which allows for answers to specific questions about specialized interests. In the process, conceptualizations of behaviors in unidimensional terms is facilitated and experimental designs are applied, which are congruent with such thinking. The results of these efforts can usually be found under the heading "Sex differences" in academic literature.

A cursory scrutiny of library entries indicates that since the early 1960's an ever increasing number of books and articles about the subject has been published. The major impetus for this explosion of academic activity has been the change in views regarding the role of women in their relationship to: (a) society at large, (b) men, (c) each other. This change has been instigated by a female population which, due to innovations of modern science and technology (e.g. conception control, household appliances, communication devices) finally has the opportunity to more fully actualize and develop its cognitive and affective potentials. The resulting growth in self-awareness already exerts an impact on most Western societies and in time will influence all existing civilizations.

Frequently used phrases in connection with females and males are: "The sexes are equal," "the opposite sex," "the sexes complement each other" and "that is typically 'masculine' or feminine.'" In spite of the abundance of information from historical and contemporary, non-scientific and scientific sources, and the subsequent debates about

sex differences, the meaning of such general statements (and the underlying concepts) is still not clear.

A major problem related to this lack of clarity, involves the validity of criteria for making judgements about essential and meaningful differences between females and males. It is thought here, that neither the non-scientific, traditionally loose, descriptive terminology of stereotypes, nor the scientific approach involving narrowly defined traits, meet the standards for making such judgements. Rather, it is thought to be of greater value to investigate the problem through the concept of "conscious experience" using information from both scientific and non-scientific sources in the process. As such, consciousness is central to the meaning of human nature and human differences, certainly more so than the assumed existence of traits such as "submissiveness" vs. "dominance" or "tenderness" vs. "toughness" or many others available in the literature on sex differences.

The concept of conscious experience has occupied philosophers and scientists for centuries and many theories about the nature of consciousness have been developed. The difficulty of "grasping" the concept has been expressed by Battista (1978) who describes it's three most common usages.

> First a theoretical construct, referring to the system by which an individual becomes aware; second to refer to reflective awareness, an awareness of being aware; third as a general term encompassing all forms of awareness (57).

Battista (1978) perceives the last, i.e. general term as being the most useful, since the first description refers to the experience rather than a means of explaining consciousness and the second excludes

developmental experiences of growing awareness.

The difficulty of describing or defining "consciousness" concisely is also expressed by Angel (1908) in

> Consciousness we can only define in terms of itself. Sensations, ideas, pains, pleasures, acts of memory, imagination and will . . . These taken together are what I mean by consciousness (1).

Strange relates how William James has equated consciousness on different occasions with (1) Mental activities, (2) Regions of the spirit, (3) A self or ego function (4) Feeling or thought, (5) Something that does not exist (1978, 12). Natsoulas (1978) has gone so far as to present seven concepts of consciousness, i.e.: (1) Joint or mutual knowledge, (2) Internal knowledge or awareness, (3) Awareness, (4) Direct awareness, (5) Personal unity, (6) Normal waking state, (7) Double consciousness.

Theories of conscious experience include implicit and explicit conceptions about the central role of perceptual and cognitive processes. At times the terminology is interchanged and related concepts are equated (Byrne and Maziarz, 1969, 93-168). It is noted in this context that the rapidly developing psychobiological perspective on human consciousness incudes topics such as: "consciousness, unconsciousness and biocognitive structures: (Davidson, 1980), "consciousness and perception" (Pribram, 1980), and "affect-perception-cognition relation and levels of consciousness" (Izard, 1980). The return of cognition as a valid factor in the study of consciousnss has also been reviewed extensively by Hilgard (1977, 1980) although he recognizes that "cognitive psychology is not necessarily a consciousness psychology" (1980, 19).

The identification of consciousness with the mind has long been recognized by many investigators, among them Titchener (1909) who states that

> Consciousness is identified with mind and conscious with mental. So long as mental processes are going on, consciousness is present, as soon as mental processes are in abeyance, unconsciousness sets in (18).

Others have identified consciousness with mind also. For instance, Moss (1980) equates the two concepts in the phrase "Consciousness, mind, or the mental, is a matter of organizing the relationship between the organism and the environment..." (24) and Pucetti (1981) uses "conscious duality" and "mental duality" interchangeably.

Neuropsychologists have demonstrated the relationships between brain structures and functions (especially in terms of brain hemispheres) on the one hand, and perceptual, cognitive and conscious processes on the other (Furst, 1979; Gazzaniga, 1977; Nebes, 1977; Uttal, 1980).

In summary, conscious experience is an elusive, difficult to define concept; it has been identified with both the human mind and the human brain and it includes many mental states and processes, cognition being of the most central importance among these.

The reader will understand the relevance of the previous observations, when it is realized that Ornstein (1972) attempts to identify different modes of consciousness with both, differences between brain hemispheres and sex differences. Ornstein's foundations for the concept of two modes of consciousness are presented in the following section of this chapter.

Ornstein's Two Modes of Consciousness

In his book, The Psychology of Consciousness, Ornstein (1972) presented a number of dichotomies in support of his proposal for the existence of two modes of consciousness. The dichotomies appear in the following chart:

The Two Modes of Consciousness

A tentative dichotomy

Who proposed it?		
1) Many sources	Day	Night
2) Blackburn	Intellectual	Sensuous
3) Oppenheimer	Time, History	Eternity, Timelessness
4) Deikman	Active	Receptive
5) Polanyi	Explicit	Tacit
6) Levy, Sperry	Analytic	Gestalt
7) Domhoff	Right (side of body)	Left (side of body)
8) Many sources	Left hemisphere	Right hemisphere
9) Bogen	Propositional	Appositional
10) Lee	Lineal	Non-Lineal
11) Luria	Sequential	Simultaneous
12) Semmes	Focal	Diffuse
13) I Ching	The creative: heaven masculine, Yang	The receptive: earth feminine, Yin
14) I Ching	Light	Dark
15) I Ching	Time	Space
16) Many sources	Verbal	Spatial
17) Many sources	Intellectual	Intuitive
18) Vedanta	Buddhi	Manas
19) Jung	Causal	Acausal
20) Bacon	Argument	Experience

(Ornstein, 1972, 83)

Several aspects of this chart are significant. First, Ornstein presents the two modes of consciousness in the context of neuro-psychology or more specifically, in terms of brain hemisphericity as demonstrated by:

- the inclusion of "left hemisphere" versus "right hemisphere" as one of the dichotomies.
- the inclusion of the chart in a chapter labelled "Two sides of the brain"
- numerous references to the right and left brain hemisphere in the text of that chapter, such as:

> If the left hemisphere is specialized for analysis, the right hemisphere...seems specialized for holistic mentation (Ornstein, 1972, 67).

and

> There is no evidence that the two cerebral hemispheres of other primates are specialized, although it would be reasonable to assume some evolutionary precursor of man's hemispheric asymmetry (Ornstein, 1972, 79).

However, scrutiny of the original sources shows that only four of the sixteen documented dichotomies in Ornstein's chart find their origin in neuropsychological research literature (i.e. Bogen, 1969; Levy Agresti-Sperry, 1968; Luria, 1966; Semmes, 1968).

Secondly, he includes implicitly all dichotomies while attaching the labels "female" (or feminine) and "male" (or masculine) respectively to each mode of consciousness:

> If your are right handed, most likely you (feel) the right side of your body as more masculine, light, active and logical, the left side as more feminine, dark, passive, intuitive, mysterious and artisitic (Ornstein, 1972, 67).

and

> The Chinese Yin-Yang symbol neatly encapsulates the duality and complementarity of these two poles of consciousness--Note that one pole is in time, the other in space; one is light, one dark; one active, one receptive; one male, one female (Ornstein, 1972, 81-82).

The general application of these labels occurs while in only two of the original sources (Domhoff, 1969; I Ching, 1950) references are made to sex differences in relation to the relevant individual dichotomies.

Lastly, analysis of the original sources reveals a remarkable variety in origin, nature, length and date in the material from which the chart was composed. Examples are:

Blackburn's (1971) and Oppenheimer's (1953) dichotomies are included in texts related to philosophies of science.

The Buddhi-Manas dichotomy is based on different concepts of mind in Hindu psychology (Akhilananda, 1948); and, ancient Oriental philosophy as contained in the I Ching (1950) is responsible for inclusion of the dualities #13, 14 and 15 of the chart.

Of the four previously mentioned neuropsychological sources, one (Levy Agresti-Sperry, 1968) occupies the space of one printed column, two are articles in Journals (Bogen, 1969; Semmes, 1968) and include literature reviews, while the fourth consists of an entire chapter in a neuropsychological text (Luria, 1966).

Bacon's contribution (Shah, 1964) dates from 1268 A.D., Lee's article (1950) is of a psycholinguistic nature and Polanyi's book (1959) involves epistemological and phenomenological thought.

Finally, a four-page article by Domhoff (1969) provides historical, anthropological and "pop-psychological" information about the preference of "right" over "left" and Jung's concept of the causal and acausal is contained in a 150-page volume about synchronicity with contents from physics, astrology, philosophy and parapsychology (Jung, 1955).

In view of the diversity in origin of the dichotomous concepts present in the chart, they are herewith questioned as a valid basis for Ornstein's concept of two modes of consciousness. In addition, the identification of the dichotomies with functional differences between brain hemispheres and the association of the two modes with "male" and "female" respectively, also causes problems. Thus, one can legitimately ask whether even for "...the purposes of suggestion...in an intuitive sort of way, not as a final categorical statement of the conception" (Ornstein, 1972, 81-82) the manner of presentation, but especially the labelling of the chart is oversimplified and academically not justified.

Criticism of and Support for Ornstein's Concepts

Concerns about the popularizaton of insufficient and unsubstantiated information about structural and functional brain asymmetry and its relation to sex differences have been expressed in the professional literature. The criticisms have been of a general nature and specifically aimed at Ornstein's formulations also, as will be ascertained from the following.

In relation to the hemispheric laterality of conscious and cognitive processes, Corballis (1980) refers to non-scientific origins of the concept:

> Interpretations of cerebral asymmetry that emphasize a fundamental duality in cognitive processing between the two sides of the brain...are probably modern manifestations of the age old mythology of left and right...(284).

The author suggests that more careful interpretations be made based on biological information. He also observes that for instance Bogen's original concept of "propositional" and "appositional" thought

> ...as examplified in the pre-Confucian Chinese concepts of Yin and Yang, in the Hindu philosophy of Buddhi and Manas...was enthusiastically pursued by Robert E. Ornstein in his popular book The Psychology of Consciousness, which is largely responsible for the present wide acceptance of dualistic notions about hemispheric specialization in all areas of life (286-287).

The popularity of Ornstein's book is attested to by its sales figures; 283,000 copies have been sold thus far, mainly to University and College bookstores (figures provided by the publishers, July 1982). The book has been translated in the Dutch language and has been published in Great Britain.

Curiosity in and speculation concerning brain laterality is laudable according to Gardner (1980), but he strongly objects to magazines such as the "garish" Psychology Today and Human Behaviour, as well as the "staid" Saturday Review and the New York Times Sunday Magazine, producing covers with

> ...an artists rendition of the two halves of the human brain. Written athwart the left cerebral hemisphere...are the words "logical", "analytical", or "Western rationality"...etched across the right cerebral hemisphere are the words "intuitive", "artistic" or "Eastern consciousness" (113).

Without reference to individuals, Gardner (1980) finds that the popular press "often abetted by neuro-scientists who should know better, is engaging in name calling" (113).

Such name calling is also popular in relation to sex differences in cognition. According to Star (1979)

> In sources ranging from the Boston Herald to Neuropsychologia, both scientists and journalists have hailed right and left brain

> differences as the "solution" to the enigma of sex differences - why men and women think differently, and appear to have different abilities (113).

Star (1979) could have used specific illustrations through for example Psychology Today (November, 1978) which announced an article on its front cover titled: "Special abilities of the sexes: are male and female brains different?". Another example is Newsweek (May 1981) with a cover that shows a drawing of a male and a female head and the caption: "The sexes, how they differ and why."

In view of the previous, it is not surprising that Ornstein, who is described as "a major figure in both the research on brain asymmetry and its popularization" (Star, 1979, 117) also comes under attack.

For instance, in a text sympathetic to the concept of differences in (but also the complementarity of) modes of consciousness, Singer (1977) also questions labelling in terms of sex differences. She claims that:

> We recognize in Ornstein's chart the residue of the many of the older myths as well as the basic material contributing to recent and possibly still current beliefs relating to human nature and especially to the purported nature of "the masculine" and "the feminine" (Singer, 1977, 215).

However, Star (1979) goes well beyond the expression of mere concerns. She is outright critical of and strongly objects to theoretical interpretations regarding the biological bases for sex differences in conscious experience:

> Some of the writing about brain asymmetry has not bothered to weed out...types of sexist stereotypes about "masculine" and "feminine" in its discussion of brain asymmetry. Robert Ornstein...draws upon old Buddhist doctrine to emphasize his points about left brain and right brain functions.... In doing this, he reifies and further extends common traditional stereotypes into the literature on brain asymmetry (Star, 1979, 116-117).

However, it is also implied that Ornstein's conception may have been a temporary aberration only, for:

> In the years since Ornstein's book was written, many psychophysiologists have revised their initial conceptions of brain asymmetry, and most, including Ornstein, now realize that there is no duality of consciousness in the brain, nor are the "energies" described above limited to men or women (Star, 1979, 117).

The "revisions of conceptions" (including Ornstein's) are not documented by Star (1979), possibly because "...such realizations are rarely put forth clearly or forcefully..." (117). Another reason is that in contemporary neuropsychological and philosophical literature the topic of two modes of consciousness, cognition or experience of reality and related sex differences is alive and well, at times hotly debated, while the concept is not infrequently supported. (Bakan, 1978; Corballis, 1980; Eling, 1980, Gardner, 1980; Gazzaniga and Le Doux, 1978; Hilgard, 1980; Pelletier, 1978; Prohovnik, 1978; Pucetti with peer commentary, 1981).

Without documenting the support, Star (1979) at least acknowledges its presence:

> ...even careful researchers in brain asymmetry still slip into the culturally-condoned and readily available language of sex differentiation to describe brain functions (Star, 1979, 117).

Reference could have been made to Pelletier (1978) who, six years after the appearance of Ornstein's chart observes that:

> In any case, there is increasing evidence that males and females differ with regard to hemispheric asymmetry, which lends credence to the concept that sexuality reflects complementary opposites with regard to perception as in the Yin-Yang of Tao (Pelletier, 1978, 99).

Such evidence is indicated in an exhaustive review of literature

dealing with spatial perception by Harris (1978). He suggests:

> ...that the genetic hormonal factors that create male and female children also predispose the operation of modes of both cognitive and physical activity that tend to enlarge and widen initial differences. The boy more naturally involves himself in experiences that sharpen spatial skills; the girl involves herself more in experiences that strengthen interpersonal skills (486).

That initial differences exist and may be enlarged and widened over time has also been suggested by Lambert (1978) in her thoughtful review.

Restak (1979) confirms some of Harris' findings. When contrasted with boys,

> ...who show a superiority in visual acuity, which compensates for their lowered auditory capacities...(199).

he states that:

> ...girls differ in their approaches to gaining knowledge about the world. They tend to favor a "communicative" mode...(199).

Restak (1979) also comments on the role of biology as compared to that of the environment in relation to the brain functions of the sexes:

> Recent psychobiological research indicates that many of the differences in brain function between the sexes are innate, biologically determined, and relatively resistant to change through the influence of culture (197).

Other scholars (Bixler, 1980; Lowe & Hubbard, 1979; Parsons, 1980; Salzman, 1979; Star, 1979) have also commented on the nature-nurture issue as it applies to research in sex differences.

While recognizing the inability to resolve the nature-nurture dilemma, Parsons (1980) finds that "an examination of the (sex

differences) studies conducted from these perspectives, however, permits an evaluation of what we know from what has been studied" (11).

Lowe and Hubbard (1979) react negatively to the possibility of obtaining answers from either the biological or environmental perspective. They argue that:

> ...the search for unique causes of behavioural sex differences is doomed, whether it sets the locus of causation in evolutionary prehistory, in the effect of sex hormones on the prenatal differentiation of the brain or in specific patterns of socialization (104).

While referring to the two most extensively and frequently researched cognitive processes in relation to sex differences, Star (1979) makes the following comments:

> Many of the major hypotheses about sex differences in hemispheric asymmetry are inferred from differences in performance on specific verbal and spatial tasks...most of the test results can probably be attributed to training or socialization, and do not necessarily reflect inborn differences in brain functioning (119).

Bixler (1980) argues against such a strong environmentalist position frequently taken by extreme feminists. He emphasizes that

> Nature and nurture are totally and inextricably involved in each and every organismic response (154)...all human behaviour and attitudes are mediated by a human organism, the structure and physiology of which are determined in part by heredity (155).

In summary, the following has been observed:

a) Scientific and non-scientific research in sex differences has frequently resulted in stereotyping and/or superficial descriptions of differences between females and males.

b) Conscious experience is fundamental and central to the nature and functioning of humans; it is therefore a valid alternative for the investigation of sex differences.

c) The discipline of neuropsychology provides a contemporary perspective on the study of conscious experience. It relies

greatly on knowledge about the relationship between brain functions and perceptual or cognitive processes.

d) Based on dichotomies present in many "psycho-philosophies," Ornstein proposed in 1972 two modes of consciousness, which he identified with the functional duality of the brain.

e) Ornstein placed two modes of consciousness in the context of sex differences by labelling these "female" and "male" respectively, seemingly without clear justification. As a result he has been accused of perpetuating "feminine" and "masculine" stereotypes.

f) Neuropsychological literature published since 1972 (and not related to Ornstein's modes) appears to be supportive of theories that relate sex differences in conscious experience to innate differences in brain functioning.

g) It has been questioned whether neuropsychological research can contribute meaningfully to the study of sex differences in view of the difficulties inherent in the related nature-nurture issue.

Purpose, Form and Content of the Thesis

Concerns relevant to Ornstein's presentation of a concept of two modes of consciousness and the criticisms of it, have led to the writing of the present thesis. These concerns will be discussed.

Firstly, with a few exceptions (e.g. left and right hemisphere) Ornstein rarely provides an extensive discussion of the dichotomous concepts included in his chart, by means of material obtained from the original sources. It appears that the reader is expected to know and fully understand the conceptual contents of e.g. Polanyi's "explicit-tacit" or Jung's "causal-acausal" dichotomy.

Secondly, possibly because of such a lack of contextual information about the majority of dichotomies, criticisms of Ornstein's concept have been concentrated on those dichotomies that are associated

with extensive research data, i.e. sex differences in brain hemispheric asymmetry and some specific cognitive functions related to it. However, such concentration has left the majority of the dichotomies unchallenged in that they have not been investigated in terms of their conceptual congruency with Ornstein's two modes of consciousness.

Thirdly, whereas "two modes of consciousness" and related sex differences have been criticized for lack of substantive support, the criticisms are at times also questionable, since they are not at all, or not thoroughly documented either (e.g. Gardner 1980; Star 1979).

Therefore and in view of the popularity of his book and the interest it has created in different forms of consciousness, brain hemisphericity and sex differences, it is thought that 10 years after their initial publication, the time has come to stand back and evaluate Ornstein's concepts in depth. This thesis is meant to serve that purpose. It consists of an investigation and evaluation of the specific formulations (and their foundations) by one of the major protagonists of that concept; that is, someone whose influential and popular writings have been accused of being superficial and stereotypical in, at times, superficially and/or angrily worded critiques.

The evaluation will take place through the presentation and exploration of Ornstein's two modes of consciousness, of the conceptual congruency of the original dichotomies with the two modes, and of the relationship between the dichotomies and differences in brainhemispheric functions and sex differences in cognition.

A major task during an in-depth investigation and subsequent evaluation, is to provide sufficient and relevant background information so that the reader will be able to appreciate the scope and

complexity of the subject matter under scrutiny. Therefore, throughout the thesis, but especially in Chapters II, III and IV, extensive material pertaining to the many complexities involved in "sex differences in conscious experience" is brought to the attention and discussed.

More specifically, Chapter II will first present background information about the body-mind issue and its solutions to provide a functional framework for understanding Ornstein's (1972) concept of consciousness. An exposition and discussion of Ornstein's concept of two modes of consciousness and the determination of his position in relation to the body-mind issue completes Chapter II.

In Chapters III through IV, the dichotomies on which Ornstein (1972) based his concept for two modes of consciousness will be presented. An assessment will be made whether the dichotomies' content justifies their presence in Ornstein's chart in support of his concept. However, before proceeding with the task, some comments are in order.

Firstly, the "Day-Night" and "Intellectual-Intuitive" dichotomies will be deleted since Ornstein provides "many sources" as to their origin which does not allow for a useful search of relevant material. "Many sources" are also mentioned for the "verbal-spatial" dichotomy. However in this particular case, the significance of "verbal" and "spatial" cognitive functions has generated the largest body of research in comparison to the other dichotomies. Thus, the "many sources" of information about "verbal" and "spatial" will be presented in two separate Chapters, (i.e.: III and IV) the more so since verbal and spatial functions have been associated with the left and right

brain hemispheres, which constitute another dichotomy in Ornstein's chart. The two chapters will deal with information on the basis of the general population and sex differences respectively. Many of the difficulties encountered in the literature on verbal and spatial abilities in relation to the brain hemispheres and sex differences will be discussed in the process. Specifically, in Chapter III the importance of clinical versus normal subjects, mode of stimuli presentation and verbal-spatial mediation will be brought to the attention of the reader. Contentious issues, important for research in general, but of increased significance for research in sex differences will be presented in Chapter IV: among the issues are: the political nature of the biology versus environment argument, the presence of confounding variables and the use of dichotomous concepts. Genetic, hormonal, brain hemispheric and environmental explanations for sex differences in cognitive functions will also be reviewed extensively in Chapter IV. It is hoped that such background information will promote understanding of the complexities of the subject-matter.

With a few exceptions, the remaining dichotomies in Ornstein's chart are presented in Chapter V, by means of - at times lengthy - quotations from their original sources. The exception, in addition to the previously mentioned "day-night" and "intellectual-intuitive," consists of the "buddhi-manas" dichotomy, which has its origin in Vedanta. Vendanta is "the chief Indian philosophy, that forms the basis of orthodox Hinduism" (Randon House, 1980). Differing descriptions and interpretations of buddhi and manas have been brought forward (e.g. Akhilananda, 1948; Owens, 1977; Whorf, 1956). This writer is not familiar with Hindu philosophy and, therefore, is not qualified to

judge the validity of the differing interpretations.

Also, the separately listed dichotomies resulting from the book I Ching have been combined since they came from one original source, i.e. two symbolic hexagrams.

Simultaneous discussion and evaluation of the appropriateness of their inclusion in the chart occurs through the following questions. For a group of dichotomies that can be related to organismic functions:

(1) Is the original dichotomy conceptually congruent with Ornstein's position vis a vis the body-mind problem?

(2) Can the original dichotomy be related to differences between brain hemispheres in cognitive functions?

(3) Can the original dichotomy be related to sex differences in cognitive functions?

For a group of dichotomies that can not be related to organismic functions:

(1) Is the original dichotomy conceptually congruent with Ornstein's two modes of consciousness?

(2) Can the original dichotomy be related to sex differences in cognitive functions?

Chapter V concludes with a summary evaluation of the dichotomies in terms of their congruency with Ornstein's two modes of consciousness, their relationship with brainhemispheric functions and sex differences in cognition. Chapter V also includes a discussion of difficulties inherent in dichotomous concepts and how these difficulties relate to dichotomies in Ornstein's chart.

At the beginning of this introduction it was stated that the meaning of phrases such as "the sexes are equal," "the opposite sex,"

"that is typically masculine or feminine" and "the sexes complement each other" is not clear. The investigation of Ornstein's writings does not shed much light on such statements either. Therefore, in the final Chapter (VI) the validity of "psychological androgyny" as a unitary concept created through the complementarity of "masculinity" and "feminity" is discussed in the context of "dichotomy." Finally the topics of education and valuing of different modes of experiences in relation to sex differences conclude the thesis.

Limitations

It should be clearly understood that the thesis is not intended to be an evaluation of the concept of two modes of consciousness, associated with brain hemispheres and sex differences, per se. Rather it is an investigation within the context of, and therefore limited by, Ornstein's concept in this respect.

A consequence is that, for instance, an important topic such as the states of consciousness of other species will not be dealth with at all. Also, only some aspects of the development of human consciousness is touched upon, i.e. during the extensive literature review of verbal and spatial cognition.

Finally, it has been voiced that the sex and cultural background of the writer of the thesis inherently influences the manner in which the subject matter will be presented and investigated. The logical consequence of such an observation is of course, that no objective scientified research (in whatever form) on sex differences is possible,

since the researcher will always be of some cultural background and of one of the two sexes.

However, being fully aware of the possibility of bias, the writer of this thesis, who is a white male from a "mixed" West European/North American cultural background, has attempted consistently to set rigorous standards of objectivity in the selection, presentation and discussion of material. It has also been attempted to let the conclusions be the logical consequences of the presented material although it is not denied that, at times, personal bias may have "slipped into" the interpretations.

The following chapter contains a presentation of the body-mind issue, proposed solutions, Ornstein's concept of consciousness and his position regarding the body mind issue.

CHAPTER II

TWO MODES OF CONSCIOUSNESS

Introduction

In the first section of this chapter general background information about the body-mind issue and its solutions will be presented. The reason for inclusion of the issue is that, through the acceptance of a specific solution to the problem, one expresses implicitly the views one holds about the nature of consciousness. Thus, the existing solutions can be used meaningfully as criteria for a comparison between Ornstein's concept of consciousness and that of the authors (or sources) who proposed the dichotomies that Ornstein uses in his chart in support of his own concept. Therefore, an exposition and discussion of Ornstein's concept of two modes of consciousness is contained in the second section of the chapter which also includes a final assessment of his position in terms of the body-mind issue.

While it is fully realized that the body-mind issue deserves the extensive treatment it usually receives in the philosophical literature, for the purpose of this thesis the many perplexities associated with the subject matter have been greatly simplified and abbreviated.

What has been labelled the "world-knot" at the centre of human existence, concerns questions about the nature of the human body, the human mind, and the nature of the relationship between body and mind.

As such, the mind-body issue entwines problems of metaphysics (theory of the nature of reality) and epistemology (theory of the methods for acquiring knowledge), since the human organism attempts to understand reality, while simultaneously being a part of it. Thus, man is a student of himself, but cannot separate from his environmental reality.

Historically, metaphysical questions have involved the concepts of "Idealism" versus "Realism," the basic Idealist tenet being that reality can be comprehended only through the senses, and since sensory perception is mental, reality resides within the ideas of man. By contrast, the "naive" Realist (also called Materialist) maintains that "basic reality" is physical and exists independently of sensory perception. As will be noted during the discussion of proposed solutions to the mind-body issue in this chapter, it has also been suggested that the reality of the human organism can be both "ideal" and "real."

The epistemological controversy involves "Empiricism" versus "Rationalism." The Empiricist contends that direct experience with reality (through sensation and perception) permits understanding of reality. However, the Rationalist position is that sensation and perception are causes of illusions and distortions and, therefore, intellectual processes such as reason must be relied upon for knowledge about reality.

Metaphysical questions generate axiological considerations. The answers provided about the nature of body - mind interaction have a direct bearing on beliefs about human origin and destiny and, about human conduct, for, "what form of life is best depends on what sort of beings we are" (Campbell, 1980, 9). Thus, the mind-body issue is

important for its metaphysical, epistemological and axiological aspects, and in the context of this thesis it is of immediate relevance to concepts of male and female modes of consciousness.

The body-mind issue

In practically all views of the body-mind issue there is general acceptance of the material nature of the human body. It has been demonstrated scientifically that the body is composed of elements (such as carbon, oxygen and phosphorous) that are not different from elements in the inanimate material environment and all are subject to the same physical laws of for instance motion, dissolution and combination.

However, agreement does not exist regarding the nature of mind. Reasons are, that mental states and processes (e.g. willing, perceiving and feeling) cannot be of, or in themselves, but must be of, or in some entity. That entity is usually labelled "the mind" and "the identification of the subject of the mentalistic predicates" (Bunge, 1980, 1) is at the core of the mind-body issue.

One position holds that mind exists as an immaterial entity apart from the body. The strongest arguments supportive of that position are interrelated. Firstly, it is reasoned that the phenomenal properties of mental processes and states are not reducible to physical ones, thus the mind must be substantially different from the material brain. Secondly, mind is known differently (i.e. privately) from the way matter is known (i.e. publicly, scientifically) therefore it must be immaterial. From these arguments arises the question whether differences in a manner of knowing, or obtaining knowledge, entails

differences in the manner of being and vice versa, whether a manner of being requires a particular form of knowing or understanding. This problem will be discussed again during the presentation of Ornstein's two modes of consciousness.

Other arguments favouring an immaterial mind can be traced to the previous and tend to be more superficial. For instance, conviction about the survival of a spirit or soul after (material) death, and the belief in "extra-sensory" phenomena are used in this respect. Also, man's knowledge of mathematics and ethics, his production of culture and engagement in planning and voluntary movement have been thought to demonstrate the immaterial nature of mind.

A different position regarding the nature of mind proposes that the mind is a set of brain functions and that mental processes are brain processes. The main argument favouring this position, while disputing the previous, is of scientific origin. It holds that the existence of an immaterial mind is not demonstrable through a hypothetical-deductive system, with technical, testable, systematic assumptions. Thus, the "immaterial mind" position is based on belief systems, uses introspection as investigative method, which leads to pronouncements in imprecise language, without lawful statements about either the nature of the mind or its relationship to the body. It is maintained that all mind-body interactions can be accounted for in terms of interactions among neural systems or between neural systems and other components of the body and that includes mathematical knowledge, voluntary movement, and culture, etc.

The previous solutions to the body-mind problem have been broadly categorized as "dualism" and "monism" respectively. In addition

"pluralism" and "rejections" have been proposed as acceptable solutions. Some solutions have been placed in more than one category. Forms of dualism, monism, pluralism and rejection will occupy the following section of this chapter.

Dualisms

The basic premise of dualism is that body and mind constitute two different entities of material and immaterial substance.

Interactionism. Interactionist dualism proposes that the immaterial mind and material body interact, i.e. each has an effect upon the other. The objection to interactionist dualism is the following. During its lifespan the human organism perceives the environment through its sensory system which is linked to the brain and the brain in turn sends messages to the muscles regarding activities to be performed in that environment. The sequence sensory perception-brain-action is demonstrably a series of continuous physico-chemical relations without a time lag and with brain activity crucial and central in the sequence. If mind were to act on matter in man, this would have to take place, in all probability, during a time lag in brain activity, assuming linearity of time within the limits of the brain's functioning. However, there is no evidence that mind influences or interferes with brain activitiy, or, that the brain is subject to other than physical laws.

The response to this scientific objection is as follows. Non-energy absorbing or supplying systems can bring about changes in systems that are subject to the physical laws of energy conservation. An example is the pendulum, whose string causally determines the path

of the bob, without supplying energy to it. In addition, quantum laws dictate that there is some room for non-physical activity even within the limits set by physical laws. Without violating these laws a general immaterial constraint upon brain activity is a possibility, without having to rely on a time lag in the physico-chemical sequence "sensory perception-brain-action" for an opportunity to act.

Parallelism. According to the parallelist philosophy, body and mind are perfectly correlated in their simultaneous reactions to the same stimuli. The metaphysical assumption is that God created the world in this manner.

Epiphenomenalism. Epiphenomenal dualism allows for an effect of some sort by the body on the mind. That is, the mind emerges from, or is a byproduct of physical processes. Mental processes are reflections of physical states and of little consequence. Epiphenomenalism has also been categorized as a form of materialistic monism or emergent monism (see following solutions).

Monisms

Some monisms are reduced from dualisms. Their basic premise claims that only one substance or reality exists.

Idealism. Idealistic or subjective monism maintains that reality (including the human organism) does not have an existence independent of individual ideated perceptions in the mind. The existence of matter or physical reality is denied, instead it is absorbed into the ideating human mind. God is the infinite idea-generating spirit and humans are finite idea-receiving spirits.

Other monistic philosophies go beyond Idealism and hold that the entire universe is spirit. Man participates in this spirit through his body, which itself, is a form of spirit.

Materialism. Materialistic or objective monism holds the position that all matter and mental substances are made up of physical elements. An objection to Idealistic monism stems from evolutionary considerations. The question arose when immaterial minds arrived on the scene in the phylogeny of the species. The concept of continuity in evolutionary theory holds that man evolved gradually from one-celled organisms and is of the same basic biological nature. This means that if amoebae have no immaterial mind, as is maintained by most contemporary scientists, man can not have such a mind either.

A modern version of materialism is contained in theories of Psychobiology, a discipline that asserts an essential unity of mind and body. The implicit assumption is that so-called mental processes can be reduced to processes of matter, which is the ultimate reality arranged in time and space.

Other monisms are based on the premise that only one basic substance or principle exists; therefore, both mind and brain are expressions of that basic substance.

Identity hypothesis. According to the identity hypothesis, mental processes and physical brain processes are one and the same. This does not mean that the identity of mind and brain processes is a logical necessity, but rather a scientific working proposition which can not be ruled out on logical grounds only. It means that structure and function are inseparable and that a group of neurons (whatever their pattern or state) also constitute a mental process. Neuro-

physiological and corresponding phenomenal terms may differ in sense, but have identical referents. Brain and mind connote different things, but denote one and the same thing.

A form of the identity hypothesis is expressed in the theory of "double aspects," wherein mind and brain are both expressions of one and the same reality, but different measurements are required for either mental or physical observations. This theory has been expanded into a question about differences in subjective mental and objective neuronal events. Subjective experiences are thought to be the events themselves, while objectivity involves their representation. Unfortunately, it is impossible to simultaneously experience and observe the same brain event, since the representation of an event experienced requires a change in its physical state. The identity hypothesis has been categorized by some philosophers as a materialistic monism.

Emergent Evolutionism. The theory's position is that mind and brain functions are emergent properties of the complex nature of the human organism. Accordingly, an ongoing occurrence of events leads into a compound structure and results in the emergence of new properties, that could not have been predicted from knowledge about the nature of the events and their interactions. Thus the configuration of a group of events is more important than the individual events. In relation to the theories about mind and body the emerging levels in ascending order of complexity of characteristics are physical - biological, behavioural, mental (conscious/unconscious) and trans-personal (transcendental).

"Emergent interactionism" is a form of emergent evolutionism theory, which postulates that the mental processes emerging from the complex interplay of highly organized neuro-physiological brain phenomena are a higher-order molar property of these brain phenomena and capable of controlling and providing feedback to the brain. Because of the brain-mind-brain aspect of emergent interactionism it has also been categorized as an interactionist dualism.

Pluralisms

The general premise of pluralism is that a multiple of components in a system facilitates the explanation of the interactions between an original lesser number of components.

Occasionalism. Occasionalist pluralism rejects interaction between body and mind, but proposes that a third reality, which is neither physical nor mental, exists. The third reality in the tripartite universe is an active God who coordinates mental and physical activities.

Tripartite Reality. A contemporary pluralist philosophy, "Tripartite Reality" accepts the interaction between body and mind, but proposes the existence of a third reality, i.e. the reality of culture and knowledge. Thus, there is a reality of physical objects and states, a reality of states of consciousness and a reality of objective knowledge. The realities are labelled World I, World 2 and World 3 respectively, and subdivided into components. Two classes of perception and knowing, that is, an inner sense responsive to World 2 and 3 and an outer sense responsive to World 1, are available to man. A "pure ego," similar to a theological "soul" is the central

interpreter of the perceptions. A conceptual model for an intricate system of interactions between the three worlds is part of the theory.

Rejections

Rejectionist philosophies deny the existence of a mind and therefore of the mind-body issue. The position is that "mind is immaterial" is a meaningless statement.

Behaviourism. Behaviourism considers empirically obtained data to be the only valid source of information about man. The emphasis is on data that have resulted from the measuring of motor and linguistic responses to stimuli and the establishing of lawful (mathematical) relationships between environmental stimuli and human responses to them. The study of observable learning paradigms takes a central place in the methodology at the cost of the investigation of processes which are essentially private and intrapersonal phenomena.

Logical Positivism. The basic premise of the Logical Positivist is that only publicly shared and demonstrable knowledge obtained through the methods of scientific empiricism is meaningful. This emphasis on the public and interpersonal aspects of knowledge led to a major concern with meaningful communication of scientific information. Thus, the meaning and usage of language and psycholinguistics became important in the description of the nature of reality.

Reference material consulted for the previous section of this chapter includes: Battista (1978), Bunge (1980), Campbell (1980), Davidson and Davidson (1980), Davidson (1980), Furst (1979), Pelletier (1978), Strange (1978), Tart (1975, 1980), Uttall (1978).

Since the purpose of this chapter is to assess Ornstein's

position regarding the nature of consciousness, his formulations in this respect will be presented and discussed in the following section.

Ornstein's two modes of consciousness

Exposition

Ornstein (1972) proposes that "two major modes of consciousness exist in man, and function in a complementary manner" (204). The most concise description of the two modes of consciousness is the following:

> The ordinary mode of consciousness can be characterized as analytic, sequential, and limited by the characteristics of our sense organs. A second major mode...may be characterized as receptive and holistic, one in which all action can be perceived simultaneously (240-241).

The two modes of consciousness operate "physiologically as well as mentally and culturally" (85).

The "ordinary" mode of consciousness, which functions verbally, analytically and actively, is

> ...an exquisitely evolved personal construction, "designed" for the primary purpose of individual biological survival. (61)

However, this "ordinary" consciousness, which is also labeled "personal," "subjective" or "individual"

> cannot fully represent the external world or even our internal world...it must consist of an extremely small fraction of the entire "reality" (33).

This is so because the

> ...sense organs discard most of the input information reaching us. The brain further limits input...Our senses and central nervous system select by responding primarily to changes...we sort the input into categories that depend on transitory needs, language, our history, our expectations, and our cultural biases (58-59).

By comparison, the "second" mode of consciousness, which is also labelled "other," "objective" and "cosmic," functions spatially, holistically and receptively, and in it

> ...the concepts of future and past are irrelevant...many phenomena within (it) will seem to "transcend" the ordinary notion of time - but only for those who attempt to account for all phenomena within the linear and sequential mode (241).

As such the "cosmic" consciousness is a

> ..."higher" level of consciousness...often referred to as mystic experience, the perception of unity...an emergent level of organization (which) may become perceptible in the same way that the sum of cells in a body are individual, yet make up one person (196).

Not only are the two modes of consciousness associated with different brain hemispheres, i.e. ordinary-left, cosmic-right, but their relationship with the autonomic nervous system is also different. Ornstein describes that difference as follows:

> The central (outward) nervous system, which includes the brain and the nerves that direct skeletal activity, is concerned with thought, voluntary action, and manipulation of the external environment through the limbs. The "autonomic" (inward) nervous system maintains the internal milieu - it controls the activity of the heart, the stomach and the glands...In ordinary consciousness, the state of our internal physiology is usually irrelevant...yet the esoteric traditions note the effect of controlled inner states of consciousness (208-209).

In summary, Ornstein proposes the existence of two complementary modes of consciousness. One, the "ordinary" mode is primarily based in the left hemisphere and limited by the functions of the sensory and central nervous systems. Its psychological manifestations come in the form of analytical, sequential and verbal-logical perceiving and processing. The other or "cosmic" mode is of an emerging, higher level nature, based primarily in the right hemisphere but also associated

with "whole organism" functioning. Its psychological manifestations come in the form of transcendental states or experiences, simultaneous and intuitive perceiving and processing.

In the discussion of the esoteric traditions, Ornstein includes meditation practices, Yogic self-control, Zen Buddhism and contemporary biofeedback techniques. The role of such traditions in the emergence of the "other" consciousness and the relationship between the two modes of consciousness are illustrated by the following passages:

> The esoteric practices attempt to suppress temporarily the individual, analytic consciousness and to allow the consciousness of the "whole organism" to emerge.
> Many have become confused at this point, believing this to be an either-or question...However, the existence of an individual consciousness does not rule out the possibility of the simultaneous co-existence of another level of organization (just as) the existence in the body of billions of individual cells...does not rule out the existence of an emergent, whole person... (195).

Discussion

Ornstein consistently expresses the importance of the education and use of the "other" (cosmic) mode of consciousness, its complementarity to and thus, by necessity, its co-existence with the ordinary mode. However, we have learned that the "other" mode is not only of a "higher" level of organization than the "ordinary" mode, but also that it emerges from it, i.e. evolves through "a breakdown of the constructs which maintain personal consciousness." Several observations have to be made in this respect.

Firstly, the description of the two modes of consciousness involves the concept of "the whole is larger than the sum of its parts." In that description a qualitative difference between the two modes is at least implied, for "the whole" is of a "higher level" than

its "parts." It can be questioned whether the complementarity of two qualitatively different phenomena is logically possible. A "whole" consisting of complementary parts is meaningful if these parts are of the same "order," e.g. two halves of a circle (two dimensional) but not half of a circle and half of a ball (two and three dimensional). Similarly, the ordinary and cosmic consciousness complement each other to form "... a complete human consciousness (which) involves the polarity and integration of the two modes" (83). However, if the transcendental emerging consciousness is of a different "dimension" (i.e. higher level of organization) than the "ordinary" mode, it possibly supersedes, but does not complement the latter.

Secondly, and closely related to the previous argument, the simultaneous existence of the two modes of consciouness is advocated by Ornstein. However, the "other" mode breaks down the constructs of the "ordinary" mode, thus, the latter does not exist in its original form when the former emerges from it. This implies an impossibility for bi-modal "co-existence" a term defined as "to exist together at the same time" (Random House, 1980). It may be valid to state that one is capable of functioning in either the one, or the other mode at different times, but not simultaneously.

Thus, the complementarity and co-existence of Ornstein's modes of consciousness are questionable. The analogy with the "cells" and "the body" is invalid in this respect. Indeed, the body can be conceived of as emerging through the "building up" of billions of cells, which complement each other to form that body. However, body and cells co-exist but do not complement each other. By comparison, "cosmic" consciousness supposedly emerges through the "breaking down" of the

constructs of the "ordinary" consciousness. The constructs do not "build up" for the emerging of the "cosmic" consciousness, which neither co-exists with nor complements the "ordinary" consciousness.

Another problem arises when Ornstein discusses Science. Throughout The Psychology of Consciousness he identifies science with the analytic mode of knowing, as expressed most succinctly in

> Science is the very essence of the analytic mode, one of meticulously charting causes and effects of radically restricting the conditions of observation in order to attain precision. It constitutes (a) highly specialized development of consciousness, at once its most conservative, yet its most reliable (57).

It appears then, that the "other" mode, although being of a "higher level" is not as reliable as the "ordinary" mode. Nevertheless, Ornstein also would like to

> ...begin to integrate the rational (i.e. analytic) and intuitive (i.e. holistic) approaches to knowing and consider the essential complementarity of these two modes of consciousness as they are manifest in science in general (28).

Such integration will take place when

> ...the intellect can begin to process the intuitive leaps, to explain and "translate" the intuition into operational and functional knowledge.
> It is the function of the verbal-scientific intellect to fit the intuition into the linear, so that ideas may be explicitly tested and communicated in the scientific manner (28-29).

Many incongruencies are evident in the previous passages. For instance, on the one hand "science is the very essence of the analytic mode," but on the other hand both approaches, rational (i.e. analytic) and intuitive (i.e. holistic), are "manifest in science in general." Also, the integration of the two approaches of knowing into science is not a real integration, that is, the combination or incorporation into a whole. Rather the intuitive mode is to be "fit into the linear

(analytic, rational) mode." In other words, the intuitive mode has to become similar to the linear, this in spite of the fact that the former has emerged from the latter and in its transcendence accounts "for all phenomena within the linear mode." One also wonders what happens to the complementarity of the two modes during this process of "translation" and "fitting" of one mode into another.

In the context of such "translation" the following is of pertinence. The essence of transcendental states, such as mystic and peak experiences and perceptions of unity, is the intensely phenomenal aspect of its occurrence. This is frequently expressed in the non-scientific terminology of "one has to experience in order to understand" by the "enlightened" to those who have not been subject to transcendental experiences. By contrast, among those who have experienced such states, no descriptions or "translations into the analytic mode" seem to be required since everyone "knows," possibly holistically. The very nature of the holistic mode may be such that it can not be communicated or translated into the scientific-analytic mode. It has been argued that this is true because in the translation the "cosmic" mode loses its essence. In spite of his insistence on the need for "translations" Ornstein alludes to the difficulties involved. For instance, while commenting on a story, he not only contrasts the two modes of gathering knowledge,

but he also informs the reader that the story illustrates

> ...the strength and limitations of the ordinary mode, and the necessity to operate in a mode appropriate to the kind of knowledge one is seeking (194).

Such comments suggest that specific forms of knowledge require specific forms of seeking knowledge (understanding), which exclude the possible translation into a different form.

Thus far, the following has been argued during the discussion of Ornstein's proposal for two modes of consciousness. Contrary to his stance, the complementarity and co-existence of the two modes can be questioned on logical grounds. Also, the translation of knowledge or phenomena of one modes of consciousness in those of the other appears to be an impossibility, since the nature of the two modes is essentially different.

One of the main reasons for the difficulties encountered during the exploration of the meaning of the two modes of consciousness, is Ornstein's lack of a clearly defined position vis a vis the mind-body problem. In the context of the subject matter one could rightfully expect some formal and substantive exposition of his philosophical stance, but in actuality the terms "mind" and "body" are only linked twice in the entire text. The lack of clarity leaves Ornstein free to present the two modes with descriptive terminology that allows a variety of interpretations. Several examples follow.

In a section labelled "Research on Physiological Self-control" he indicates that

> the division some have made between mind and body - the mind as a process of reason and will, the body as an automaton, à la Descartes - is unnecessary limiting (212).

The "unnecessary limitation of a mind-body division" hints at the non-existence of such a division, but does not negate it and Ornstein does not elaborate. "Internal self-regulation" is a term Ornstein uses

and he describes the phenomenon as "the control of physiological processes associated with the autonomous nervous system." He is an advocate of self-regulating techniques and conveys that they "gave birth to the concept of psychosomatic medicine - a discipline whose very name links the worlds of mind and body" (212). At no time is the reader informed about Ornstein's version of a) the concept of self (either internal or external), b) its relationship to physiological states, c) who or what does the "controlling" or "regulating" and d) what is meant by the "worlds of mind and body."

When informing the reader about the "recognition of the physiological basis of the dual specializations of consciousness..." (85) we are again not certain whether this means that physiological processes are equated with consciousness.

Finally, two passages used previously, will again be quoted; this time the purpose is to illustrate the ambiguity in Ornstein's conceptualizations.

> Our personal consciousness cannot fully represent the external world...it must consist of an extremely small fraction of the entire "reality" (33)
> and
> ...sense organs discard most of the input information reaching us. The brain further limits input...our senses and nervous system select by responding primarily to changes...we sort the input into categories that depend on transitory needs, language, our history, our expectations, and our cultural biases (58-59).

One interpretation is that Ornstein equates "personal consciousness" with "our senses and nervous sytem" and "we" in their functional relationship with the external world. Another interpretation maintains the common, every-day meaning of the three terms. The first interpre-

tation has a strong "monist" flavour, the second is considerably more "dualistic."

Since Ornstein does not take an explicit position on the topic of the body-mind issue, it is now the task of the writer of this thesis to assign him such a place. Based on the general and persistent "theme," and "frame-of-mind" and in spite of lack of clarity in the Psychology of Consciousness, Ornstein is herewith classified as a reluctant "monist" of the "emergent evolutionist" variety. More often than not, he seems to identify body with mind, and he persistently attempts to establish the emergent qualities of both, but especially the cosmic, modes of consciousness.

The following chapter will consist of an extensive review of the research literature on brain hemispheric differences in verbal and spatial abilities. This is important since Ornstein (1972) includes both left-right hemisphere and verbal-spatial in his chart of dichotomies used for support of his concept of two modes of consciousness.

CHAPTER III

BRAIN HEMISPHERIC DIFFERENCES IN VERBAL AND SPATIAL ABILITIES

Introduction

> "One of the most interesting research findings about the human brain is that its two hemispheres function differently in important ways" (Wittrock, 1977, 89).

Extensive reviews of these findings (Bradshaw & Nettleton, 1981; Dimond, 1978; Furst, 1979; Gazzaniga, 1977; Geschwind, 1979; Krashen, 1977; Nebes, 1977, 1978; Restak, 1979; Weinstein, 1978) reveal that there is agreement about hemispheric specialization, but that no clarity about the characterization of the asymmetry of functions exists.

The classical view regarding the specialized functions of each hemisphere revolved around the importance of the qualities of the stimuli presented to the hemispheres. The idea was that specialized skills necessary for the perception and cognition of linguistic material belonged in the domain of the left hemisphere (LH). Since these skills are of major importance to human functioning, the LH rapidly obtained the reputation of being the "major" or "dominant" hemisphere. By contrast, the right hemisphere (RH) was thought to be active primarily in visuo-spatial and, therefore, "minor" tasks.

Through subsequent research it became known that the LH, in addition to linguistic functions, was also capable of performing

arithmetic, and the RH demonstrated specialization for musical tasks. More recently, it has been found that the RH is engaged in certain limited facets of language and the LH, similarly, in limited aspects of non-linguistic (e.g. musical) functions.

It has been established that a global relationship exists between the sides of the human body and its brainhemispheres; the RH directs with the left side of the body and the LH with the right side. Thus, perceptions in the left visual field (LVF) correspond with neurological activities in the RH, while a touch by the right hand registers in the LH (Dimond, 1978; Furst, 1979; Gazzinga, 1973; Restak, 1979). It is also known that approximately 85-95% of the population is right-handed, which is indicative of similarity in the brainorganization and lateralization of functions in the hemispheres. Non-righthanders, i.e. lefthanders and ambidextrals, display a rather complex picture in this regard (Beaumont, 1974; Dimond, 1978; Furst, 1979; Hicks & Kinsbourne, 1978; Levy, 1974-a).

One of the best methods for the determination of speech lateralization is the Wada Test, which involves the injection of a barbiturate into a carotid artery, causing a transient anesthesia of the ipsilateral hemisphere. Speech is assumed to be associated with that hemisphere in which the anesthesia causes a temporary loss of speech ability. A more simple and certainly less traumatic way for determining the speech ability of the hemisphere is through handedness. The speech hemisphere is usually the one contralateral to the hand most frequently used for manipulation.

It has been estimated that 90-99% of the righthanders (Branch, Milner & Rasmussen, 1964; Levy, 1974; Restak, 1979; Wada & Rasmussen, 1960; Zangwill, 1960) and 50-70% of non-righthanders (Branch et al, 1964; Hecaen & Sauget, 1971; Restak, 1979; Wada & Rasmussen, 1960; Warrington & Pratt, 1973) have their speech functions located in the LH. It can therefore be assumed that approximately 90% of the general population is lateralized for language in the LH.

A variety of methods with a very diverse body of subjects has been used in the research of differences between brainhemispheric functions. These methods include dichotic listening, tachistoscopic viewing, the use of electrophysiological measures and those of blood flow in the cerebrum. Traditionally, the first two of these methods have been most frequently applied and a majority of information has been obtained in related manner.

Dichotic listening involves the monaural or binaural presentation of speech and/or non-speech sounds such as words, vowels, consonants, music, natural environmental and artificial noises. In tachistoscopic viewing, language and/or non-language stimuli, e.g. sentences, words, letters, shapes, dots, faces and lines, are presented to either the left or right visual field or to both simultaneously. Ingenuous instrumentation allows for control over stimuli input to each visual field, if so desired. In these dichotic listening and tachistoscopic viewing experiments the correct identification of stimuli and the reaction time for overt responses are usually accepted as an indication of corresponding hemispheric activity. The responses may be in the

form of verbalizations, pointing, the pressing of a button or other modes of communication.

The measuring of alpha wave suppression is a major electrophysiological technique used in hemispheric research. Alpha waves are "synchronized waves which appear in the EEG during wakefulness and which indicate that the underlying brain tissue is momentarily idling" (Furst, 1979, 249). Thus, alpha wave suppression is an indication of activity taking place in the hemisphere under scrutiny; the greater the suppression, the more active is the hemisphere.

By introducing a radioactive tracer in the cerebral blood, through inhalation or carotid artery injection, and following its clearance from brain tissue, it is possible to measure the flow quantitatively. This procedure produces a reliable index of metabolic neuronal activity and therefore provides the opportunity for a comparison of information processing activity in the cerebral cortex of each hemisphere.

Nature of Subjects

Primary evidence for the differences in hemispheric functions has been obtained through the direct examination of clinical cases. These involve individuals treated by surgical procedures, such as commissurotomies, lobectomies and hemispherectomies, performed to alleviate or eradicate brain dysfunctions. The anesthesizing of patients with brain lesions has also resulted in documentation of relevant information

Commissurotomy. A commissurotomy consists of severing all direct connections which transmit information and coordinate activities between the two brain hemispheres. Most importantly, the corpus callosum which is a connecting cable of nerve fibers, is sectioned.

In 1960, Bogen used this procedure initially with great success for the purpose of controlling the inter-hemispheric spread of epilepsy (Gazzaninga, 1977). Subsequent patients of Bogen completed an extensive psychological test battery involving visual, tactile, proprioceptive, auditory and olfactory tasks. The test results demonstrated dramatically that the normal hemisphere exchange of information had been disrupted. The processing of information took place in the hemisphere to which it was presented, but one hemisphere did not know about the activities of the other, or, as Gazzaniga (1977) phrased it, the processing occurred "outside the realm of awareness of the other half-cerebrum" (90-91).

One advantage of studies with commissurotomized patients is that both hemispheres are available for testing, each providing a "perfectly" matched control for the other. However, only a small number of commissurotomized patients is available and due to the histories of their severe epilepsy, the extent of brain damage is not always known. Also large intersubject variety is observed. Therefore disadvantages as well as advantages are present with such patients as subjects (Nebes, 1978).

Hemispherectomy and lobectomy. Hemispherectomy involves the surgical removal of the entire cortex of one hemisphere (and frequently of some subcortical tissue also). In some instances, as in

lobectomies, only a section of the hemisphere is removed.

The first hemispherectomy on a human was performed in 1923 by Dunbar. Early reports in the literature dealt with operative techniques, and special studies of postoperative functioning such as auditory acuity, pain-pathways and skin-temperatures. The operation is performed when brain damage, encephalitic disorders, malignant tumors, atrophy, head injuries and epilepsy requiring surgical removal of affected tissue are apparent (Basser, 1962; Gott, 1973; Nebes, 1978).

One advantage of neurological and psychological testing of hemispherectomized patients is that no doubts exist about which hemisphere is functioning. This facilitates the investigation into the limitations of that hemisphere's abilities for its own functions and even for the ones normally carried out by the missing hemisphere.

Anesthesia. Anesthesizing most frequently involves the injection of 10% sodium amytal into the carotid artery ipsilateral to a brain hemisphere.

Wada and Rassmussen (1960), report that commencing in 1948 epileptic patients were injected with the substance to investigate the mechanism of the spread of epileptic discharge between the brain hemispheres. More recently, they used the anesthetic to discover the area of speech presentation in patients, thus preventing possible trauma to that area during the treatment of focal epilepsy. Subsequently, the procedure has been applied in a variety of clinical cases involving disorders such as cerebral vascular diseases, hemiplegia and atrophy. Apart from medico-diagnostic implications through this technique, its modifications have been used to study hemispheric

specializations of memory, consciousness, affect, verbal functions, the relationship between handedness and cerebral dominance for speech, visuo-spatial recognition, modes of cognitive processing etc. (Branch et al, 1964; Fedio & Weinberg, 1971; Gordon & Bogen, 1974; Perria, Rosadini & Ross, 1961; Serafetinides, 1965, 1966).

One of the reasons for this technique to be useful is that both hemispheres can be anesthesized and studied in sequence, allowing for intra-subject comparisons regarding hemispheric abilities, which is an advantage. Disadvantages are that the validity of results can be doubted in some cases of equivocal hemispheric lateralization and that a risk exists of puncturing the carotid artery. In addition, the state of anesthesia persists for only 5-10 minutes, therefore, it is not possible to administer an extensive test battery during such a short time period.

Practically all "early" research studies (and a majority of contemporary ones) on brain hemispheric functions were conducted with clinical cases as subjects. Recently, however, an increasing amount of research pertains to "normals" only (e.g. Arndt & Berger, 1978; Cotton, Tzeng & Hardick, 1980; Demarest & Demarest, 1980; Eisert, 1979; Mills & Rollman, 1980; Schwartz & Smith, 1980). Data obtained simultaneously from clinical and normal subjects also appear more frequently in the literature (e.g. Bowers, & Thomas, 1978; Cremonini, De Renzi & Faglioni, 1980; Fennell, Satz, Van Den Abell, Gainotti, Caltagirone & Miceli, 1978; Milner, 1978; Riege, Metter & Hanson, 1980).

Confounding Variables

When reviewing the body of literature related to the functions of the brainhemispheres, one is struck by the enormity of available information. During the last decade and a half, academic journals such as Brain and Language, Brain and the Behavioral Sciences, Neuropsychologia and Cortex have been devoted entirely to the publication of neuropsychological research. Other journals, for instance Perceptual and Motor Skills and The Journal of Experimental Psychology, present an increasing number of articles similar in content.

An outstanding feature of research on cerebral functions is its complexity, resulting from the complexity of the human brain and human behaviour. The ultimate goal of neuropsychologists is to unravel the complexities and to establish the existence of clear and direct cause-effect relationships between cerebral activities and human behaviours. However, contemporary researchers are restricted in their efforts by the state of technological advancement and by ethical considerations. Thus, it is necessary to employ methods that include difficult to control variables. The nature of the more salient and influential of these variables will be discussed presently in order to point out some of the causes of inconsistencies and contradictions reported in the literature.

In addition to the specific drawbacks previously mentioned in some of the approaches involving clinical cases, more general disadvantages are also apparent. In this context, Caplan (1981) points out that the establishing of functional loci in the cerebrum on the basis

of deficit analysis is rife with difficulties of practical, empirical and theoretical nature. For instance, in relation to language skills, these difficulties include the existing criteria in linguistics and psycholinguistics for models of normative functioning and "empirical considerations (which) suggest that the effects of lesions cannot entirely be subsumed under the rubric of a functional deficit analysis" (Caplan, 1981, 134).

It must be recognized that patients are subjects who function with a cortex that, in some form, has been traumatized or interfered with. It cannot be assumed that findings from such people can be generalized to the population at large, since the overall effect on brain functioning created by the disease in one part of the brain is not known. The weakness inherent in drawing conclusions about the "normal" through the investigation of the "abnormal" becomes even more evident when it is realized that the patients are quite disparate in intelligence, education and motivation.

Similarity in treatments does not provide sufficiently valid reasons for the grouping together of subjects as a truly representative or homogeneous sample. In view of the plasticity of functions in the developing hemispheres, the age of a hemispherectormized patient at time of testing in relation to his stage of development when the hemispherectomy took place, is relevant. For instance, it can be questioned whether a 50 year old individual, whose right hemisphere was removed at age three, should be grouped (for testing purposes) with a 25 year old who suffered from identical surgical inference only one year previously.

Similarly, for a valid comparison between right and left lesioned patients, the severity and location of the lesions (contralaterally) and the age of the patient at the time of injury would have to be identical, which is an obvious impossibility.

Such subject related factors are of importance when it is realized that results based on small samples (frequently less than 10 subjects) or on case studies with one individual without controls, are commonly encountered in the literature.

In contrast to the assessment of clinical cases which are based on direct interference at the cortical level, inferences about the normal subject are made indirectly. Since control for interhemispheric transmission is not possible, it is in the case of the intact brain more difficult to establish whether the performance on a particular task can be related to the activities by one specific hemisphere. Moreover, the possible suppression of a specific, but limited skill of one hemisphere by its counterpart who possesses the skill in abundance, is worthy of consideration also. In a similar vein, discrepancies between the results obtained from clinical and normal subjects could be caused by the tendency of one hemisphere to "take over" when the other side is injured or no longer present. Comparisons with normals sometime after the trauma, might result in distorted information.

Thus it becomes clear that studies of clinical cases are "a useful but limited way to discover how the normal brain works" (Restak, 1979, 172); for a balanced picture of differences in brain hemispheric functions both sources of information, clinical and normal cases, are

needed while it must be realized that all cases present advantages and disadvantages.

Other confounding variables related to the nature of the subjects can be the cause of contradictory results in research. For instance, uncertainty about the brain organization and lateralization of the subjects because of the handedness and, related to that, the history of handedness in their families may be a factor. It is also becoming evident that males and females differ with respect to lateralization of functions (McClone, 1980); therefore the sex of the subject appears to exert influence on test performances. Although in surveying the literature one detects an increase in control for such variables, it occurs in only a minority of studies. Bradshaw (1980) discusses the importance of subject selection specifically in relation to RH language skills; however, it is thought here that his comments are valid for all research in brain hemispheric functions.

> The exact extent of a RH contribution to linguistic functions can in the future be easily mapped if care is taken in the selection of subject groups (which should be balanced or controlled for such factors as sex, strength and family history of handedness) and the employment of adequate numbers....Otherwise, confusion and conflicting data will continue to appear (182-183).

Another cause of conflicting data involves the simultaneous and sequential presentation of stimuli, with testing for identification afterwards, during dichotic listening and tachistoscopic viewing. In contrast to presentations simultaneously to both eyes (or ears), the presentation of stimuli in squence to one and then the other eye (or ear) engages subjects in perceptual tasks with an inherent memory component. The identification of that component as right or left

hemispheric in nature may not be possible and misjudgment of RH and LH abilities is the consequence. The following illustration will clarify. Testing for RH verbal identification abilities through presentation to the left ear of the word "sheep" may evoke an RH "image" of a sheep. If that image is encoded in memory it may become a facilitating factor in the identification task which takes place after the right ear has also been presented with the word "sheep." The "imaging" assistance would presumably not be available to the LH (right ear) since it does not visualize. A reversal in order of presentation, right ear before left ear, would provide the RH with less time for visual encoding and the results of the identification tasks could differ substantially. Thus, the order of presentation is of importance.

Likewise, during tachistoscopic viewing of a verbally encodable picture presented to the LH, the identification task may demonstrate verbal rather than visual abilities (and possibly both) of that hemisphere depending on the order of presentation of the stimulus to the eyes. By contrast, identification by the RH would not be expected to be influenced by verbal encodability. It is obvious that the memory component plays a role in sequential presentations and that it is a possible cause for inconsistent results. Besides, comparison of data resulting from sequential and simultaneous presentations of even identical stimuli are invalid, since a memory component cannot be expected to be of influence in simultaneous presentations requiring immediate identification. As will be noted in the following review some researchers deal extensively with aspects of this issue, but a vast majority does not take it sufficiently into account.

It is noted here that a proposal for the existence of differing modes of consciousness, which is partially based on research literature in cognitive functions, should include the discussion of confounding variables involved in methodology and the nature of subjects. Ornstein (1972) has neglected to do so.

The most extensive information about differences in hemispheric performances has been obtained in the areas of cognition related to linguistic skills and visuo-spatial perception. Following is a review of studies with clinical and normal subjects selected from the enormous body pertaining to these topics. Theories about cognitive processing mechanisms will be discussed extensively when they are presented as a part of Ornstein's modes of consciousness in Chapter V.

Linguistic Skills

Commissurotomy

Expressive language. Gazzaniga and Sperry and several other researchers have clearly demonstrated in their, now famous, studies with patients that words or objects, visually or haptically presented to the LH are identified without difficulty. (Bogen, 1969; Gazzaniga, 1973; Gazzaniga, Bogen & Sperry, 1962; Gazzaniga & Sperry, 1967; Sperry & Gazzaniga, 1967). Nebes (1978) observes that "when using input restricted to the left hemisphere, the verbal capacities demonstrated are roughly equivalent to those elicited from the whole subject under conventional testing" (102).

The early reports by Gazzaniga and Sperry described also how commissurotomized patients were not capable of naming words and objects presented to the LVF or felt by the left hand. Such results led Geschwind (1965-a,b) to refer to the RH as being "word-blind" or "word-deaf." However, subsequent findings have demonstrated actual, although limited, verbal output by the RH (Butler & Norsell, 1968; Gazzaniga, 1970; Gazzaniga & Hilyard, 1971; Milner & Taylor, 1970; Teng & Sperry, 1973). These results have been interpreted in the context of hemispheric "cross-cueing," that is in this instance, the nonverbal signalling by the LH (e.g. by means of facial movements, body tilt or other peripheral cues) to the RH when to respond. The "cross-cueing" phenomenon makes the accurate measuring of RH linguistic abilities problematic (Nebes, 1978; Searleman, 1977).

Another form of RH expressive language by commissurotomized subjects was shown in the spelling of simple words through the tactual manipulation of groups of letters with the left hand (Gazzaniga, 1970; Gordon, 1980-b; Levy, Nebes & Sperry, 1971; Nebes, 1974).

Comprehensive language. Proof of language comprehension by the LH was obtained by Gazzaniga and Sperry in the following manner. Items named or described to patients were retrieved by them with their right hand and written commands presented to the right visual field (RVF) were easily followed. These researchers found the LH capable of common calculations: adding, subtracting, dividing and multiplying. Consistently similar results have been obtained since the early studies and they were once more confirmed through Zaidel's (1979) administration of the Illinois Test of Psycholinguistic Abilities to completely and

partially commissurotomized patients. A generally superior (although at times erratic) LH performance was demonstrated.

The abilities in comprehensive language of the RH in commissurotomized patients appear to be less limited than the expressive ones. For instance, Gazzaniga and Sperry found a RH ability to understand nouns and names of objects when these were presented in the LVF. Gazzaniga and Hilyard (1971) showed that the RH cannot distinguish the active from the passive form, the present from the future tense and the singular from the plural, although it was successful in distinguishing positive from negative statements. Contradictory results have been reported by Zaidel (1973), for he demonstrated the RH to be capable of comprehending syntactical construction, a variety of sentential transformations and some semantically abstract references.

Dichotic listening studies are difficult to assess in commissurotomized patients due to left ear input suppression, during simultaneous presentation of stimuli. Nevertheless, RH comprehension of spoken commands has been reported repeatedly (Gordon, 1973; Gordon, 1980-b; Milner, Taylor & Sperry, 1968; Nebes, 1974). Pairs of words such as "doggey-horsey" were processed without great difficulty, as a result of left ear input, but the same mode did not produce the reporting of consonant-vowel pairs (Gazzaniga, Risse, Springer, Clark & Wilson, 1975; Springer & Gazzaniga, 1975). Pairs of complete words have a more global (holistic) meaning than the combination of a few letters, which might explain the RH performance on these tasks.

In summary, information from studies with commissurotomized patients indicates that the LH is capable of unimpeded comprehensive

and expressive language functions, while the RH has a much greater potential for comprehensive than expressive language. The RH is inferior to the LH in both aspects of linguistic skills.

Hemispherectomy and lobectomy

Expressive language. Studies involving unilateral lesions, lobectomies and hemispherectomies generally show that speech losses are much more frequently due to left side injuries than to those in the RH (Gott, 1973; Russell & Espir, 1961). Interestingly, right hemispherectomies do interfere with singing (Smith, 1969).

Lesions in Broca's area result in a form of aphasia characterized by laboured, poorly articulated and grammatically inappropriate verbal output and comparably disordered written language. This area is located in the left frontal lobe of the cortex and was named after its discoverer, the 19th century French neurologist, Paul Broca. Disturbances, similar to Broca's aphasia have been obtained through left hemispherectomies (Crockett & Estridge, 1951; Hiller, 1954).

In 1874 the German neurologist Carl Wernicke identified a form of aphasia caused by damage to the left temporal lobe of the cortex (Wernicke's area). In instances of such damage the expression of both written and oral language suffers greatly; it frequently includes nonsensical syllables and words and generally contains little meaning (Geschwind, 1979; Teyler, 1977).

The effects of temporal lobe damage on auditory perception have been well documented by Kimura (1961-a). The right ear advantage in terms of accuracy, as it is typically observed with righthanded

subjects, has been interpreted as reflecting the specialization of the LH for speech processing as well as the superiority of contralateral over ipsilateral ear-cortex connections.

Some RH residual abilities in the form of automatic phrases, expletives and limited propositional speech were demonstrated in later research (Gott, 1973; Smith, 1966; Zaidel, 1973). Writing is usually impaired in the case of left hemispheric lesions (Boller, 1968; Rossing, 1975; Smith, 1966). Simernitskaya (1974) noticed this mostly for the conscious and organized aspects of writing, but not for automatic forms.

Singing, as a form of speech, seems to be least interfered with by left hemispherectomies (Gott, 1973; Smith & Burkland, 1967). It has frequently been demonstrated that, in comparison to ordinary speech, verbal expression through singing is superior. Such observations are in all likelihood related to those of the RH specialization in musical ability (Bogen & Gordon, 1971; Gordon, 1973; Kimura, 1964). Interesting in this context are Ross and Market-Marsel's (1979) arguments "given to support the idea that the right or 'minor' hemisphere has a dominant role in modulating the affective components of speech" (144), as a result of a study with patients with lesions in the RH.

Comprehensive language. The importance of the role of the LH in the comprehension of language is suggested by information obtained from studies involving left sided lesions and lobectomies. For instance, patients of Milner (1960, 1964, 1967) who suffered from lesions in the left temporal lobe, or were the recipient of a lobectomy of this area, experienced impairment in the learning and retention of both aurally

and visually presented verbal material. The recall of short prose passages, consonant trigrams and recurring digit strings, as well as the performance on paired associate learning tasks was severly disturbed.

Wilkins and Moscovitch (1978) found the verbal, but not the pictorial, component of semantic memory to be impaired following left temporal lobectomy. Gainotti et al (1978) demonstrated how even visuo-spatial memory and recognition became non-functional due to an inability in verbal coding caused by left hemispheric lesions.

Left sided hemispherectomies result in relatively less (but still severe) impairments when compared with lesions and lobectomies. A reason might be that the RH is forced to "take over" as many language functions as possible after such an operation. For example, Smith (1969) obtained practically equal LH and RH scores on the Peabody Picture Vocabulary Test when administered to left and right hemispherectomized patients respectively. The test examines comprehension of individually and orally presented words. Verbal directions were followed by Gott's (1973) patient and the same subject demonstrated phonemic discrimination, an understanding of prepositions related to location (except left and right) and various syntactical propositions Understanding diminished greatly when sentences were long with many related elements (Zaidel, 1973). Rossing's (1975) hemispherectomized patient could, upon verbal command, designate numbers and letters and match these with written words.

Data from right hemispheric lesions or lobectomies are sparse but ascribe some importance to the RH in comprehensive language

skills. For instance, Eisensohn (1962) reported that patients with unilateral RH damage performed poorer on the sentence completion subtest from the Stanford Binet Intelligence Scale than a group of normals. Critchley (1962) suggested that such RH damage may cause an inability to do creative literary work, hesitation in finding "right" words and difficulty with articulation. These suggestions were partially confirmed by Marcia, Hécaen, Dubois and Angelergues (1965) who found disorders of articulation, syntactic transformation and sentence production in cases of RH lesions and lobectomies. Hécaen and Marcie (1974) related disorders of reading, writing and calculation to spatial factors involved in these verbal skills, a finding supported by Rivers and Love (1980) whose data indicated that the minor hemispheres lesions (as compared to those of the major hemisphere) "appeared to produce verbal differences that reflected defects associated with the special contribution of the RH in higher level visual information processing" (398).

However, some studies of patients with right sided braindamage reinforce the importance of the role of the LH in linguistic skills. For instance, subjects with right temporal lobe lesions performed normally in both immediate and delayed recall of abstract paired-associates (Jones-Gotman & Milner, 1978) and others with similar damage were able to discriminate between words recalled from a list presented previously (Reige et al. 1980). Finally, the results of a study by Wapner, Hamby and Gardner (1981) suggested a RH difficulty in the utilizing of a surrounding context when linguistic messages are presented as in humorous situations. The LH did not encounter such

difficulties, possibly because of the abstract characteristics of stimuli. Studies with normals have suggested that aspect to be of influence on RH and LH performances.

Similar to the results from studies with commissurotomized patients, it is indicated through individuals suffering from unilateral lesions, lobectomies and hemispherectomies that the LH is capable of comprehensive and expressive language functions. The RH of such patients demonstrated some minor ability for comprehensive language and a capacity for limited expressive language through singing, possibly due to the association with musical abilities which are also located in the RH.

Anesthesia

Expressive language. Studies of left hemispheric anesthesia have usually revealed a complete loss of speech (Gordon and Bogen, 1974; Serafetinides, 1965; Wada & Rasmussen, 1960). Right ear advantages in dichotic listening tasks have also been related to LH specialization for expressive language as determined by sodium amytal testing (Kimura, 1961-b).

Comprehensive language. Following left sided anesthesia aurally learned verbal and numerical material frequently becomes impaired (Serafetinides, 1966); disruptions in the naming of objects and mnemonic responses, transient dysphasia and deficits in short term verbal memory were apparent (Fedio & Weinburg, 1971) and not only disordered speech, but also an inability to understand examiners' instructions was obvious (Perria, Rossi & Rosadini, 1961). Only minor

indications of language comprehension in the RH have been obtained after left sided anesthesia (Branch et al, 1964; Kinsbourne, 1971; Terzian, 1964). These data from studies with anesthesized subjects confirm the greater importance of the LH in both, expressive and comprehensive language skills, when compared to the RH.

Thus, the studies of clinical cases indicate that the LH is quite capable of normal expressive and comprehensive language, while the RH, although probably mute, is certainly not uncomprehending. There appears to be a RH deficit in phonemic analysis, syntax and articulation. The lexicon of the RH is probably imaginal, associative and connotative rather than phonological, denotative and precise (Zaidel, 1978).

Normals

The information obtained through studies of linguistic skills with normals will be reviewed primarily in the context of dichotic listening and tachistoscopic viewing, since these are the two major research methods involved. Additional, but less extensive material from electrophysiological and cerebral blood flow studies will also be presented.

Dichotic listening

Expressive language. The presence of expressive language is difficult to demonstrate in dichotic listening tasks. However, the originator and developer of the technique (Kimura, 1961-b, 1967) demonstrated LH superiority in verbal responses measuring accuracy and

reaction time. Auditory tracking techniques developed by Sussman (1971) and Sussman and MacNeilage (1975) have provided indirect indications that the usual right ear advantage in verbal tasks may be due to greater LH functional control of motor pathways in speech production, rather than to structural advantages. This is of importance, since it is known that motor pathways for speech production are present bilaterally (Gazzaniga, 1970) and therefore, in cases of left sided lesions, lobectomies and hemispherectomies, the RH may be able to master the functional control skills needed for speech production.

It has been consistently reported that the RH participates in expressive language through intonation and pitch processing (Blumstein & Cooper, 1974; Van Lancker, 1975; Zurif, 1974).

Comprehensive language. A right ear (LH) advantage for general language perception has been demonstrated through a number of studies with various stimuli. For example, such results were obtained by Kimura (1961-b) and Nachson (1978) with digits, by Dirks (1964) and Lazarus-Mainka and Lazarus (1978) with words in general and by Curry (1967) with meaningful and nonsense words. Other studies showed such an advantage when words were interfered with by artificially produced noise (Young & Ellis, 1980) and when digits had to compete with tones (Teng, 1980).

This right ear advantage is not merely the result of LH specialization for levels of audition or general attention, since melodies (Kimura, 1964), sonar signals (Chaney & Webster, 1966) and environmental sounds (Curry, 1967) were better perceived by the left ear.

Kimura (1967) noted also that familiarity with the presented material, was not a critical factor.

Studies concerned specifically with speech perception, provide a picture of LH and RH participation. The following will clarify. Right ear (LH) dominance is indicated in specific decoding and restructuring of speech sounds that are strongly encoded (Darwin, 1971; Liberman, Cooper, Shankweiler, Studdert-Kennedy, 1967). Some of these sounds are stopconsonants (Shankweiler & Studdert-Kennedy, 1967), consonant-contrasting syllables (Studdert-Kennedy & Shankweiler, 1970), or liquid consonants (Cutting, 1972). In addition, Klatzky and Atkinson (1971) obtained LH dominance on the kind of tasks which depend on detecting phonetic similarities or identities.

No LH dominance has been found in the processing of vowel-consonant syllables (Studdert-Kennedy & Shankweiler, 1970), vowels without language expectation (Spellacy & Blumstein, 1970), or semi-vowels (Haggard, 1971) while RH participation in the processing of fricatives has also been apparent (Cutting, 1974; Darwin, 1971). Furthermore, the analysis of general acoustic parameters, as measured by neural responses (Wood, Goff & Day, 1971) and of acoustic change in syllables (Schwartz & Tallal, 1980), the perception of pitch and loudness in speech (Nachson, 1978) and of the melodic structure of sentences (Dwyer and Rinn, 1981), have been shown to be within the capabilities of the RH as well. Data obtained from these studies in speech perception suggest a RH ability to extract global meanings from sounds related to acoustics, rather than a specific meaning through

analysis and decoding of sound combinations. The LH seems to be capable of performing both forms of language skills.

A right ear advantage is suggested for other linguistic functions. For instance, the grammatic structure of sentences is analyzed by the LH (Zurif & Sait, 1969), as is the semantic system, so indicated by superiority in the recognition of abstract but not of concrete nouns (McFarland, McFarland, Bain & Ashton, 1978). Some linguistic variables differ only in tone, as in certain non-English languages when the pitch of a word changes its meaning. Dichotic presentation of such variations results again in superior right ear processing (Van Lancker & Fromkim, 1973).

In summary, it can be stated that the usual right ear advantage in dichotic listening is generally interpreted as being indicative of LH dominance in language skills. However, it seems clear that such an interpretation is complicated by the multidimensional nature of linguistic information. The right hemisphere is obviously more capable of comprehensive than of expressive language as measured by dichotic listening tasks. However, these tasks are not always sufficiently discriminatory because of the previously mentioned difficulties involved in the sequential and simultaneous presentation of stimuli.

Tachistoscopic viewing

A body of literature presenting complex studies and results of tachistoscopic viewing is available. Subsequent to the presentation to both visual fields of material coded in language, response accuracy

and/or reaction time are usually measured and both, inter and intra-hemispheric indices are analyzed. A review follows.

Response accuracy. A right visual field (RVF) advantage was obtained in general word recognition ability by McKeever and Huling (1970, 1971) and Cohen-Leehey and Cahn (1979). The McKeever and Huling (1970, 1971) results support the hypothesis that words projected to the RH traverse a less efficient route, or longer neural pathway, to the language centers of the LH. Large RVF superiorities were found in the naming of nouns and consonant-vowel-consonant nonwords and similar, but smaller, differences resulted from the naming of line drawings and picturable nouns (Young, Bion & Ellis, 1980). The latter result is possibly due to the visuo-spatial aspects of the stimuli, allowing for more RH (LVF) involvement.

An important finding has been that the visual hemifield asymmetry for word recognition is influenced by the type of words shown, but there does not appear to be congruency in related research results. For instance, Ellis and Shepherd (1974) found that abstract and concrete nouns are better recognized in the RVF than in the LVF. Hines (1976) and Day (1977) obtained such results for abstract nouns only, while Hines (1977) also concluded that the LVF can recognize high frequency concrete nouns independently from the RVF. Leiber (1976), Axelrod, Haryadi and Leiber (1977) and Bradshaw and Taylor (1979) demonstrated consistent RVF superiority with a variety of words of either high or low frequency, although it must be noted that the latter study was with sinistrals and the laterialization of language skills in such subjects is not entirely clear. The Leiber (1976) study did not

produce visual field differences in pronounceable and unpronounceable nonwords, which led the author to conclude that "meaning is a more salient parameter of wordness than pronounceability" (443).

Other studies indicate also that the type of visual input is of influence on hemifield recognition. For instance, Kimura (1966) suggested that the left posterior part of the brain plays an important role in the identification of verbal-conceptual forms, since identification of letters was more accurate in the RVF, while performance on the enumeration of non-alphabetical stimuli was better when these appear in the LVF.

In relation to the type of words presented, intrahemispheric findings tend to be inconsistent. In this context, the RVF has shown to recognize familiar (Hines, 1976) or regular (Day, 1977) abstract nouns better than similar concrete ones, but no such result was obtained by Ellis and Shepherd (1974) who reported no differences between the two kinds of nouns. The latter did find better concrete than abstract noun recognition in the LVF; however, the result could not be replicated by Ornstein and Meighan (1976). Marshall (1973) found the LVF to recognize high frequency nouns better than low ones. The information provided by the response accuracy studies is clearly inconsistent and difficult to interpret, unless one is fully aware of the research methodologies in relation to e.g. the manner of presentation (sequential vs. simultaneous) of stimuli. However, that factor is rarely taken into consideration by the researchers and therefore seldom reported. Combining the results of interand intra-hemispheric studies, it appears valid to suggest (at most) that the RH is capable of

processing concrete, imageable, high frequency nouns, while the LH in addition to that skill processes abstract nouns with low frequency.

Reaction time. Reaction time studies have also produced inconsistent outcomes as the following will illustrate. Day (1977) compared abstract and concrete nouns in lexical decision (i.e. word vs. non-word) tasks. He found the RVF and LVF to be equally efficient at the recognition of concrete nouns, but a RVF advantage in the case of abstract nouns. In addition, the LVF was able to detect the relationship between the concrete nouns and the superordinate categories they belong to; however, a RVF superiority was demonstrated in the detection of such relationships for abstract nouns. Day's conclusion was that the concrete nouns can be processed equally well by either hemisphere, but that information about abstract words must be transferred to the left for analysis.

Day's (1977) study has been criticized on the basis of methodology (choice of subjects, set of abstract words) and the results of similar studies have produced contradictory results. Gross (1972) had found, prior to Day, a strong RVF superiority following LVF and RVF presentation of concrete, also to be categorized, nouns and Bradshaw and Gates (1978, experiment 3) obtained similar RVF advantage for all four classes of words created from the dimensions high vs. low and abstractness vs. concreteness. In another lexical decision task, Leiber (1976) and Bradshaw and Gates (1978, experiment 1) found RVF superiority for both high and low frequency items. Contrary to Day's conclusions, these data are indicative of general LH superiority in processing regardless of the nature of the word.

Other reaction time studies are relevant to the issue. In one of these, the responsiveness of the RH to syntactic class was measured (Koff & Riederer, 1981). Subjects were presented with four word classes, i.e. pure nouns, verb-derived nouns, category ambiguous words and adjectives. These word classes were recognized at the same rate within the LVF, but much faster in the RVF than in the LVF, indicating greater LH ability. In another study, familiar numbers, Gothic-like numbers, binary numbers in the form of dots rather than digits, and symbols from the Digit Symbol subtest of the Wechsler Adult Intelligence Scale were stimuli presented by Gordon and Carmon (1976). The novel, i.e. binaral, symbols were initially recognized at a faster rate in the LVF, but the RVF became progressively more prominent in this activity. Such a shift did not take place for familiar numbers, for dominance was consistent in the RVF. The results have been interpreted in terms of the greater recognition and verbal coding ability of the RH and LH respectively.

Finally, since the results of studies with commissurotomized patients demonstrate much greater RH language skills than those with normal subjects, Moscovitch (1972, 1976) has suggested, as a consequence of his reaction time studies, that interhemispheric pathways may allow the LH to suppress RH language abilities. This view has been strongly supported by Searleman (1977). The results of reaction time studies are only partially congruent to those suggested by the response accuracy studies. There is less support for a RH ability in the processing of concrete high frequency nouns, but

agreement about the LH processing abilities of all forms of linguistic items.

Electrophysiological and cerebral blood flow indices

Indices of alpha wave asymmetry are used in support of data from dichotic listening and tachistoscopic viewing tasks. Greater left alpha wave suppression (and therefore LH activity) has been measured during the following language activities: a) verbal reasoning (Morgan, McDonald & MacDonald, 1971); b) the writing of a letter (Galin & Ornstein, 1972); c) the reporting of words in ascending form of complexity (McKee, Humphrey & McAdam, 1973); d) the presentation of words and arthimetic tasks (Doyle, Ornstein & Galin, 1974; Osborne & Gale, 1976); e) writing from memory (Galin & Ellis, 1975); and f) tests involving vocabulary and word arrangements (Ehrlichman & Wiener, 1979). Greater right alpha wave suppression was obtained in all these studies when non-linguistic (visuo-spatial and other) tasks were performed, such as: mental imagery, block designs, paper formboard test, musical test, naming of abstract pictures, cube comparisons, shapes and colour and surface development tests. This confirms that the RH is more active during visuo-spatial tasks.

Carmon, Lavy, Gordon and Portnoy (1975), using the carotid injection method, demonstrated how listening to verbal material resulted in a clear increase in cerebral blood flow in the LH, without any apparent increases in the RH. The inhalation method was used by Risberg, Halsey, Wills and Wilson (1975). During a verbal analogies

reasoning test their subjects' hemispheres both increased their activity, but the increases in the LH were considerably larger.

These direct electrophysiological and blood flow measures of hemispheric activity clearly indicate that the LH is more involved than the RH in linguistic tasks.

Comments and Summary

It is obvious that the left hemisphere is the most prominent hemisphere in governing the linguistic skills of most people. Studies with clinical and normal subjects demonstrate that the left hemisphere is capable of performing all expressive and comprehensive linguistic skills. Spontaneous writing and writing from memory, reading aloud and regular speech production are under the dominant control of the left hemisphere. Other skills within the domain of this hemisphere include decoding and restructuring of a majority of speech sounds; analyzing grammatical, syntactic and semantic structures; verbal reasoning; and, numerical calculating. Furthermore, the immediate and delayed recall of verbal and numerical material, the identification of letters and digits and the recognition of words, are also left hemispheric activities.

In comparison to the LH a picture of considerably less RH language abilities emerges from the literature. An unanswered question is: "to what extent does the RH play a significant role and can it perform skills controlled by the LH." Obviously, RH expressive functions are extremely limited in clinical cases (with the exception of singing), although some form of processing automatic material may be

possible. Contributions to the acoustic aspects of speech have been demonstrated through the studies with normals. More or less rudimentary syntactic and semantic constructions, simple sentences, verbal directions and simple verbs and nouns (especially when imageable) can be perceived and comprehended by the right hemisphere of patients. Comprehension and analysis of the acoustic facets of speech perception and the processing of high frequency concrete or imageable items have been shown to be a function of the right hemisphere in normals.

It is again emphasized here that several variables confound clear interpretations of research data. Among these variables are the uncertainty about the brain organization and functional lateralization of some subjects, cross-cueing by the LH, suppression of RH linguistic skills by the LH tasks in case the latter is injured or absent. Finally, the previously discussed mode of stimulus presentation, i.e. sequential vs. simultaneous, is another source complicating the interpretation of results.

Visuo-Spatial Skills

Introduction

As will be noted from the ensuing review, a number of contradictory results emerges from the research in visuo-spatial perception. Early reports reflected the view that the RH contains the seat for visuo-spatial processes, but subsequent findings ascribed a role to the LH which diminished the importance of the RH. The extent of the LH role has been associated with the degree of complexity of visuo-spatial

stimuli and their encodability into short and long term memory through verbal mediation. The explanation is that verbal mediation (a LH process) during encoding in memory is easier for simple and common than complex and uncommon stimuli. As a result, better encoding and subsequent recognition and identification of the "easy" stimuli is expected to take place when compared with the "difficult" material.

Although literature related to such explanations pertains mostly to recognition studies, the issues involved are of general importance in visuo-spatial perception. In this context, Cremonini et al (1980) arrived at the following conclusions after reviewing results of a limited number of studies in spatial memory tasks: (1) Injury to the RH is associated with impaired performance on tests not including verbally identifiable stimuli (e.g. meaningless patterns, unknown faces); (2) short term memory for pictorial stimuli is mediated by encoding and rehearsing the pictures as names. The evidence for long term memory is contradictory since right as well as left lesioned patients have performed either better, or equally well on relevant tasks.

Several other issues, infrequently raised in the literature, have to be mentioned since they influence research outcomes and their interpretations.

Firstly, if judgments about the complexity or commonality of stimuli in relation to subjects are to be valid, one would require considerably more extensive information about the background of the individuals than is usually provided. For example, whether one is a mathematician or playwright will influence the perception of polygons;

and interior decorators probably discriminate more easily between colour patterns than coal miners do. Even so, uncommon shapes or patterns used in tests may be more readily recognized precisely because of their novelty and in spite of difficult encodability through verbal mediation. Researchers rarely take such factors into consideration (at least they do not report them) and they appear to assume that "complexity" or "commonality" of stimulus material is identical for all subjects.

Secondly, if verbal mediation is involved in the perception of visuo-spatial stimuli, the "nature" of clinical subjects becomes even more crucial. After all, commissurotomized and left hemispherectomized patients will not have any, or at least very little, access to language facilities depending on the method of stimulus presentation. Those with left sided lobectomies and lesions may or may not have verbal capacities, depending on the nature and location of injury, while in normals there would be no loss of language skills.

It is obvious then that, in addition to the confounding variables discussed in the introduction of this chapter, the kind of stimuli and nature of subjects are also cause for lack of clarity in research in visuo spatial perception. Thus, it is not surprising that many unexplained contradictory outcomes do not lead to clear interpretations of LH and RH abilities as the following review will illustrate.

For the sake of organization the forthcoming material has been organized into tasks of perceiving one, two and three dimensional stimuli.

Studies with undimensional stimuli

Dot perception. Kimura (1966, 1969) demonstrated in early studies of dot perception that the RH is more adept than the LH at the enumeration and location of dots, but not in the detection of such stimuli. The latter finding was supported by Bisiach, Capitani and Tansini (1979), but not by Davidoff (1977) who showed superior RH ability especially in the detection of dots that were reduced in contrast from their background. McKeever and Huling (1970) found the RH also more proficient in the copying of dotted lines following a brief exposure of examples. The foregoing studies were all conducted with "normals" as subjects.

Warrington and Rabin (1970) found significant differences in favour of the RH on a matching test for dot positions when the performances of right and left lobectomized patients were compared.

Finally, Bryden's (1976) results did not demonstrate a clear RH superiority for dot location abilities under four experimental conditions, i.e. presentation (a) within a frame, (b) within a blank field, (c) combined with a dot detection task, and (d) combined with a dot detection task within a frame. The conclusion by Bryden (1976) is that the results of dot localization experiments do not warrant their use for a measure of hemispheric functions. RH superiority in detection and localization is slight and partially explained by "a bias for subjects to claim that dots appear in the LVF" (28). One could suggest that "bias" to be an important RH function as such; Bryden does not provide an explanation for the phenomenon.

Line orientation. Judgments about the similarity or difference between the slopes of two lines exposed simultaneously or sequentially, were more accurate in the LVF (RH) with normal subjects (Atkinson & Egeth, 1973; Fontenot & Benton, 1972; Kimura & Durnford, 1974; Sasanuma & Kobayashi, 1978), with commissurotomized patients (Nebes, 1974), with left or right braindamaged individuals (Benton, Hannay & Varney, 1975) and with left or right lobectomized patients (Warrington & Rabin, 1970).

However, a LH advantage was obtained in a line orientation study with normals by White (1971) and no difference between LH and RH performance was demonstrated by Bisiach, Nichelli and Spinnler (1976) with subjects suffering from left or right sided lesions.

In an extensive study, Umilta, Rizolatto and Marzi (1974) presented normal subjects with three experimental conditions. Lines were presented (a) horizontally, vertically or 45° from vertical, (b) 30° and 45° from vertical, and (c) 15°, 30°, 45° and 60° from vertical. Condition (a) resulted in superior LH performances, but conditions (b) and (c) produced the opposite result, a RH advantage.

Berlucchi (1979) discussed a complexity factor in line orientation. They suggest that discrimination of line orientation is affected by RH lesions and has been shown to engage the RH more when the discriminations are of a difficult nature. By contrast, LH superiority has been demonstrated in simple line orientation tasks. Berlucchi (1979) think that the findings can be related to the verbal mediation process leading to verbal encoding of easier tasks.

Obviously, the majority of studies with unidimensional stimuli produce data indicative of RH superiority in relevant tasks. In

response to Berlucchi (1979) it can be argued that in comparison to perceptual tasks with one dimensional stimuli, those with two dimensional material are more difficult and should show less LH involvement. The following section will provide information related to that argument.

Studies with two dimensional stimuli

Extensive research concerning the perception of two dimensional stimuli is available. In these studies the assessment of RH and LH abilities occurs through a variety of tasks such as recognition, reproduction and part whole perception with different sorts of material including blocks, shapes and figures.

Recognition. Recognition studies produce inconsistent results. Serafetinides (1966) demonstrated that recognition of complex geometric designs was not affected by the anesthesizing of the dominant hemisphere of patients with left or right brain lesions, and Levy, Trevarthen and Sperry (1972) concluded that the more rapid and accurate recognition of the shape of complex figures by the minor hemisphere of commissurotomized patients demonstrated that hemisphere's superiority in such tasks. Dee and Fontenot (1973) also obtained RH superiority when normals were required to recognize complex random shapes, but Hines (1978) found only minor, statistically insignificant RH advantages with similar stimuli and subjects.

The results of the foregoing studies support the notion that LH verbal mediation is of no consequence, since the RH is quite capable of perceiving complex stimuli. This supports the Berlucchi (1979)

argument. However, different results obtained through studies with left or right brain damaged patients complicate the picture. For instance, Boller and De Renzi (1967) presented common, easy to verbalize figures and complex scrawls that could not be described verbally; Boller and Spinnler (1967) used simple and complex patterns of colours and Bisiach and Faglioni (1974) showed simple and complex black patterns. These three studies demonstrated that subjects with left sided lesions suffer greater impairment in the recognition of simple as well as complex visuo-spatial stimuli, when compared with subjects with right brain damage. Finally, Schmuller and Goodman's (1980) recognition task of common drawings found normals to make more errors in the RVF (LH) than in the LVF (RH), which indicates a RH advantage with simple material. These results are difficult to reconcile with the hypothesis that recognition of simple stimuli is aided by LH verbal mediation during encoding.

Thus, recognition studies do not precisely clarify the role of the RH and LH in visuo-spatial perception and, although the issue of verbal mediation does not appear to be of importance in studies of visuo-spatial comparison and discrimination, relevant results do not shed much light on the RH and LH abilities either as the following illustrates.

Discrimination and comparison. In a discrimination and comparison task, Bisiach et al (1976) obtained a minor, but statistically insignificant RH advantage. Left and right braindamaged patients and normals (as controls) were required to make judgments in terms of "same" or "different" about form (circle vs. ellipse), area (circle vs.

circle) and curvilinearity (scrawl). However, Ehrlichman and Wiener (1979) demonstrated greater and more integrated RH electrophysiological activity on a comparison test of cubes drawn on paper and during the matching of abstract figures by normals.

Comparison tests with block designs have produced general (but not consistent), indications of greater RH involvement. For instance, greater RH alpha wave suppression in normals has been reported by Galin and Ornstein (1972), Doyle et al (1974) with Koh's Block Design and with the Block Design subject of the W.A.I.S. (Galin & Ellis, 1975). However, Amochaev and Salamy (1979) did not obtain differences between RH and LH hemispheric activities of normal subjects through the W.A.I.S. subtest.

The Block Design test of the W.A.I.S. was also used by Smith (1969) with left or right hemispherectomized patients and by Warrington and Rabin (1970) with individuals suffering left and right sided lesions. Traumata of the RH resulted in considerably more impaired performances in comparison to LH injuries. By contrast, removal of the LH caused poorer scores on the W.A.I.S. subtest when compared with right sided hemispherectomies (Gott, 1973). The author ascribes the outcome of her research to the lack of "analytical and sequential capacities necessary for success in...(this)...test" (270). As has been related in the introduction of this chapter, the analytical and sequential capacities are thought to belong in the domain of the LH. However, this does not explain the demonstrated RH superiority of clinical subjects in the Smith (1969) and Warrington and Rabin (1970) studies.

Reproduction. Tasks involving the reproduction of "general" designs produce consistent RH superiorities with left or right hemispherectomized patients as reported by Nebes (1974). Normals demonstrated greater RH than LH alpha wave suppression during the copying of general design overlays (Doyle et al, 1974).

By contrast, the copying of Bender Gestalt figures, which are more detailed and complex than "general" designs, produced different results. Gott's (1973) patients with left or right hemispherectomies demonstrated a LH superiority and Amochaev and Salamy (1979) could not obtain conclusive evidence of greater alpha wave suppression in either hemisphere. Possibly, the reproduction of relatively complex Bender Gestalt figures requires LH participation not needed for the copying of general designs. Verbal mediation in reproduction tasks is not discussed in the literature, but LH superiority in the copying of the complex Bender Gestalt figures, would argue against the hypothesis that only simple visuo-spatial perceptions are assisted by involvement of the LH.

"Part-Whole" perception. In "part-whole" perceptual tasks, subjects are required to demonstrate their ability to perceive relationships between individual parts of pictures and their meaningful whole, by constructing the whole picture from incomplete or limited information and material.

Early studies showed such perceptual abilities to be more disturbed in patients with right sided rather than left sided brain damage (De Renzi & Spinnler, 1966; Landsdell, 1968). Also, right lobectomized patients performed worse than their left lobectomized

counterparts on a test requiring the matching of gap sizes in the contours of circles, squares and triangles (Warrington & Rabin, 1970).

Research with commissurotomized patients provided Nebes (1971, 1972, 1973) with consistently better performances from the RH than the LH on tasks such as (a) choosing from among three different sizes of complete circles the one from which a given arc had come, (b) reconstructing geometrical shapes that had been cut up, and (c) making judgments about the horizontal and vertical organization of dot arrays.

Studies with normals produced results indicative of greater RH involvement in part-whole perceptual tasks. For instance, Risberg et al (1975) tested perceptual closure abilities by means of incomplete pictures. A significant increase in RH blood flow was demonstrated in highly motivated subjects and a similar, but statistically insignificant increase with lesser motivated individuals. Ehrlichman and Wiener (1979) obtained greater electrophysiological activity in the RH when their subjects completed a simple jig-saw puzzle.

However, results from other studies contradict the foregoing. For instance, left and right hemispherectomized patients of Gott (1973) demonstrated a LH advantage during a test requiring the identification of an object through its fragments. Ornstein, Johnstone, Herron and Swencionis (1980) were surpised to find results opposite to those of Nebes (1971), i.e. the LH was primarily engaged in the selection of circles to which a given arc belonged. One can speculate about the causes for the contradictory results of the last two studies. As will be noted throughout this section of the review (dealing with the perception of two dimensional stimuli), the results of Gott's (1973)

study are contrary to the general trend of RH superiority. A possible explanation is that Gott's sample was too small (three subjects) and included a relatively young individual (16 years old). It may therefore be that the outcomes of that study lack the sophistication of studies with larger samples. The discrepancy between the Nebes (1972) and Ornstein et al (1980) results on identical tasks could be due to the kind of subjects (commissurotomies vs. normals) and measurement (visual matching vs. alpha wave suppression) used by the experimenters.

The modified version of the Minnesota Paper Form Board Test has been used by several researchers for the assessment of part-whole perceptual abilities. During testing a person is presented with a sectioned figure and asked which one from five assembled figures could be constructed from the sections. Consistently greater RH activity, as indicated by electrophysiological measures (Doyle et al, 1974; Galin & Ornstein, 1972; Ornstein et al, 1980) and by cerebral blood flow indices (Dabbs & Choo, 1980), were obtained. The subjects all being normals could be a major cause for the uniformity in results.

In summary of the studies with 2-dimensional stimuli, it can be stated that no clear evidence exists for more RH involvement in relevant perceptual tasks, although a tendency in that direction has been noticed by several researchers. The nature of the task appears to be of influence in this respect, with recognition, discrimination and comparison studies providing results with less clarity when compared to reproduction and part-whole perception studies.

Studies with three dimensional stimuli

A number of researchers have explored the ability of the hemispheres to transform two dimensional stimuli into three dimensions and vice versa. Some of the tasks are relatively simple and involve visual or manual recognition of drawings and shapes, while the more demanding tests require some form of "mental rotation" of materials. Results of depth perception studies have also been included in this section.

Recognition. Recognition tests have produced results that are indicative of greater RH than LH ability. For instance, Levy-Agresti and Sperry (1968) tested their commissurotomized patients' capacity to identify, through manipulation, a three dimensional spatial structure from a two dimensional pictorial presentation. The left hand was more capable of identifying the shapes. According to the authors, the right hand (LH) analyzed shapes in terms of the relationship of their details, while the RH folded the two dimensional layouts mentally and visualized the forms. Commissurotomized patients of Bogen (1969) were more capable of drawing two dimensional representations of three dimensional cubes with the left than the right hand. Franco and Sperry (1977) presented two and three dimensional geometric forms to commissurotomized, left or right hemispherectomized patients, and normals as control. The subjects selected manually one of three shapes, screened from sight, that best fitted one of a set of five different forms presented together on a panel in free vision. A consistent RH advantage was obtained. Interestingly, one left hemispherectomized patient scored as well as the normal subjects, thereby re-emphasizing the importance of the RH in this specific task.

Finally, Beaumont, Mayes and Rugg (1978) found a greater RH than LH electrophysiological involvement when normal subjects completed the Space Relations subtest of the Differential Aptitude Test. In this test individuals are required to mentally construct a patterned cube from an unfolded plan and match the results to various samples.

Rotation. The results of rotation studies are not consistent. Both, RH and LH advantages as well as equivalency in performances by the hemispheres have been obtained, as the following will illustrate.

Spatially transformed digits shown to the left of subjects' point of fixation and read from right to left were recognized faster than when shown to the right of fixation and read from left to right (Taylor, 1972). Such RH superiority was also evident when subjects were required to mentally rotate and match randomly shaped polygons, in contrast to a task with unrotated polygons which did not produce a RH advantage (Krynicki, 1976). Hayashi and Hatta (1978) required rotated Kanji figures (linguistic symbols) to be matched with similar stimuli in upright position. Under "no cues" experimental conditions the LVF (RH) reacted faster; when "cues" were present this RH performance was obtained only when more difficult to discriminate angles of rotation of the stimuli were used. The foregoing studies were with normals and seem to indicate that increased complexity in the stimulus situation causes the RH to become more capable than the LH in performing the tasks.

Contrary to the previous observation, it has also been suggested that in "mental rotation" tests "the superiority of the RH is still clear cut, but it subsides as the task becomes more complex" (De Renzi,

1978, 81-82). Two findings supportive of De Renzi's observation follow. Ratcliff (1979) conducted an experiment in which right-left judgments were made about stimuli in upright and inverted positions. Patients with right hemispheric lesions made fewer errors than those with left sided damage on the easier task with upright stimuli. However, with the inverted, more difficult stimuli, the results were reversed; that is, the injured LH made less errors than the injured RH.

Ornstein et al (1980) presented two dimensional drawings which were transformations, by means of perspective, from three dimensional figures. Normals were requested to match the drawings with either the original figures rotated in three dimensional space or with different figures. Although this was expected to be a highly complex, and therefore an RH task, the researchers were surprised to find the LH primarily engaged in the activities as measured by electrophysiological indices.

Other studies have shown both hemispheres equally involved in rotation tasks. For instance, Butters, Barton and Brody (1970) Benson and Barton (1970) and Butters and Barton (1970) used subjects with right hemispheric lesions, right hemispheric lesions and undamaged hemispheres (i.e. normals as controls), and right and left hemispheric lesions, respectively. The individuals were required to rotate wooden sticks horizontally or vertically in the manner of an example. No hemispheric superiority was demonstrated, but an explanation for the poor performance by patients with left sided lesions was that "internal verbalized cueing accompanies a successful rotation from the examiner's model to the construction in front of the patient, requiring visual-

verbal association" (Benson & Barton, 1970, 41). Presumably, a traumatized LH interferes with the establishing of "visual-verbal association." One can argue though that, in essence, one dimensional stimuli (i.e. sticks) and a basically two dimensional task (i.e. vertical or horizontal rotation) should not be interpreted in the context of three dimensional visuo-spatial abilities, although the authors do not consider that possibility.

Depth perception. The results of studies in depth perception have been rather consistent. Carmon and Bechtold (1969), Benton and Hécaen (1970) and Durnford and Kimura (1974) reported that stereoscopic vision is primarily a RH function. Durnford and Kimura tested normal subjects, the other studies were with left or right lesioned patients. Response latency and error were used as criteria.

In spite of De Renzi's (1978) observation it appears that the perception of three dimensional stimuli is foremost a RH function in both simple and complex stimulus situations. Of all recognition, rotation and depth perception studies reviewed here, only two ascribed greater ability to the LH. It is suggested therefore, that the LH is of less importance in visuo-spatial perception of three dimensional, than of one and two dimensional stimuli.

In general, the studies with 3-dimensional stimuli have demonstrated greater RH than LH involvement in recognition and depth perception tasks, while inconsistent results were produced in rotation tasks.

Colour perception

The perception of colour does not fit directly into any of the three categories of visuo-spatial perception reviewed previously. However, since the colour of stimuli is of influence on perception, a review of relevant findings is herewith included.

The roles of the RH and LH in colour perception are not clear, although indications are that the LH is limited to involvement in the naming of colours. For instance, damage to the "visual" areas of the LH results in deficits in the ability to designate colours by name (Geschwind & Fusillo, 1966; Oxbury, Oxbury & Humphrey, 1969) and commissurotomized patients have demonstrated a bias of the LH for naming colours (Levy & Trevarthen, 1981). Simple naming, discrimination and memory tasks produced approximate equivalency in hemispheric performance by normals (Dimont & Beaumont, 1972; Schmidt & Davis, 1974), but an increase in stimulus complexity was cause for RH superiority. Pennal (1977) also reports a positive relationship between RH performance and the degree of complexity of colour stimuli. He obtained a much greater RH than LH ability, as measured by response latency and errors, on an intricate colour matching test with normals. By contrast, Cohen and Kelter (1979) assigned a task, considered to be complex, requiring that associations be made between the typical colours of objects and their usual achromatic line drawings. The poor performance by left brain damaged patients led the researchers to conclude that the disability had effects beyond the purely perceptual level, since conceptualization and abstract thinking, which are predominantly covert activities, appeared to be impaired. Such a conclusion puts

colour perception as a phenomenon in the domain of hemispheric processing mechanisms and not in that of the perception of verbal vs. visuo-spatial characteristics of stimuli. The question still remains why the Cohen and Kelter (1979) study produced results different from those of Dimont and Beaumont (1972), Schmidt and Davis (1974) and Pennal (1977). The answer may be found in the difference in subjects (clinical vs. normals) rather than the task per se.

Research not related to the degree of complexity in colour stimuli or verbal involvement in their perception, has in general demonstrated RH advantages in relevant tasks. For example, right hemispheric damage produced deficits in colour discrimination (De Renzi & Spinnler, 1967) and high error scores in the judgment of hue (Capitani, Scott & Spinnler, 1978; Scott & Spinnler, 1970). Commissurotomized patients demonstrated better RH than LH memory for colour (Levy & Trevarthen, 1981) and for detection of colours patterns (Trevarthen, 1974). Much better RH than LH performances were obtained by normals in tests of hue, saturation and brightness discrimination (Davidoff, 1975, 1976; Kimura & Durnford, 1974) and reaction times to colour slides (Pirot, Pulton & Sûtker, 1977). Covert imaging of colours resulted in greater alpha wave suppression in the RH than the LH (Robbins & McAdam, 1974).

Summary

Although the evidence is not conclusive, the general indications are that the RH is the major perceiver or processor of visuo-spatial stimuli. The picture is clouded by a variety of issues, the major one

being possible involvement of a LH verbal mediation and memory process, depending on the degree of complexity of the stimuli. No solution regarding this confounding variable is available at this date. The perception of simple one dimensional stimuli appears to be aided by LH verbal mediation, the information from studies with two dimensional stimuli is equivocal at best in this regard, while indications from research with three dimensional stimuli (if at all present) point at possible LH involvement in more complex tasks. Concerns in relation to subject samples and stimuli materials have also been raised during the review.

In summary, the RH has been demonstrated to play a major role in all forms of dot perception and line orientation and the recognition of simple and complex geometric designs and regular figures. It is superior in tasks involving the matching of contours of geometrical figures, the perception of relationships between parts and the whole of pictures and forms, and discriminating between various block designs. The RH is capable of perceptually transforming two and three dimensional shapes in space and on paper. Depth perception is mainly controlled by the RH as is the perception of patterns, hue, brightness and saturation of colours.

By contrast, the LH may be capable of dot detection and simple line orientation tasks. It can recognize simple and possibly complex patterns and figures and may have some ability in the discrimination of block designs and the perception of part-whole relationships. It can perform some forms of rotation in space and is involved in the naming of colours.

A question came to mind during the reading and reviewing of the studies, i.e.:

> Is the qualitative "superior performance on a task" a better, worse or as good an indicator of hemispheric functioning as the quantitative "greater involvement in a task"?

It has been noted that the former statement is more frequently encountered in studies with clinical cases and involves measurements of perceptual tasks. The latter statement primarily derives from studies with "normals" involving measurements of brain activities. No studies could be found in which a correlation between both forms of measurement was presented.

The following chapter will present extensive material regarding sex differences in verbal and spatial abilities, explanations that have been offered for the existing sex differences and a discussion of contentious issues associated with research in sex differences.

CHAPTER IV

SEX DIFFERENCES IN VERBAL AND SPATIAL ABILITIES

Introduction

The previous chapter presented a detailed review of contemporary research concerning brainhemispheric differences in verbal and spatial functions of the general population. Presently, sex differences in verbal and spatial functions (abilities) and their determinants will be surveyed, however with less regard for precise detail. One reason for a less detailed account is that less information is available about the abilities of the sexes as compared to the general population. It is also thought that the previous chapter has allowed the reader to become acquainted with the many intricacies involved in investigations of linguistic and visuo-spatial cognitive abilities. Repetition of detail would blur, rather than clarify, the picture in relation to sex differences in cognition.

In the first part of this chapter some contentious issues related to the research in sex differences will be discussed, followed by a short review of actual findings. In the last part of the chapter current explanations for sex differences will be reviewed. The explanations are of genetic, hormonal, brainorganizational and social origins. The aspects of brain organization as an explanation will be

emphasized, since the research related to this topic occupies a major place in the literature.

Contentious Issues

It is emphasized here that when a general acceptance of sex differences is expressed in the research literature it is frequently couched in qualifying terminology of "indications," "suggestions" or "tendencies." In addition, phrases similar to "the difference between the sexes tends to be small compared to the range of individual differences within each sex" (Burstein, Bank & Jarvis, 1980, 297) are present in practically every review. The expressed caution is caused by studies that produce data that lead to tentative conclusions and to a variety of interpretations about the determinants of sex differences in cognition. The lack of "robust" data has been linked to insufficiently controlled research methodologies. Burstein et al (1980) comment on the problems encountered by investigators and reviewers:

> Research on the existence and determinants of sex differences in cognitive abilities has provided confusing and contradictory data. Generally, the existence of sex differences emerges clearly but their determinants do not. Problems...include flaws in construction, reliability and validity of tests, methodological problems such as small sample size, lack of measure of effect size, possible underreporting of negative results and failure to replicate studies (308).

In addition to problems associated with the technical aspects of research methodologies in sex differences, concerns of a different nature also emerge from the literature. These concerns involve the issue of biological vs. environmental causes of human behaviour and stemming from that, the role of confounding variables and the dichoto-

mizing of cognitive functions. At face value, such concerns should also be of a "neutral" scientific nature and dealt with accordingly. However, it is thought here that socio-political and even philosophical considerations colour the manner in which research in sex differences is conducted, reported and above all, criticized. A short clarification and discussion follows.

In the case of "exploratory" research with a general population (as e.g. described in the previous chapter), the knowledge and information obtained is perceived to affect that general population also.

However, as soon as "comparative" research between groups of individuals is conducted, be it on the basis of age, education, economic background or any other dimension, a potentially controversial situation is created because knowledge and information about differences between groups may result in discriminatory treatment. Therefore, it is not surprising that groups of individuals feel threatened when they are subjected to comparative investigations. Consequently, pressures will be exerted on researchers regarding the reliability, validity and even motivation and social implications of their work. When the results of comparisons between groups are published in the value-laden terminology of qualitative and quantitative differences and when the causes for the differences are perceived to be unalterable, the pressure on researchers is strong.

The research in sexual variation of cognitive abilities and their determinants appears to be a prime example of the situation just described. The elements for controversy, i.e. comparison of individuals, value-laden results and perceived unalterability of

causes, are easily observed. It is in that context that Harris (1980) came to the conclusion that "the study of sex differences in human cognition is...politicized within and outside the scientific community" (237). The "hemispheric lateralization - cognitive ability" relationship will presently be used as a vehicle for the discussion of socio-political aspects of three concerns.

Biology vs. environment. In the context of the biology vs. environment issue, the literature relevant to sex differences in cognition provides few in-depth discussions. As noted previously, researchers make qualified statements about differences in either hemispheric lateralization or in cognitive abilities. However, the lateralization-ability relationship is frequently ignored, or in other instances, alluded to but not discussed in a thorough manner. For instance, in the conclusion of a widely acclaimed review of lateralization research, McGlone (1980) states:

> The following discussion will attempt to identify and integrate some emerging trends, while avoiding the temptation to relate sex differences in brain organization to sex differences in overall cognitive skill (226).

Another author who has extensively documented sex differences is willing to speculate about the lateralization-ability relationship, but does not pursue:

> One question that is unresolved is whether bilateral or more complete unilateral cerebral representation is associated with superior performance. If...more complete lateralization means greater specialisation...the female superiority in linguistic skills becomes difficult to explain, unless of course cerebral specialization has little implication for performance. Other questions have more immediacy (Hutt, 1979, 82).

The reluctance to discuss the biological predispositions of human behavior may stem from the awareness that many scholars have debated the issue for centuries and that no unswerving conclusions have emerged from the debates. Possibly it is thought that complete understanding of the biology vs. environment problem is beyond the realm of human abilities, therefore, research in sex differences cannot produce viable solutions. Thus, the existing knowledge about correlational relationships between, in this case, lateralization and ability continues to be acceptable as sufficient, but an important consequence is that the search for causal relationships suffers.

However, another possibility is suggested here. If presumably unalterable biological (neurological) determinants for sex differences in cognitive abilities were established, such information would exert tremendous socio-political and philosophical impact. Rather than facing the consequences of these findings, the issue is circumvented. However, such circumvention hampers even the modest research efforts aimed at approximating the solution to the biology vs. environment problem in human behaviour. Stated in simple terms, "not wanting to know" by some, negatively alters the chances of "obtaining the knowledge" for all.

Confounding variables. Researchers in sex differences are acutely aware of the fact that simple explanations for sex differences in cognition are difficult to produce. Interpretations of data which differ from the explanations proposed by the scientist who initiated a specific study are frequently encountered in the literature. For example, a cursory scrutiny of the McGlone (1980) review and its "peer

commentary" resulted in the following list of possible confounding variables suggested as alternatives for the original explanations, which came in terms of differences in hemispheric lateralization: localization, severity and etiology of brain lesions; types of cerebral vascular disorders; quality of callosal transmission; coexisting intra and interhemispheric exchange; cortical-subcortical interaction; somatotype; ovulatory phase; hand preference and familial sinistrality; attention and information processing strategies; overall cognitive skills; motivation; age; education; memory load and duration; task familiarity (practice) and duration; positive and negative response bias. As Annett (1980) remarked "the number of possible patterns is enormous" (227), and in view of that fact it appears to be surprising that meaningful results have been obtained at all.

The awareness of such an array of confounding variables promotes caution in the interpretation of data. However, a related danger is that if interpretation of results in terms of sex differences is resisted for political reasons, it may be attempted to explain data in terms of an irrelevant variable. Since research in sex differences suffers seriously from methodological difficulties and since so many confounding variables have been suggested already, it is difficult to refute the validity of another, possibly obscure variable that, on the basis of non-scientific considerations, has been introduced for explanatory purposes.

Dichotomizing. The literature concerning lateralization and cognition in relation to general population differences does not provide sufficient evidence for an unambiguous conceptualization of a

dichotomy in cognitive functions, i.e. of a "linguistic LH and a visuo-spatial RH." In addition to the foregoing, the reader of the literature about sex differences in lateralization and cognition is reminded of the hazards involved in the dichotomy emerging from research, in terms of "the linguistic female and the visuo-spatial male." The latter concern is expressed not only because insufficient evidence exists for the support of such a dichotomy. Rather, it is also thought that, being based on supposedly unalterable biological determinants, the dichotomy leads to stereotyping of sex roles, a phenomenon that historically has been detrimental to both sexes, but especially to females. Nash (1979) defines stereotypes as "abstractions, simplifying what otherwise might have overwhelming diverse meaning" (271) and describes sex role stereotypes as "tenaciously held, well defined concepts that prescribe how each sex ought to perform" (271). Burstein et al (1980) point quite clearly to the biological causes of sex role stereotyping and its ultimate socio-political consequences:

> In our culture, for example, the biological pull of genetic sex is frequently polarized from birth onward into assigned sex roles for women and men which inhibit the development of full human potential. Stereotypes about the ways in which men and women think and solve problems are pervasive. Conclusions from stereotypes affect opportunities for men as well as women to reach a variety of educational, occupational and social goals (289).

Valid as such considerations may be, the danger exists that a preoccupation with the "consequences" of sex role stereotyping may bias the direction of research, thus hampering the chances of obtaining "neutral" knowledge about sex differences in cognition.

The dichotomizing aspects of sex role stereotyping brought forward here in relation to its influences on research, will be discussed again during the presentation in this chapter of environmental explanations of sex differences in cognition. Dichotomy as a concept related to sex differences in consciousness will be dealt with in the last chapter.

It is emphasized that the foregoing discussion is not an indictment of the research concerning sex differences and their determinants. Rather, it is argued that a socio-political variable has the potential to inhibit and retard scientific investigation. Such a variable affects other areas of scientific endeavour also, however, the many personal and social sensitivities in contemporary female-male relationships may have a greater impact on the study of sex differences than is realized. The precarious nature of the situation is noted by two experts who write about sex differences. Both researchers emphasize the non-scientific influences on research, but they also appear to express a resistance to (if not resentment of) the endeavours by others. Block (1976) thinks that:

> The study of sex differences is...a difficult, complicated, arbitrary and inevitable premature undertaking...Intellectual values, preferences and biases, therefore, direct inquiry and influence conclusions more than a little (284).

Block's (1976) sentiments are amplified by Kinsbourne (1980) who appears to be antipathetic:

> Under pressure from the gathering momentum of feminism, and perhaps its backlash to it, many investigators seem determined to discover that men and women "really" are different. It seems that if sex differences (e.g. in lateralization) do not exist, then they have to be invented (242).

In this section the socio-political influences on research in sex differences of cognition have been discussed; a short review of differences in verbal and spatial abilities between females and males will occupy the following section in this chapter.

Sex Differences in Verbal and Spatial Abilities

Linguistic Skills

While acknowledging the existence of some contradictory information in the summary of their encyclopaedic review, Maccoby and Jacklin (1974) consider it "fairly" well established that females demonstrate greater abilities than males in linguistic skills, especially after the age of 11 years. Similar conclusions have been derived by Hutt (1979) and Burstein et al (1980) in their more recent reviews. According to Maccoby and Jacklin (1974) the results obtained from over 120 studies indicate female advantages in the frequency of vocalizations by infants, talking among toddlers, and in articulation, general language competency and comprehension by preschoolers. Girls of school age score higher than boys on measures of general language ability; reading readiness, speed, ability and comprehension; linguistic categorization; word association and anagram tasks; vocabulary, and complexity in word definition. Female adults obtain better results than males on tests of verbal achievement, reading comprehension, vocabulary, and on the English language section of the American College Test and the linguistic scale of the American College Entrance Examination.

Although the Maccoby and Jacklin (1974) review has been based extensively on studies with pre-adults, their conclusions have been accepted as representative of females and males.

Their findings have been supported by additional studies with adults, of which a sample follows. (All female performances are in comparison to male performance).

Female adults (Bromley, 1958) and college students (Milburn, Bell & Koeske, 1970) made less errors in serial learning. A longitudinal study conducted in the 1950's and 1960's with twins of both sexes produced consistently higher female performances on vocabulary and verbal similarities tests (reported in Burstein et al, 1980).

More recently, Kail and Siegel (1977) presented letters in a matrix format to college students. Females remembered the names of the letters better in the recall task, a finding also obtained by Chairman (1980) under similar conditions. Royer (1978) reported that females perform better in digit symbol substitution tasks, a result that was previously obtained by Estes' (1974) studies and at that time attributed to greater ability by females in verbal encoding. In a study with epileptics as subjects (Kupke, Lewis & Rennick, 1979) females performed better on digit symbol, spelling and writing tests. Variables related to etiology and severity of impairment, neuropathology, I.Q., age, medication, etc. were stringently controlled in this experiment. Piazza (1980) obtained better performances by females on a dichotic listening task involving the recognition of syllables and a tachistoscopic task involving the recognition of words. Females

demonstrated greater ability to recall high and low imagery words as reported by Haynes and Moore (1981).

Finally, investigators of elderly persons' abilities reported female advantages in the following tasks: serial learning of nonsense syllables (Bromley, 1958); recall of nonsense and meaningful words (Ganung, 1971; Gordon & Clark, 1974); serial rote learning (Wilkie & Eisdrofer, 1977); and, verbal ability and word fluency (Cohen, Schaie & Gribbin, 1977; Schaie & Strother, 1968).

Some results with adults have been inconsistent or contradictory. For instance Kail and Siegel (1968) found females and males to be equally able in the recall of digits presented in a matrix, and Searleman (1980) obtained similar performances by the sexes in a consonant-vowel dichotic listening task. Males demonstrated a better verbal memory span than females (Grossi, 1980); female and male lefthanders performed better than their righthanded colleagues, but female and male righthanders obtained similar scores in a vocabulary test (Johnson & Harley, 1981).

In summary, it has been demonstrated consistently that both the expressive and comprehensive linguistic skills of females are superior to those of males.

Visuo-spatial skills

In summarizing the results of more than 75 studies, Maccoby and Jacklin (1974) state that "male superiority on visuo-spatial tasks is fairly consistently found in adolescents and adulthood, but not in childhood" (351). Harris (1978) concurs and reinforces: "the male's

superior spatial ability is not in dispute" (406). Hutt (1979) is in agreement with the foregoing, but Burstein et al (1980) find some bases for dissent in the ability of females to use verbal abilities in visuo-spatial tasks.

Research conclusions favouring males include: tests of pattern reproduction; block and cube designs; two and three dimensional visual spatializations; spatial aptitudes and orientation; performances on mazes; field (in) dependence and embedded figures tests; and tasks involving vertical and horizontal body adjustments.

Since the Maccoby and Jacklin (1974) review, a wide variety of studies have supported their general conclusions. A sample selected from relevant studies follows. (All male performances are in comparison to performances by females.)

Males performed better on mental rotating tests involving two dimensional representations of three dimensional objects (Wilson, DeFries, McLearn, Vanden Berg, Johnson & Rashad, 1975; Yen, 1975). Jahoda (1980), who obtained similar results with adolescents from Ghana and Scotland, equated for education and family background, thinks that the results throw "doubt on purely environmental interpretations" (431). Males also perform better on various maze tasks (Spuhler, 1976; Wilson et al, 1975). Factor analyses of cognitive test scores have revealed strong spatial loadings for adult males, but not for females (Carter, 1976; Wurmack, 1980). Kail and Siegel (1977, 1978) found males more capable of remembering the position of letters and digits presented in the form of a matrix. Sex differences, favouring males, in the perception and cognition of "horizontality" have been reported

consistently (Kelly & Kelly, 1977; Munsinger, 1974; Walker & Krashnoff, 1978). The study by Kupke et al (1979) with epileptics (referred to in the section on verbal abilities also) produced data demonstrating greater male abilities in the picture completion and block design subtests of the W.A.I.S. The results reflected the "usual sex differences found in normals" (1130) according to the authors. Bart, Baxter and Frey (1980) hypothesized that spatial abilities related to formal reasoning abilities, thus favouring males. The hypothesis was not substantiated, but the researchers did find males to be more accurate in the judging of pendulum oscillation, of conservation of motion, and of equilibrium in balance.

The foregoing studies were all conducted with adults as subjects. Studies with children showed 14 week old male infants fixate more on visual than auditory stimuli, while the opposite occured with females (Watson, Hayes, Dormann & Vietze, 1980). Male elementary school children recalled the positions of letters and digits in a matrix better (Kail & Siegel, 1977, 1978) and had a better visual memory span (Grossi, 1979) than their female counterparts.

Obviously, the conclusions by Maccoby and Jacklin (1974), that females are linguistically more capable than males and that males perform better on visuo-spatial tasks than females, have found continuous support in subsequent research. Since these sex differences in cognition have been well established, investigations have become more frequently involved with their possible determinants. Related research has been directed towards biological and environmental explanations and will be reviewed in the following section.

Biological Explanations

Introduction

Prior to a review of the research in biological and environmental aspects of sex differences in cognition, a short account of the biological sex differentiation process will be presented.

A newly formed human zygote has 46 chromosomes arranged in 23 pairs. One pair, the sex chromosones, may be similar (XX), or dissimilar (XY) in the structure of its individual chromosomes. During the first six weeks after conception no sex differentiation takes place; both XX and XY individuals produce primitive gonads (sex glands). Subsequent sexual differentiation into "maleness" will only take place in the presence of a Y chromosome. In all other cases the embryo will develop into a female, i.o.w. "femaleness" is determined by the absence of the Y chromosome.

After the initial six weeks, the primitive gonads develop into testes under the influence of the Y chromosome. If this fails to occur, ovaries will develop instead, approximately a week later. Immediately after their development, ovaries and testes secrete sex hormones. In males the sex hormones are collectively termed "androgens," while in females a distinction is made between "estrogens" and "progestins." The sex hormones are involved in the prenatal organization of, in sequence, the internal reproductive tracts, the external genitalia, and brain differentiation. The latter does not take place until blood vessels are formed and vascular transportation is adequate. The sex hormones also play an important role in the post-

natal development of secondary sex characteristics, often referred to as "feminization" and "masculinization," and the production of ova and sperm.

The stages of male differentiation precede those of females with increased disparity over time. As a result the process is completed at sixteen weeks for males and at twenty weeks for females. In spite of the faster prenatal sexual differentiation of males, they are considerably slower in other facets of development when compared to females.

The biological aspects of sex differences in cognition are usually categorized in terms of genes, hormones and brain organization. The relationship between brain and cognitive functions are much easier to establish than the connections between genes or hormones and cognition. Therefore, research in brain hemispheric differences has been greatly facilitated and has produced more information than the other categories.

Clear and consistent categorization of environmental aspects of sex differences in cognition are seldom encountered in the literature, although the interrelated terms "socialization," "modelling" and "sex role stereotyping" occur most freqeuently.

A review of biological and environmental explanations for sex differences in cognition follows.

Genes

Problems with the definition of subject matter and with research methodology are causes for controversy when investigations into the heritability of cognitive abilities take place. Nevertheless, it has

been recognized through family studies of twins and "regular" siblings raised in the same and/or in differing environments, that a strong genetic component influences the expression of cognitive abilities on I.Q. tests. There has been a concentration on research in genetic factors related to spatial abilities, rather than verbal abilities, since the former are less affected by environmental variables (Harris, 1978; Vanden Berg, 1960; Vanden Berg & Kuse, 1979). The most frequently proposed model for genetic inheritance of spatial ability is the sex linked recessive mode of transmission (Boles, 1980; Harris, 1978; Stafford, 1961; Vanden Berg, 1968). A simplified clarification of the model follows.

The term "sex linked" refers to genes borne on sex chromosomes. In terms of their expressive ability individual genes are of a "dominant" or "recessive" form, with the dominant form suppressing the expression of its recessive counterpart. Recessive forms of a gene can only be expressed if a) it is located on both members of a pair of chromosomes or b) if one of the members of a pair of chromosomes carries the recessive form, while the other does not carry it in any form. The sex linked recessive trait model of spatial ability assumes that a) the recessive form of a gene is responsible for the enhancement of the trait, which may be produced by a variety of gene combinations and b) the gene is borne on the X chromosome.

Since the constitution of their sex chromosomes is XX, females can express the recessive trait only if it is present on both X chromosomes. By comparison, the male chromosome constitution is XY and therefore the recessive trait can be expressed in any member of the sex

since, in the absence of another X chromosome, no other form of the gene is present. A consequence of these conditions is that when a female carries the recessive form of the gene on both X chromosomes, all her sons will express the trait. However, since a daughter's second X chromosome is contributed by the father, and may or may not carry the recessive form of the gene, the daughter's probability of expressing the ability are smaller than those of the son. Therefore, the model predicts higher mother-son than mother-daughter correlations in spatial abilities. Some correlation between mother and daughter is to be expected as a result of expression, as well as non-expression of the trait in both. However, an X linked trait can never be transmitted from father to son, since the father contributes only a Y chromosome in the determination of the sex of the son. In contrast to that for mother-daughter, the father-son correlation should therefore be zero.

When viewing the foregoing as "participation" of the X chromosome with its recessive form of a gene (X_s) in child-parent pairings, the following possibilities arise:

a) son (X_sY) and mother (X_sX), with two of three X chromosomes shared;

b) daughter (X_sX) and father (X_sY), also with two of three X chromosomes shared;

c) daughter (X_sX_a) and mother (X_sX_b), with two of four X chromosomes shared;

d) son (X_sY_a) and father (X_cY_a) with no X chromosomes shared.

The correlations for family members in case of complete and "pure" (i.e. non environmentally contaminated) expression of sex linked recessive traits are expected to follow the following pattern:

Mother - son = father - daughter > mother - daughter > father - son = 0 (Boles, 1980; Harris, 1978).

It is mainly through the investigation of patterns of family correlations that the sex linked recessive gene model for spatial ability is either supported or refuted.

Normal populations. Support for the model is provided by Harris (1978) on the basis of studies by Stafford (1961), Corah (1965), Hartlage (1970) and Bock and Kolakowski (1973) which produced the predicted pattern of family correlations to a greater or lesser degree. Vanden Berg and Kuse (1979) refer to research data reported by Goodenough, Gandini, Pizzamiglio and Witkin (1977) and Yen (1975) which also lend credibility to the model.

However, information from an equal number of studies contradicts the previously noted results. DeFries, Mi, Rashad and Vanden Berg (1976), Carter Saltzman (1977), Fralley, Eliot and Dayton (1978), Loehlin, Sharan and Jacoby (1978), McGee (1978) and Park, Johnson, Rashad and Wilson (1978) all failed to obtain the unique pattern in family correlations.

The discrepancies in outcomes are discussed by Vanden Berg and Kuse (1979) and Burstein et al (1980). They name as main "culprits" differences in sample size, variation in the methods of statistical analysis, and diversity of instruments used for measuring spatial ability. Boles (1980) solved the problems related to differences in statistical analysis and sample size through the pooling of the populations of 10 previous studies and through the statistical manipulation of data involving the transformation of correlations to Z scores and

the use of weighted means. As a result he obtained the following correlations corresponding to mean Z scores:

Mother - son pairs: 0.27 (N = 1,476); father - daughter pairs: 0.31 (N = 1,505); mother - daughter pairs: 0.31 (N = 1,535); and father - son pairs: 0.25 (N = 1,456). It will be noted that the overall pattern of correlations is not in accordance with that predicted by the sex linked recessive gene model. However, Boles, (1980) remarks that "overall analyses such as these do not take into account the possibility that some tests of spatial ability are better than others" (632).

It is noted here also, that the age of the offspring in the studies used by Boles for analysis, varied from six years to adolescence. Maccoby and Jacklin (1974) stated that sex differences in spatial ability are not found consistently until adolescence and Vanden Berg and Kuse (1979) maintain that "the trait shows a developmental pattern" (91). Thus, the pooling of samples of populations involving non-adults may in itself invalidate Boles' (1980) in-depth analysis.

Clinical populations. Research of genetic abnormalities also contributes to the knowledge of sex differences in spatial ability. Specifically, persons suffering from Turner's syndrome have been investigated. Such individuals are phenotypically females but most frequently they lack one sex chromosome (XO), although in some instances they display a mosaic sex chromosome pattern (e.g. XX, XO). If spatial ability is a trait related to a sex linked recessive gene, the XO individuals can be expected to demonstrate spatial abilities similar to those of normal males who also have only one X chromosome.

However, findings indicate that such individuals not only perform worse than normal males on tests measuring spatial ability, but also worse than normal females (Buckley, 1971; Garron, Molander, Cronholm & Lindsten 1973; Garron & Vander Stoep, 1969; Mascia, Money, Ehrhardt & Lewis, 1969; Money, 1963; Money & Granoff, 1965).

In the case of Klinefelter's syndrome a male is diagnosed as having an extra X chromosome (XXY). Frequently, hypogonadism and poor virilization are symptoms of the syndrome. Testing of patients' cognitive abilities has produced normal and superior results (Money, Lewis, Ehrhardt & Drash, 1967), but subnormal I.Q. scores have been reported in a majority of cases (Nielsen, 1969; Raboch & Sipova, 1961). Although Money (1964) did not obtain significant differences between verbal and performance I.Q. scores, Nielsen (1969) considers a depressed performance I.Q. to be mainly responsible for the majority of scores in the defective range produced by individuals suffering from Klinkefelter's syndrome.

A third syndrome results from the presence of an extra Y chromosome in males (XYY). An initial review of studies by Daly (1969) indicative of subnormal cognitive functioning by XYY males has been criticized by Owen (1972) on the basis that population samples were selected from prisons and other institutions. Noel, Duport, Revil, Dussmyer and Quack (1974) did not obtain subnormal performances by XYY subjects from the general population, but Witkin, Mednick, Schulsinger, Bakkestrom, Christianson, Goodenough, Hirshborn, Lundsteen, Owen, Philip, Rubin and Stocking (1976) reported depressed intellectual functions by such individuals.

In summary, it is clear that no conclusive evidence exists for either support or refutation of genetic inheritance models for sex differences in cognitive functions. The possibility does exist that genetic sex differences may be translated into sex differences in cognition through the effects of sex hormones. A review of related research follows.

Hormones

The chemical substances called "hormones" interact with cells that have matured or differentiated to the extent that they are prepared to receive the hormonal "message." Hormone activity is of consequence only when the target tissue is receptive and responsive.

The focus in this section is on sex hormones produced by ovaries and testes. Of the androgens, testosterone is primarily active in the male differentiating process. That task belongs to estrogens in females, while the other major female sex hormone, progestin, is important mainly in the preparation for pregnancies. A few other phenomena relevant to sex hormones are noteworthy. First, female and male hormones are produced by both, ovaries and testes; the main difference is that ovaries produce more estrogens and testes more androgens. Secondly, a number of sex hormones can transform into one another by means of biochemical processes. Finally, it is known that the simultaneous presence of female and male sex hormones may reciprocally inhibit their biological effect.

The constitution and functions of sex hormones are not yet fully understood. The lack of knowledge leads to methodological problems

when the relationship between hormonal and cognitive functions are investigated.

Normal populations. Data from dozens of studies conducted over several decades caused Broverman, Kleiber and Vogel (1980) to report that differences in stimulative potencies of respectively, estrogens and testosterone are at the basis of feminine superiority in automatization tasks and masculine superiority in perceptual structuring tasks. Automatizers are capable of performing repetitive tasks at a higher speed than would be expected from their general level of ability. Through proficency in practice they learn to automize and in the process they also are less susceptible to mental fatique than non-or weak automatizers. Related tasks are e.g. the speed of naming repeated common objects of color hues, and intrinsically simple, repetitive coding. By contrast, perceptual restructuring tasks "require individuals to inhibit...initial automized responses to obvious stimulus attributes in order that responses may be made to less obvious stimulus attributes" (Broverman et al, 1980, 58). Examples of such skills are involved in the Block Design and Object Assembly subtests of the W.A.I.S.

Petersen (1979) discussed the relationship between somatic measures, cognitive functions and sex hormones.

> If we accept the data that males tend to perform better at spatial tasks and females at verbal ones, a reasonable hormonal hypothesis in view of sex related differences, would be that "male" hormones should produce proficiency at "masculine" cognitive skills...while more "female" hormones should produce the "feminine" cognitive skills..." (205).

However, Petersen's own investigations showed that stereotypically less "masculine" male somatotypes of 16 and 18 years performed better at spatial than verbal and coding tasks, while opposite performances were obtained from subjects with more extreme "masculine" somatic characteristics. By comparison, females in the same age groups who were more "masculine" in physical appearance performed well at spatial tasks, but measures of verbal and coding ability were not meaningfully related to somatotype. Petersen's (1979) conclusion is that "androgynous males and females tend to excel at spatial ability...(while)...individuals who are more sex-stereotypic in appearance tend to be poorer at spatial ability" (204). This conclusion is difficult to reconcile with the Broverman et al (1980) results, unless one assumes that different levels of male hormones are required for optimum spatial ability and somatic masculinization respectively, in the case of males. However, such an assumption would be irrelevant in the case of females.

It is obvious that the few studies with normal populations do not provide sufficient information for the drawing of conclusions about the influence of sex hormones on the cognitive functions of males and females.

Clinical Populations. Clinical populations provide two avenues of investigation of the relationship between hormonal and cognitive functions. Firstly, there is a number of individuals who suffer from genetic anomalies and subsequent endogenous alterations in hormone production. Secondly, offspring of mothers who received hormone treatments during pregnancy have been exposed, exogenously, to these

hormones. Patients in both categories are affected by hormonal imbalances.

The adrenogenital syndrome (AGS), caused by an autosomal recessive gene, belongs in the first category. The resulting over-production of endogenous androgens is reflected in males who display short stature, increased muscle growth and precocious puberty. Females suffering from the syndrome show various degrees of masculinization of the external genitalia, hair growth and voice, and lack of breast development. The condition can be corrected through hormone treatment and surgery.

Reinisch, Gandelman and Spiegel (1979) and Ehrhardt and Meyer-Bahlburg (1981) report that early studies of AGS patients produced data with a high percentage of individuals with significantly elevated levels of cognitive (especially verbal) abilities. Subsequent re-analysis of data did not produce significant differences between verbal and performance I.Q.'s and it was demonstrated that siblings and parents of the subjects also tended to score above the normal range of a full I.Q. scale. In 1974, Baker and Ehrhardt designed a study with AGS children and siblings and parents as control groups. Their findings were: a) I.Q.'s above 110 occurred in 59% of the sample of the AGS children, rather than in the expected 25%; b) no significant differences between AGS children, their siblings or parents were obtained; c) no significant differences between verbal and performance I.Q.'s for either AGS children, their siblings or parents were demonstrated; and d) AGS children did show lower scores than their siblings on the numerical subtests of the SMA; a similar finding had

been reported previously by Lewis, Money and Epstein (1968) and Perlman (1973).

Neither the Baker and Ehrhardt (1974) study, nor one similar to it, by McGuire and Omenn (1975) produced evidence that exposure to greater than normal prenatal levels of androgens affected the general cognitive abilities of males differently than those of females. The hypothesis that exposure to a high level of male hormones would cause females to display a pattern of cognitive abilities more similar to that of normal males than of normal females, has not been supported either (Baker & Ehrhardt, 1974; McGuire, Ryan & Omenn, 1975).

Ehrhardt and Meyer-Bahlburg (1981) argue on the basis of available evidence that levels of androgen do not directly influence general cognitive abilities or the usual patterns of sex differences in cognition. Rather, it is thought that the effect on cognitive abilities by the autosomal recessive gene for AGS, could be independent (pleiotropic) of its effect on hormone levels.

Another syndrome in the category of hormone imbalances is "androgen insensivity," also known as "testicular feminization." Individuals suffering from the syndrome are genetic males whose cell tissue is incapable of incorporating androgens, especially testosterone. Thus, these genetic males are born as hormonal and phenotypic females exhibiting female secondary sex characteristics. Money (1968a, b) and Mascia et al (1969, 1972) reported that such individuals demonstrate significantly better verbal than performance I.Q.'s. Similar results have been obtained by Perlman (1972) with pseudohermaphrodites, i.e. genetic males who are born with incomplete masculinized

external genitalia due to androgen insufficiencies experienced in utero. In contrast to individuals suffering from androgen insensitivity, pseudohermaphrodites do benefit from postnatal hormone treatments. Perlman's (1972) subjects not only scored higher on verbal than performance I.Q. related tasks, but also lower in Block Design and Picture Arrangement subtests on the WAIS and other spatial tasks, when compared with matched normal control subjects. The foregoing studies with genetic males deficient in male sex hormones suggest the existence of a relationship between the condition and depressed visuo-spatial abilities.

Males inflicted with testosterone deficiencies as a result of diets lacking in proteins, also displayed significantly inferior spatial abilities in comparison to matched controls with sufficiently nutritious diets (Dawson, 1967).

Harris (1978) refers to studies of "androgen insensitive" or "androgen deficient" males, while suggesting an explanation for the lack of spatial ability in Turner's syndrome (XO) females discussed previously. He argues that the expression of a sex linked recessive gene for spatial ability may be dependent on a normal environment of gonadal hormones, especially of testosterone which is also secreted in small quantities by the ovaries of females. Surgery on Turner's syndrome patients have revealed inadequately formed and functioning ovaries, which produce neither sex hormones nor ova (Bock, 1970; Gupta, 1975; Hyde & Rosenberg, 1976). Thus, Harris (1978) suggests that:

> it maybe that proficiency in spatial tasks is linked both to the X chromosome and to the presence of testosterone, and that the capacity of normal monozygous recessive females to express the

spatial trait depends on the production of ovarian testosterone above some threshold level (481).

In view of the information presented thus far, Harris' suggestion deserves serious consideration and if possible, investigation at the clinical level.

When pregnancies are endangered because of e.g. toxic conditions, pregnant females are treated with hormones and their offspring are exposed to these exogenous hormones. A number of studies have provided relevant information concerning the effects on the cognitive functions of the sexes.

Ehrhardt and Money (1967) evaluated girls exposed to androgenic synthetic progeston. In addition to masculinized genitalia at birth and stereotypical "masculine" behaviours and interests thereafter, the girls manifested mean I.Q. scores significantly above the norm, with no significant differences between verbal and performance I.Q.

Dalton (1968) reported on 9 and 10-year-old subjects whose mothers were treated for toxemia with naturally occuring progesterone, and on the same youngsters when they had reached adolescence (Dalton, 1976). Offspring from untreated toxemic mothers and from uncomplicated pregnancies were used as control groups. The children who were exposed to progesterone performed superior in school subjects, while the offspring of untreated toxemic mothers performed poorly on school related skills. High dosage and early administration of the hormone treatments correlated positively with the better ratings. The effects continued into adolescence.

Male adolescents whose diabetic mothers had been treated with synthetic estrogens and progestins during pregnancy performed inferior on visuo-spatial tasks when compared to two control groups (Yalom, Green & Fisk, 1973). A critique of the study is that a control group with the same intra-uterine history, but without hormone treatment was not included; the cause of the effects, therefore, cannot be attributed conclusively to the treatment (Ehrhardt, 1979). However, this and foregoing studies involving exogenous hormone exposure appear to establish some kind of relationship between the treatment and performances on tests of cognitive abilities. Whether and how it affects the sexes in different manner is at this time difficult to ascertain.

Finally, Reinisch and Karrow (1977) divided a sample of 71 subjects into groups predominantly exposed to estrogens, progesterone or a combination of both. Results were that:

> Neither the subgroups nor the total sample showed any significant differences in W.A.I.S. I.Q's from untreated sibling controls (Ehrhardt, 1978, 428),

but

> There was also some evidence...that a prediction of higher school achievement in the progestin exposed offspring would not be unreasonable (Reinisch, Gandelman & Vogel, 1979, 228).

The foregoing review convincingly suggests that research in hormonal influences on sex differences in cognition is in its infancy; obviously, conclusive evidence about these influences has not been arrived at yet.

The possibility exists that a) sex hormones have multiple effects, b) sex hormones affect the cognitive abilities of the sexes differently and c) different optimal levels of one or more sex hormones are required for the expression of different cognitive abilities. These possibilities, in combination with the knowledge that a) female and male sex hormones are produced by both sexes and b) under certain circumstances sex hormones reciprocally repress their expressions, allows for a vast array of possible hormonal influences on male and female cognitive functions. The fact that hormones are specialized and difficult to measure, complicates matters even more so.

In spite of the complications, two theories concerning the influence of hormones on sex differences in cognition have been advanced. The first theory hypothesizes that environmental stimuli do not have the same "meanings" for the sexes, because sex hormones influence female and male sensory information and perceptual processes differently. The influences of sex hormones can occur prenatally, perinatally and postnatally and the sensory and perceptual differences would through their close association with cognitive processes, ultimately be the cause of many sex differences in cognition. Most supportive evidence for this theory has been obtained through animal studies, but more recently the human menstrual cycle and its varying levels of sex hormones has been used as a vehicle for relevant studies (Dan, 1979; Reinisch et al, 1979).

The second theory postulates that the maturation process, which is primarily controlled by hormones, creates differences in brain hemispheric development, with sex differences in cognitive functioning

as a consequence (Waber, 1979). This theory will be discussed more extensively in the following review.

Hemispheric lateralization: Introduction

On the basis of non-sex differentiated studies, one could conclude that LH cognitive functions involve verbal tasks, while the RH is engaged mainly in visuo-spatial skills. It has long been recognized that such studies included a preponderance of male subjects, but the implications of sample bias were not fully realized until more controlled studies produced contradictory results. Thus, recent reviews of studies in the lateralizations of cognitive functions are a reflection of a new body of knowledge based on sex differences. The consensus among reviewers is that little support exists for the early view of Buffery and Gray (1972) that the male brain is more symmetrically organized for both linguistic and visuo-spatial functions than is the female brain. The reverse model, i.e. a more asymmetrical male brain, is presently more accepted for visuo-spatial functions (Harris, 1978; McGee, 1979) or for both linguistic and visuo-spatial functions (Bryden, 1979; Hutt, 1979; McGlone, 1980).

McGlone (1980) cites research to support the asymmetry model. For instance, Lansdell and Urbach (1965) compared the ratio of verbal/nonverbal residual skills after left and rightsided temporal lobectomies in females and males. Relevant subtests of the WAIS were used for assessment. Men with leftsided lobectomies showed more impaired verbal than nonverbal skills; the opposite result was produced by rightsided lobectomized males. No significant differences in the

verbal/nonverbal ratio were obtained from either left or rightsided lobectomized female groups. Similar results were reported by McGlone (1978) with adults suffering from strokes or tumors. Leftsided brain injury to males produced significant discrepancies favoring performance I.Q. over verbal I.Q., but opposite findings resulted from rightsided brain lesions. No discrepancies were found for either LH or RH damaged females.

Sex differentiated data were not included in 13 studies conducted in the 1950's and 1960's with subjects suffering from right and left hemispheric lesions. Inglis and Lawson (1981) re-analyzed the studies for sex differences. They found that when significant verbal and nonverbal deficits had been reported in groups with left and right brain damage respectively, the studies contained significantly more male than female subjects. Conversely, studies with equivocal or negative outcomes ~~in~~ terms of the relationship between impaired cognitive functions and side of brain damage, had a much larger proportion of female patients. The researchers concluded that the females who did not show strong lateralized effects tended to mask the trends found in males.

The foregoing findings provide support for greater male than female hemispheric specialization, but in a strictly theoretical sense, they do not clarify which function (i.e. verbal or non-verbal) is more lateralized (asymmetrically present) in the male brain. Therefore, a small number of physiological studies will be presented that have compared the hemispheres of the sexes while they were engaged simultaneously in both linguistic and visuo-spatial activities.

Ray, Morell and Frediani (1976) demonstrated in males a greater LH desynchrony during verbal tasks and greater RH desynchrony during visualization activities. No hemispheric differences distinguished between types of tasks in females. Butler (1980) refers to studies by Carter (1976) and McGratton (1979) which obtained decreasing alpha rhythm over the RH when subjects switched from mental arithmetic to a face recognition task; the occurrence of such a switch was greater in males than females. Studies by Beaumont, Mayes and Rugg (1978) and Wogan, Kaplan, Moore and Epro (1979) have also demonstrated greater male than female hemispheric asymmetry of verbal and visuo-spatial functions, although Robert and Mahoney (1978) and Moore and Haynes (1980a) obtained opposite results in their investigations. The Robert and Mahoney (1978) study has been criticized on the basis of possible verbal mediation during the visuo-spatial tasks and Moore and Haynes (1980) suggested that the active/passive nature of the tasks and discrete/continuous nature of stimuli affect the asymmetrical hemispheric functioning of females and males.

Finally, studies have been conducted of neural and vascular asymmetries in the hemispheres of females and males. No firm conclusions have resulted from these investigations, and therefore only suggested hypotheses are related here:

a) female hemispheres may be more symmetrical in shape and more equal in weight than male hemispheres;

b) the planum temporale, believed to be related to speech, is larger in the LH than the RH in the majority of both sexes; however the reverse pattern is more frequently present in females than males;

c) the sexes may differ in interhemispheric connections;

d) the drainage pattern of blood from each hemisphere may differ for the sexes;

e) the incidence of cerebrovascular disease may differ between the sexes in side and vessel site.

The electrophysiological studies were conducted with normal subjects who performed linguistic and visuo-spatial tasks, simultaneously. The information suggests that the male brain asymmetry involves more RH than LH activity during visuo-spatial tasks, and vice versa, more LH than RH activity during linguistic tasks. Also, both kinds of tasks engage the hemispheres of females more evenly than is true for males.

In addition to the limited number of studies that focused on sex differences in lateral activities during simultaneous, linguistic and visuo-spatial tasks, many more have investigated sex differences in lateral activities during either linguistic or visuo-spatial tasks. These investigations are reviewed in the following sections.

Hemispheric Lateralizaton: Linguistic Skills

Normal Populations. In a number of dichotic listening studies consonant-vowel (CV) syllables have been used for testing sex differences in lateralization of linguistic skills. Compared to the left ear, significant right ear advantages (REA) have been demonstrated by males in CV tests, indicating that the LH is more involved in such tasks. Although females also showed REA, these were not significantly different from left ear performances (Gordon, 1980; Lake & Bryden, 1976; Piazza, 1980). Harshman, Remington and Krashen (1975) combined

and reanalyzed the findings of three studies which had not produced significant sex differences (own unpublished data; Ryan & McNeil, 1974; Van Lancher & Fromkin, 1973). The combined results produced significant greater REA in males than in females. Other studies with CV syllables have either not produced significantly sex differences in hemipsheric functions (Bryden, 1975) or manifested results opposite to the foregoing, i.e. greater REA in females than in males (Dorman & Porter, 1975).

Two studies with numerical material (single digits, number pairs or lists of numbers) also demonstrated significantly greater REA in males, but not in females (Bryden, 1966; Gordon, 1980 a). However, other data obtained with similar material were not indicative of significant ear advantages in either sex (Bryden, 1975; McKeever & Van Deventer, 1977b) and one study showed a not-significantly greater REA in females than in males.

McGlone and Davidson (1973), Thistle (1975) and Briggs and Nebes (1976) did not obtain significant sex differences in ear advantages with pairs of words, although in these three studies the differences that were demonstrated were in the hypothesized direction of greater male than female REA.

Bryden (1979) expresses concerns about dichotic listening methods. It is felt that the manner of presentation of material and of instructions may cause subjects to attend to one ear primarily and produce results unrelated to cerebral asymmetry. In spite of the objections, Bryden (1979) concludes that the majority of studies indicate that males manifest a more frequent and larger REA than

females. On that basis, it is justified to claim that dichotic listening tasks show males' LH to be more involved in linguistic skills than their RH, but that this is not the case for females whose LH and RH are more equal participants. This indicates that linguistic functions are more symmetrically lateralized in the female than in the male brain.

Tachistoscopic studies with a variety of linguistic material such as letters, digits and words have demonstrated right visual field advantages (RVFA) in males to be significantly greater than in females (Hannay & Malone, 1976a; Kail & Siegel, 1978; Levy & Reid, 1976; Marshall & Holmes, 1974). Sex differences in RVFA were not obtained by Hannay and Boyer (1978), Leehey, Diamond and Cahn (1978) and Piazza (1980), while a study by Bryden (1965) produced data that indicated a larger RVFA in females than in males.

Because of their more intricate experimental variables, two studies will be presented in some detail. Firstly, Bradshaw and Gates (1978) investigated the, generally accepted, RVF supriority in linguistic skills as a function of a) frequency and concreteness/ imageability of words, b) nonwords (i.e. letter strings), c) type of task (i.e. over naming vs. lexical decision by means of a manual response, d) familiarity with material and e) sex. The researchers summarize their results as follows:

RVFA (i.e. LH) superiority with verbal material was demonstrated a) by males in comparison with females and b) by all subjects for overt naming tasks in comparison to lexical decision tasks. When females were required to engage in lexical decision tasks a LVFA (i.e. RH) was

frequently apparent especially with unfamiliar material. Frequency and concreteness/imageability of material did not relate to visual advantages for either field or sex.

On the basis of this and three other studies (Bradshaw, Bradley & Patterson, 1976; Bradshaw, Gates & Patterson, 1977b; Bryden & Allard, 1976) the researchers concluded that a RH mechanism is in existence associated with lexical decisions and level of difficulty of verbal material. This mechanism is more strongly developed in females, invading the RH space normally reserved for visuo-spatial processing.

The second study was conducted by Graves, Landis and Goodglass (1981), who requested their male and female subjects to recognize emotional and non-emotional words from two separate lists. The data were analyzed for each sex on the basis of emotionality and imageability of materials with the following results:

a) males showed a RVFA for recognition of all words, while females did not show any visual field advantage.

b) the LVF of males recognized emotional words more accurately than non-emotional words; females showed a similar pattern of recognition in the RVF.

c) there were no "imageability of word" effects for males in either visual field; however, females demonstrated a positive correlation between the imageability effect and the visual field advantage in recognition of all words. In other words, females with LVFA for recognition of all words, also showed a LVF imageability effect, and vice versa RVFA for all words correlated with a RVF imageability effect.

The researchers find support for the hypothesis that the male LH is more essential for lingustic skills than the RH, but that verbal material is more evenly processed by female left and right hemispheres. They find the emotionality and imageabilty effects in females

difficult to interpret and suggest that further study is required.

Studies of electrophysiological brain activity during linguistic tasks provide an inconsistent picture. Davidson, Schwartz, Pugash and Bromfield (1976), Moore and Haynes (1980a, b) and Haynes and Moore (1981) registered greater LH than RH activity in females, but greater RH than LH activity in males during the processing of verbal material. Opposite results have also been supported, i.e. more female RH and male LH activity, during similar tasks. (Hannay & Malone, 1976a, b; Lake & Bryden, 1976). In general, researchers find the latter findings more supportive than the former of results obtained through dichotic listening and tachistoscopic viewing tasks, since they emphasize male LH linguistic activities and allow for female RH language involvements. Other researchers have found both the female and male LH most involved in verbal tasks (Molfese, 1978; Moore, 1979).

Haynes and Moore (1981) associate the differences in outcomes of electrophysiological studies with the nature of material and task. More specifically, it is thought that differences in imageability of stimulus material interact differently with either a recall or a recognition task and thus may bring about varying emphases in brain hemispheric activity in the sexes. Haynes and Moore (1981) do not come to any conclusion in this respect, but one can speculate indeed, that e.g. the recognition of highly imageable concrete words requires a different, possibly less "linguistic," hemispheric process than the recall of abstract words of low imageability. A task-material - sex interaction may also have been a factor in the difficult to interpret differences in imageabilty effects in the tachistoscopic studies by

Bradshaw and Gates (1978) and Graves, Landis and Goodglass (1981).

With the exception of data resulting from electrophysiological research, the majority of studies support the hypothesis that, linguistic skills prevail in the LH of males, but are more evenly present in the LH and RH of females.

Clinical populations. It has been reported that, in opposite to normal speaking men, a large proportion of male stutterers appear to process language in the RH (Moore & Haynes, 1980b; Moore & Lange, 1977; Sommers, Brady & Moore, 1975).

Aphasia as a result of acute LH stroke affects males more frequently (Brust, Shafer, Richler & Bruun, 1976) and more severely (Sasanuma, 1975); more male aphasics can be found in speech therapy programs (Messerli, Tissot & Rodriguez, 1976) and residual speech disorders are worse in males than in females (Edwards, Ellanus & Thompson, 1976; McGlone, 1977). The data resulting from studies with stutterers and aphasics suggest that for language skills, in males the LH is more important than the RH, and also more important than the LH in females.

Findings with various other language measures reported by Lansdell (1961, 1968a) also suggest greater LH control of verbal functions in males than in females. In men, proverb interpretation was disturbed by left temporal lobe lesions and the severity of such injuries correlated negatively with verbal I.Q. scores. Female performance did not appear to be significantly interfered with. However, in two other studies Lansdell (1968b, c) did not find significant sex by laterality interactions on a multiple choice

vocabulary and on the verbal subtest of the DAT. McGlone (1980) speculates that the discrepancies in results between the two sets of Lansdell studies may be related to the mode of responding required by the tasks. Expressive language modes (speech) were positively related to increased sex by side-of-lesion interaction, but covert linguistic responses were not.

McGlone (1977) reports results of an exclusive study of sex differences in lateralization for language functions with adults suffering from unilateral brain lesions as subjects. Controls were applied on the basis of age, education, etiology, length of illness, locus and severity of lesion, familial sinistrality and general intellectual deterioration. The most relevant findings were: a) aphasis after LH lesions occurred three times more frequently in males than in females; b) with aphasics removed from the sample, LH damaged males continued to show decreased verbal intelligence and memory loss when compared to RH damaged males; c) no significant differences between LH and RH damaged females were found through verbal indicators; d) both LH and RH damaged females scored significantly lower on verbal I.Q. than non-brain damaged controls, and e) RH damaged females showed impaired verbal I.Q., scores, but no aphasic disorders per se. A replication study by McGlone (1980) has yielded similar results. These findings are considered important because they are consistent with information obtained with normal populations.

The McGlone (1977) study has been criticized for inadequate control of variables such as age, education, severity and etiology of lesion and time of recovery since damage. Alternate interpretations

for her findings have also been provided. For instance, it has been conjectured that persons with high verbal skills prior to injury recover better than those with less skills. Thus, females possessing better initial language skills demonstrate greater recovery than males after injury. It is difficult to interpret the relative lack of significant language impairment in females with RH damage.

The burden of evidence from studies with clinical populations is supportive of greater lateralization of language functions in the LH of males, but a more even distribution of the functions over both hemispheres in females.

Hemispheric Lateralization: Visuo-spatial Skills

Normal Populations. A considerable number of tachistoscopic studies with normal populations produce data supportive of the hypothesis of greater male than female RH lateralization for spatial abilities. For instance, greater male than female LVF advantages have been obtained for dot detection, localization and enumeration (Davidoff, 1977; Kimura, 1969), the perception of faces (Rizzolatti & Buchtel, 1977; Umilta et al, 1976) line orientation (Sasanuma & Kobayashi, 1978; Walter, Bryden & Allard, 1976) and the matching of physical characteristics of letters (Segalowitz & Stewart, 1979). Bahan and Putnam (1974) reported that female brains function less asymmetrical than male brains in right-left discrimination tasks and McGee (1976) reported the female LH to be of relative greater importance than the male LH for spatial functions.

An extensive study by McGlone and Davidson (1973) showed that males and females with demonstrated RH language abilities perform poorly on a Block Design subject (WAIS) and females with the highest RH language scores perform worst of all tested groups on a Spatial Relations subtest (PMA). Subsequent testing, during which the handedness effect was controlled, indicated that the co-existence of language and spatial abilities in the RH was related to the poor performance on visuo-spatial tasks.

A study by Martin (1978) is presented here as an illustration of the many complexities involved in the results of tests for sex differences in lateralization of spatial abilities. Subjects were required to make "yes-no" decisions when comparing the similarities of curved letter segments. Interhemispheric differences obtained were: a) females responded faster in the RH than the LH for positive decisions; b) males showed the opposite pattern; c) there were no sex differences for negative decisions. Intrahemispheric differences were as follows: a) the females LH responded faster with negative than positive decisions; b) the female RH responded faster with positive than negative decisions; c) male LH responded faster with positive than negative decisions. Although sex differences in responses are obvious, the inter- and intrahemispheric differences in relation to the nature of the required response are difficult to interpret and the researchers are not successful in their attempts at clarification.

Finally, some tachistoscopic studies did not produce sex differences for lateralization of spatial abilities. These studies involved dot localization (Bryden, 1976), letter localization in a

matrix (Kail & Siegel, 1978), the perception of faces (Durnford, 1970) and colour discrimination (Fromm, 1977; Pennall 1977).

A recent study of Ray, Newcombe, Seman & Cole (1981) compared males and females with high and low spatial abilities on measures of electrophysiological hemispheric activity. Males with high ability demonstrated more RH than LH activity, but men with low ability reversed that pattern. For females no differences in activity levels were apparent.

In summary, the evidence from tachistoscopic studies provides support for the hypothesis that spatial skills are more asymmetrically present in the male than in the female brain. The RH of males is more involved in visuo-spatial tasks than the LH. The results of the few available electrophysiological studies provide similar findings. Therefore, one is inclined to conclude that explanations for sex differences in visuo-spatial skills, on the basis of differences in hemispheric lateralization, are valid.

Clinical Populations. Studies with clinical populations are limited in number and only mildly supportive of the hypothesis that spatial abilities are more unilaterally located in the RH of males than of females.

Patients of Lansdell (1962) were operated on the RH temporal lobe for relief of epileptic symptoms. Testing of spatial abilities took place through the Graves Design Judgement Test, which contains an important spatial component. In comparison to pre-operative performances, the post-operative scores of males had dropped, but those of females had risen. These statistically significant results were

limited to the immediate post-operative period. During other studies by Lansdell (1968a, b), males with RH lobectomies performed worse than any other lobectomized group on the performance subtests of the WAIS; a significant correlation existed also between the extent of RH tissue removed and the performance scores of males, but not of females.

McGlone (1980) suggests that "constructional exercise" as compared to "perceptual discrimination" components of visuo-spatial tasks provide better support for the hypothesis of greater male than female RH involvement. She refers to the previously mentioned Lansdell (1968a) and McGlone (1977) studies for significant evidence and to the McGlone and Kertesz (1973) research for support of her suggestion. However, Mach and Levine (1978) reported no sex differences in the specific visuo-spatial tasks mentioned by McGlone (1980).

Other studies with clinical populations that have not demonstrated sex differences in lateralization of spatial abilities were related to spatial agnosia (Hecaén, 1962), line orientation (Benton et al, 1975) and Raven's Coloured Progressive Matrices (Edwards et al, 1976).

Hemispheric Lateralization: Concluding Remarks

As noted in the introduction of this chapter, interpretations of data which indicate sex differences are significant are frequently couched in highly qualifying terminology and "watered-down" statements. In this respect the tentative state of knowledge of sex differences in the hemispheric lateralization of cognitive functions has been aptly summarized by McGlone (1980), when she concluded that

the data do not

> ...overwhelmingly confirm that male brains show greater functional asymmetry than female brains. However, when sex differences are found, the vast majority are compatible with the hypothesis. Consensual validation from clinical dichotic listening, and tachistoscopic studies in adults further strengthens this proposal...one must not overlook...the conclusion that basic patterns of male and female asymmetry seem to be more similar than they are different (206).

The tentative conclusions about sex differences in hemispheric lateralization of cognitive functions are partially caused by methodological and theoretical issues concerning the measurements of degree and direction of laterality as a continuous phenomenon (Eling, 1981).

A final question remains unanswered. "How do cognitive functions develop and lateralize differently in female and male brains, so that males become more capable in visuo-spatial skills but less capable in linguistic skills than females?" The theory most suited to answer that question is founded on the following presuppositions:

a) specialization for language is a primary process in man; it has precedence over non-linguistic cognitive processes,

b) the LH is either neurologically predisposed for linguistic functions or otherwise favoured to receive laguage through perceptual asymmetry,

c) the RH is more "plastic" than the LH for the incorporation of various cognitive functions,

d) the two hemispheres are in mutually inhibitory competition.

By combining the four presuppositions Hutt (1979) formulates a model:

> ...left hemispheric functions develop first whilst suppressing homologous functions in the right hemisphere and permitting other structures, like those mediating visuo-spatial functions, to differentiate. The longer the period for such differentiation, the superior the functions subserved (80).

Thus, the LH of both sexes is "destined" to be primarily involved with language functions. However, since males mature later than females their RH has more opportuntiies to differentiate structures for secondary functions, such as visuo-spatial skills. The final result in terms of the cognitive functions of mature females and males is determined by the extent of difference in structure in the RH. Males have more time to develop visuo-spatial skills at the cost of language abilities and females' RH linguistic skills will be less interfered with by the time-limited development of visuo-spatial skills.

The previous is, for explanatory purposes, a simplified presentation of the model. The presuppositions have been derived from research by Kinsbourne (1974, 1975), Kinsbourne and Hiscock (1977) and Moscovitch (1977). Waber (1977, 1979) has been able to demonstrate that the longer their period of maturation, the better individuals' spatial abilities were. It has been well established that rate of maturation is directly related to functions in the endocrine system, which therefore might be involved in the sex differentiation of cognitive functions.

The following section will review several environmental explanations of sex differences in cognition.

Environmental Explanations

Introduction

It is useful to discuss the environmental explanations for sex differences in cognition in the context of sex role socialization.

Nash (1979) broadly defines sex role as "any behaviours, traits, attitudes or expectations characteristically thought to differentiate the sexes" (271).

Those who argue that environmental influences are responsible for sex differentiated behaviours, suggest that sex role socialization results from the false assumption that females and males differ in nature. As a consequence of the assumption, sex role socialization occurs through two complementary and reciprocating processes. The first process involves societal expectations about differences in female and male behaviour to which the sexes respond accordingly, and the second process consists of the differential treatment of the sexes at home, in school and by other socializing agents.

In the context of cognitive abilities this means, on the one hand, the suppression or augmentation of specific cognitive functions by each sex in accordance with societal expectations and, on the other hand, the exposure of sex biased educational material to both sexes. More specifically, females are expected to display competency in language oriented tasks, therefore, the teaching of relevant skills is facilitated for girls. By contrast, males are expected to demonstrate visuo-spatial abilities and, therefore, more exposed to visuo-spatial materials. Thus, for each sex one cognitive function is overemphasized at the cost of another.

Supporters of the environmental position point out that the initial faulty assumption about differences in male and female natures leads to sex role stereotyping. The dichotomizing of "human nature" into "male" and "female" on the basis of biological differences (see

introduction of this chapter) ultimately results in a self-fulfilling prophecy of differences between male and female behaviors.

The socialization explanation for sex differences encounters several difficulties. Firstly, although it rejects sweeping generalities about differences in male and female nature, no attempts are made to explain why the sex-cognitive function relationship exists in the specific forms of "female-linguistic" and "male-visuo-spatial" instead of e.g. the opposite pattern. Secondly, in its extreme form the position negates one of the basic tenets of contemporary social science, i.e. that human behavior is a product of organism-environment interactions and not merely the imprinting of the environment on the human "tabula rasa." In the process, it also rejects the increasing scientific evidence that females and males seem to possess "built-in" predispositions for greater proficiencies in different cognitive functions. The exact nature of the predispositions have not yet been isolated, but their presence is more and more recognized.

However, the difficulties inherent in the extreme environmentalists' position have caused the evolution of its presently modified version. For instance, there is now more acceptance of the research indicative of certain biological predispositions and of the interactive aspects of the organism in relation to its environment (Basow, 1980; Lambert, 1978, Wittig & Petersen, 1979).

It is still maintained that the differences in biological predispositions are small and that the socialization process plays the major role in the development of cognitive functions. That position appears valid, especially when considered against the background of

non-cognitive behaviors, which have been demonstrated to become stereotyped as a result of socialization (Basow, 1980; Saltzman-Chafetz, 1974).

In view of the foregoing, it appears that contemporary researchers have not been able to establish a precise role for socialization processes in relation to sex differences in cognitive functions; this was the position held by Maccoby and Jacklin (1974) and it has been reiterated by Burstein et al (1980):

> While the evidence for differential sex role socialization is dramatic and widely accepted, there is little concrete evidence for differential socialization with respect to the development of sex differences in cognitive style (360).

The lack of concrete evidence is partially caused by an absence of longitudinal studies and it appears that methodological and ethical considerations may make such research an impossibility.

A review of investigations into sex role socialization as an explanation for sex differences in cognitive abilities follows.

Linguistic Skills

In spite of the fact that linguistic abilities are thought to be more readily influenced by the environment than are visuo-spatial skills (Boles, 1980; Harris, 1978), there have been fewer investigations into the relationship between sex roles and linguistic performances.

The majority of investigations have concentrated on sex role influences on reading skills; three major areas of influence have been reported.

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The majority of investigations have concentrated on sex role influences on reading skills; three major areas of influence have been reported.

Firstly, it is thought that children's own expectations and interests effect their abilities and performances in specific skills. The hypothesis claims that if youngsters consider reading to be a "feminine" skill, girls will become more proficient at it than boys.

The notion that reading tends to be viewed as a "feminine" rather than "masculine" activity has been supported by Mazurkiewicz (1960) and Stein and Smithell (1969). The former found significantly positive correlations between fathers' and sons' opinions in this respect. Data are also available supporting the belief that the femininity or masculinity of an activity relates to sex differences in achievement. Schickedanz (1973) found eight and nine-year-old boys who considered reading a masculine activity read better than classmates who considered the activity to be of a feminine or neutral nature. Dwyer (1972) reported that a significant amount of variation in reading performance could be contributed to the sex role standards of both boys and girls in grades two through twelve. Dwyer (1974) concluded that boys who read poorly were less motivated to do well "since there are very strong taboos against males participating in any part of the feminine role" (263) and reading was perceived to be such a part.

A contradictory result has been reported by Nicholson (1973) who did not find a relationship between the masculine activities of elementary school boys and their reading abililities.

Cross cultural studies have also investigated the influence of sex role beliefs and expectations on reading ability. In general, such studies conclude that female superiority in reading does not occur in cultures where the activity is considered to be appropriate for males.

For instance, German fourth and sixth grade boys obtained superior reading achievement scores compared to girls (Preston, 1962). English males' reading performance is significantly better than that of their fellow countrywomen (Brimer, 1969) and they demonstrate less reading problems than males in North America (Johnson, 1973-1974). Finally, in the Israeli Kibbutz system, where children perceive their sex roles as being similar, reading readiness and performance among kindergarteners, second and fifth graders were found to be equal for children of both sexes (Gross, 1978).

The sex of the teacher as an environmental influence on the reading proficiency of boys and girls has also been investigated. One reason for investigating the sex of the teacher is that female teachers are supposedly more favourably disposed towards girls than boys, encourage them more and judge their performances with greater leniency. Also, it is speculated that boys do not easily identify with female teachers. As the following illustrates, research results are contradictory.

Arnold (1968), Datta, Shaefer and Davis (1969) and Doyle, Hancock and Kifer (1972) found that in comparison to boys, girls' reading abilities were overrated and that boys obtained lower grades for equivalent reading achievements (McCandles, Roberts & Stornes, 1972). Male and female teachers have been shown to favour pupils of their own sex in the rating of reading performances (Etaugh, Collins & Gerson 1975; Lee & Wolinsky, 1973), however no such findings have been reported by Sikes (1972) and Good, Silkes and Brophy (1973). Finally, Steele (1967), Clapp (1968) and Asher and Gottmann (1973) obtained only

minimal differences when they studied the effects of female and male teachers on the reading achievement of elementary school children.

The difference in treatment that boys and girls receive from teachers is thought to influence reading performance. In general, teachers' expectations about appropriate behavior involve conforming and orderly students who listen and are quiet. It has been well documented that boys are least likely to display these favoured behaviors (Petersen, 1961; Prawat, 1976; Samuels & Turnure, 1974). Therefore, boys will more likely receive negative treatment from teachers, i.e. more scolding, less praise and instructional contacts (Etaugh & Harlow, 1975; Fagot, 1973; Vroegh, 1976) and develop more negative attitudes toward school. By contrast, it has also been reported that teachers are more likely to praise and initiate interactions with boys than girls (Dunkin & Biddle, 1974; Serbin, O'Leary, Kent & Tonick, 1973), while it has also been argued that the negative treatment of boys may have a positive effect, since it usually is directed at their lack of effort and not at personal abilities (Dweck, Davidson, Enna & Nelson, 1978). It has been concluded (Bank, Biddle & Good, 1980) that the differential treatment hypothesis is an inadequate explanation for the poorer reading abilities of boys, since their visuo-spatial skills should be equally adversely affected, which obviously is not the case.

Differences in parental vocalizations during contacts with babies and infants have also been explored as an explanation for subsequent differences in linguistic skills between girls and boys. The contradictions that are encountered in the relevant literature are illustrated by the following quotations. Maccoby and Jacklin (1974)

conclude as a result of their review that

> ...it can only be said that results are highly variable across sample subgroups, and that the bulk of the evidence does not add up to any clear trend for mothers to provide more verbal stimulation to daughters than sons. A number of studies found no sex differences, and those that did are inconsistent in the direction of the difference found (312).

This conclusion is based on 27 studies of mother-child interactions. Sixteen of these studies reported no differences in verbal contacts between mothers and their sons or daughters. In nine studies mothers interacted more with girls than boys and in two studies the opposite occurred.

However, Basow (1980) who uses Maccoby and Jacklin (1974) as one of her sources maintains that:

> ...females are more frequently vocalized to, especially by mothers. More frequent parental vocalization to daughters may lead to increased vocalization on the part of female infants (48).

Possibly, Basow considered the nine studies reported by Maccoby and Jacklin showing greater mother-daughter interactions, to be sufficient evidence for her conclusions. However, it should be noted that she does not present more recent data for support, possibly because few are available. At least, for the purpose of this review only the following, not very recent, additional studies could be found.

Moss (1974) reported that mothers tended to elicit more vocalizations from infant daughters than from sons and they responded more frequently to their daughters' vocalizations also. Data obtained by Golden and Birns (1975) indicated that highly educated mothers were more verbally explicit with their sons than with their daughters.

Finally, as as result of a rather limited and even superficial literature review, Wesley (1977) states that mothers reinforce their daughters verbal behaviour more than that of their sons.

In summary, it is correct to state that in view of the many comprehensive and expressive linguistic skills that are discernable, only a few have been investigated in depth. In relation to environmental factors it has only been demonstrated that the masculine or feminine nature (as perceived by students) of reading activities influences the performances of boys and girls. That finding is supportive of the hypothesis that sex role socialization plays a role in learning linguistic skills. Finally, it should be realized that the research "tends to be correlational in nature, making it impossible to deduce causal relationship" (Nash, 1979, 279).

Visuo-Spatial Skills

Mathematical, scientific and visuo-spatial abilities have been perceived to be "masculine" by children of kindergarten age, by second graders and by adolescents (Connor & Serbin, 1977; Hill, Hobbs & Verble, 1974; Nash, 1979). Females with strong visuo-spatial abilities have indentified with their fathers (Bieri, 1960) scored high on "masculinity" scales (Vaught, 1965) and have expressed preference for being a boy (Nash, 1975). By contrast, no relationship between measures of sex role and visuo-spatial abilities have been reported when sex differences were expected (Arbuthnot, 1975; Hyde, Gieringer & Yen, 1975: Silverman, Buchsbaum & Stierlin, 1973).

Cross cultural research has been used to exemplify the effect of sex role socializaton on visuo-spatial skills. For example, a variety of visuo-spatial tasks has been used to demonstrate consistently superior male performances with subjects from England (Bennett, 1956), the United States (Witkin, 1962), Hong Kong (Goodnow, 1962), Central Australia and South Africa (Porteus, 1965), Sierra Leone (Berry, 1966), Kenya (Munroe and Munroe, 1970) and urban India (Sinha, 1980). However, some other investigations using similar materials have not produced data indicative of sex differences in visuo-spatial skills among Eskimos (Berry, 1966; MacArthur, 1967) and subjects from rural India (Sinha, 1980). In the related cultures the sexes have more equal opportunity to experience the physical environment. Specifically, female subjects in these studies were less bound by activities involving the home only, and travelled more than their female counterparts in the studies of "westernized" or otherwise traditionally male dominated cultures. It is argued that the lack of "masculine" and "feminine" sex roles can explain the lack of differences in visuo-spatial skills. The counter argument is that the few studies with contradictory data are exceptions to the rule (Berry & Annis, 1974; Harris, 1978).

Researchers have attempted to explain the greater visuo-spatial abilities of males through the influence of sex role socialization on the play experiences of children. Since boys are stereotyped as being more active and independent than girls, it is thought that they will be more frequently encouraged to explore their environment independently and to manipulate the objects in it. Also, boys are provided with toys that are male-sex appropriate and have visuo-spatial qualities such as

blocks, building models and trucks. By contrast, and in accordance with the female sex stereotype, girls are more restricted in their activities and are given toys that are less visuo-spatial in nature, e.g. dolls, crayons and board games. The combination of differences in permitted behaviours and in the nature of toys is thought to provide boys with greater opportunities than girls for the development of visuo-spatial skills.

Sex stereotypical differences in play have been reported indeed. For instance, as a result of a review of approximately 50 studies with preschoolers, Maccoby and Jacklin (1974) reported that:

> ...preschool boys and girls do differ, on the average, in a number of their preferences for activities and toys... (285).

Other investigators have confirmed Maccoby and Jacklin's findings with children of school age in relation to sports (Saltzman-Chafetz, 1974) and choice of hobbies (McDaniel, Guy, Ball & Koloff, 1978).

However, it is difficult to establish how preferences in activities and toy selection are environmentally induced. On the one hand Maccoby and Jacklin (1974) report that, sex differences in activity levels during play are not significant and situationally determined with the higher levels most frequently occurring during social play among boys. No consistent evidence is available that boys and girls are differently socialized for independent exploratory and manipulatory behaviour.

On the other hand, as the result of recent studies with pre-schoolers it has been suggested that the bias in the introduction of toys by adults (Frasher, Nurss & Brogan, 1980; Serbin & Conner, 1979)

and the "typical" behaviour of teachers during free play (Serbin & Connor, 1981) may contribute significantly to patterns of sex differentiation and sex typing in play. Chasen (1977) reports that the lack of female competence in "masculine" activities may very well be founded on a lack of experience in childhood play with "masculine" toys such as blocks, trucks and tools.

The conclusion by Burstein et al (1980) that there is "no evidence for any relationship between (toy) preferences or modes of play and development of visuo-spatial skills in adulthood" (307) appears to summarize the contemporary state of knowledge appropriately.

Related to the issue of environmental influences on visuo-spatial skills is the issue of trainability. The question is whether visuo-spatial skills can be improved through training and if so, to what extent the two sexes benefit. Regrettably, relevant data provide inconsistent evidence and they are difficult to interpret since most studies are with adult subjects and not directly related to the effects of e.g. toys; also, appropriate pre and posttest or sex differentiated information is rarely provided. In short, engineering students have improved their spatial skills after one year of studies (Blade & Watson, 1955) and eighth grade students have benefitted from a three week training program related to visualization of spatial relations (Brinkmann, 1966) as measured by the Space Relation subtest of the DAT. Rovet (1975) demonstrated that third-grade children improved on an object rotation task after they had watched an animated film demonstrating similar activities.

However, Mitchelmore's (1974) college students did not show significant improvement on various spatial tests after a four week period of designing, constructing and sketching elementary three-dimensional models. Also, female college students were less capable than men in the judging of true horizontal levels of water in glasses after two different methods of training (Thomas, Jamison & Hummel, 1973).

Lack of clarity about the role of training is also demonstrated through studies of sex differences in mathematical abilities. When compared with females, the superiority of males in mathematical reasoning has been well established, especially in relation to geometrical concepts and principles. (Benbow & Stanley, 1980; Harris, 1978; Maccoby & Jacklin, 1974). It has been argued that greater spatial visualization abilities are the main cause for sex differences in mathematical skills (Burnett, Lane & Draftt, 1979; Saad & Strover, 1960; Smith, 1964). The counter argument is that such differences are mainly caused by environmental influences, specifically sex role socialization processes. In an extensive review, Fox, Tobin and Brody (1979) investigated the role of sex role stereotyping in the development of mathematical abilities and came to the following conclusions.

There is no consistent evidence that it is necessary to identify psychologically with a male in order to have interest and ability in mathematics. Thus, the "masculine-identification" hypothesis is not supported, partially because the definition of the concept is not presented clearly and consistently. Sex differences in expressed

liking or disliking of mathematical activities have not been demonstrated either.

However, greater female than male feelings of anxiety, discouragement and lack of self-confidence in relation to mathematics are apparent. The reviewers ascribe such emotions to pressures of many socializing agents, e.g. parents, teachers, peer groups, media, books, etc. which tend to reinforce a picture of male domination in mathematics and related activities. Although they acknowledge that the impact of sex role socialization is difficult to assess, Fox et al (1979) presume it has a negative influence on girls' attitudes towards enrolling in mathmetics courses. Luchins and Luchins (1981) have supported that presumption.

The logical consequence that the extent of exposure to mathematics courses is related to performance has been disputed by Benbow and Stanley (1980), although they do not deny that sex differences in mathematical skills "are somewhat increased by environmental influences" (1262). Benbow and Stanley's (1980) study was with approximately 10,000 female and male grade seven and eight students, who participated in a study of Mathematically Precocious Youth, between 1972 and 1979. The mathematical background and motivation was considered to be equal for the participants. Boys performed consistently better than girls on a variety of measures of mathematical ability. The mean difference between the scores of boys and girls was consistent for the different groups. The researchers concluded that the hypothesis of differential course taking does not account for sex differences in mathematical ability and that "putting one's faith in

boy-versus-girl socialization processes as the only permissible explanation of the sex differences in mathematics is premature" (Benbow & Stanley, 1980, 1264).

In summary it is appropriate to conclude that differential sex role socialization has not demonstrated clearly to influence the development of visuo-spatial skills in females and males. Such a conclusion has also been presented by Burstein et al (1980).

Conclusion

Through the previous review it has become evident that contemporary research in brain organization has provided a tentative explanation for the established sex differences in cognition. A speculative, not yet scientifically endorsed explanation, including the other possibilities presented in this chapter, could be the following.

Genetic factors i.e. sex chromosomes are responsible for the formation of specifically different sex gonads, which in turn produce sex hormones in relatively specific ratios. The sex hormones affect the brain organization of the sexes indirectly through participation in the regulation of the maturation process and influence brain functions directly through the pituitary gland, the thalamus and the hypothalamus. Differences in brain organization predispose females and males, more or less, for different cognitive abilities.

The environment plays a role during the growth and maturation processes through the physical and emotional health of the parents (prenatally especially the mother), the hereditary predispositions,

physical and emotional health and the nutrition of the individual. Finally, the cognitive predispositions of females and males may be augmented or repressed by socialization processes. Thus, multiple causations are the rule for sex differences in cognition with the genuine possibility that the "social environment multiplies and magnifies... an average kernel of intrinsic predisposition" (Lambert, 1978, 113).

Whatever the outcome of research may be, it is thought here that the limitations of psychology, sociology and anthropology as disciplines leave the social scientists with little room to manoeuvre in their quest for determinants of sex differences in cognition. A genuine possibility exists that most of the relevant questions and answers in the area of sex differences will be produced by natural scientists such as geneticists, biochemists and neurologists.

A recent interview by Hooper (1982) with the biochemist Pert has strengthened that idea. The interview demonstrates that the natural scientists become increasingly adept at the isolation and control of biological variables of human behavior. The isolation and control of environmental variables is virtually impossible in many instances.

It has been indicated that the emphasis in this chapter has been on brain organizational explanations since related research is presently the most "in vogue" and produces the most definitive and up-to-date information. Another reason is that Ornstein (1972) uses explanations in terms of brain hemispheric functions as a major underpinning for his presentation of female and male modes of consciousness.

Aside from being a review of the present state of knowledge about brain hemispheric and sex differences in cognitive functions and the relationships between those differences, Chapters III and IV also serve to demonstrate the enormous complexity of the subject matter. As such, their content is supportive of those critics who have labelled as "superficial" Ornstein's approach to the relevant dichotomies in support of his proposed two modes of consciousness. The superficiality is partially caused by Ornstein's tendency to make rash conclusions on the basis of data resulting from neuropsychological research on brain hemispheric functions which, in 1972 (and even now), was still in its infancy.

An evaluation of the appropriateness of the visual-spatial dichotomy as supportive of the concept of two modes of consciousness associated with sex differences, will occur in the following chapter. The three evaluating questions outlined in the introduction of the thesis will be applied for that purpose. In addition, the remaining dichotomies will be presented, discussed and similarly evaluated in the following chapter.

CHAPTER V

THE ORIGINAL DICHOTOMIES

Introduction

In this chapter the following dichotomies from Ornstein's chart will be presented and discussed.

Who proposed it?		
Many sources	Verbal	Spatial
Levy, Sperry	Analytic	Gestalt
Semmes	Focal	Diffuse
Bogen	Propositional	Appositional
Luria	Sequential	Simultaneous
Deikman	Active	Receptive
Domhoff	Right (side of the body)	Left (side of the body)
Oppenheimer	Time, History	Eternity, Timelessness
Blackburn	Intellectual	Sensuous
Jung	Causal	Acausal
Bacon	Argument	Experience
Polanyi	Explicit	Tacit
Lee	Lineal	Non-lineal
I Ching	The Creative heaven, masculine, Yang, light, time	The Receptive earth, feminine, Yin, dark, space

Presentation of the dichotomies will take place through quotations from the original sources. The quoted passages have been selected on the basis of being valid and clear representations of the author's formulations of the relevant dichotomy; as a consequence extensive quoting has frequently been necessary.

Through the use of evaluating questions it will be established whether each individual dichotomy is congruent with Ornstein's two

modes of consciousness, its relationship to differences in brainhemispheric functions and sex differences in cognition.

For the purpose of meaningful presentation, the dichotomies have been divided into two groups. The first group includes dichotomies that are discussed and evaluated in the context of the body-mind issue. This is possible, because the original description included, overtly or covertly, either a position regarding the body-mind issue, or some form of association of the dichotomy with organismic (most frequently cortical) variables.

The second group of dichotomies can not be interpreted in either of the manners outlined previously. One can argue that, since Ornstein presents and discusses his two modes of consciousness clearly within the context of brainhemispheric functions, he was not justified in including this second group of dichotomies in his chart. However, in this thesis, that argument will not be used for a simple dismissal of these seemingly irrelevant dichotomies. Rather, it is thought that their exposition and discussion will be meaningful, since in the process more light may be shed on Ornstein's concept. However, the "nature" of the second group of dichotomies requires the appplication of a different set of evaluative questions than that used for the first group, since reference to the body-mind issue and hemispheric functions would be inappropriate.

The following questions will be used as a basis for discussing the first group of original dichotomies.

1). Is the original dichotomy conceptually congruent with Ornstein's emergent evolutionist position vis a vis the body-mind problem?

2) Can the original dichotomy be related to differences between brain hemispheres in cognitive functions?

3) Can the original dichotomy be related to sex differences in cognitive functions?

For the second group of dichotomies the questions will be.

1) Is the original dichotomy conceptually congruent with Ornstein's two modes of consciousness?

2) Can the original dichotomy be related to sex differences in cognitive functions?

Group 1

Verbal-Spatial

1) Is the original dichotomy conceptually congruent with Ornstein's emergent evolutionist position vis a vis the body-mind problem?

The research literature presented in the previous chapters seldom includes a discussion of philosophical positions regarding the body-mind problem. However, the position generally maintained by contemporary neuropsychologists is "monist" and congruent with that of Ornstein. When research data are published, the relationship between the "verbal" and "spatial" is simply not discussed in terms of "ordinary" and "cosmic," levels of organization, emergency or complementarity.

2) Can the original dichotomy be related to differences between brainhemipheres in cognitive functions?

The previous chapters demonstrated that many variables influence verbal and spatial cognitive functions preventing the simple interpretation of verbal-LH and spatial-RH. Certainly verbal and spatial functions can be related to brainhemispheric organization, but Ornstein has not at all considered the possibility that sex differences exist in this respect.

3) Can the original dichotomy be related to sex differences in cognitive functions?

The answer is "yes," however the place of "verbal" and "spatial" on Ornstein's chart has to be reversed. Ornstein associates "verbal" with a male, analytic, LH mode of consciousness and "spatial" with a female, holistic, RH mode. The research presented in the previous chapter demonstrates that "spatial" should be associated with a "male," and "verbal" with a "female" mode of consciousness. The answers to (2) and (3) invalidate "Verbal-Spatial" as a sex differentiating dichotomy in the context of Ornstein's modes of consciousness.

Neuropsychological studies published in the late 1960's produced a small number of conceptual dichotomies that differed from the "classical" interpretations of a verbal vs. a spatial hemisphere. Although still presented in dichotomized terminology, these interpretations focus on the differences in the processing mechanisms of the hemispheres. Thus, the dynamics of each hemisphere's cognitive style

rather than the physically static attributes of the stimuli are thought to be the distinguishing factor.

Analytic-Gestalt

On the basis of experiments with commissurotomized patients, Levy-Agresti and Sperry (1968) reported that:

> the mute minor (right) hemisphere is specialized for Gestalt perception, being primarily a synthesist in dealing with information input. The speaking, major (left) hemisphere, in contrast, seems to operate in a more logical, analytic computor-like fashion. Its language is inadequate for the rapid complex synthesis achieved by the minor hemisphere (1151).

Levy (1974a) expands on these formulations six years later, while summarizing evidence on the asymmetry of the brain, as follows:

> The right hemisphere synthesizes over space. The left hemisphere analyzes over time. The right hemisphere notes visual similarities to the exclusion of conceptual similarities. The left hemisphere does the opposite. The right hemisphere perceives form, the left hemisphere detail. The right hemisphere codes sensory input in terms of sensory images, the left hemisphere in terms of linguistic descriptions. The right hemisphere lacks a phonological analyzer; the left hemisphere lacks a gestalt synthesizer (67).

Thus the left hemisphere demonstrates superiority in tasks involving grammatically organized word sequences, analysis, logic and sequences over time. Right hemisphere functions seem dominant in tasks involving imagery, certain visual and constructive activities such as the copying, perception and manipulation of spatial relations between objects or configurations, and the simultaneous grasping of fragments of a meaningful whole

Focal-Diffuse

At approximately the same time of Levy-Agresti and Sperry's (1968) publication, Semmes (1968), on the basis of studies with brain injured subjects, proposed that:

> ...contrary to the prevailing view (sensory and motor) capacities are represented differently in the two hemispheres, tending to be focally represented in the left hemisphere but diffusely represented in the right... The two contrasting modes of neural organization...provide a possible clue to the mechanism of hemispheric specialization. More specifically, it is proposed that focal representation of elementary functions in the left hemisphere favors integration of similar units and consequently specialization for behaviors which demand fine sensorimotor control, such as manual skills and speed. Conversely, diffuse representation of elementary functions in the right hemisphere may lead to integration of dissimilar units and hence specialization for behaviors requiring multimodal coordination, such as the various spatial abilities (11).

The detailed versus non-detailed functioning of the LH and RH respectively as expressed in the focal-diffuse dichotomy, is similar to some aspects of the analytic-gestalt dichotomy previously described.

Propositional-Appositional

In 1969, Bogen presented his hypothesis about the duality of mind in the following terms:

> One of the most obvious and fundamental features of the cerebrum is that it is double. Various kinds of evidence, especially from hemispherectomy, have made it clear that one hemisphere is sufficient to sustain a personality or mind. We may then conclude that the individual with two intact hemispheres has the capacity for two distinct minds... In the human, where propositional thought is typically lateralized to one hemisphere, the other hemisphere evidently specializes in a different mode of thought, which may be called appositional. The rules or methods by which propositional thought is elaborated on "this" side of the brain (the side which speaks, reads and writes) have been subjected to analyses of syntax, semantics, mathematical logic, etc. for many years. The rules by which appositional thought is elaborated on

> the other side of the brain will need study for many years to come (119).

Bogen (1969) provides some insight into the nature of appositional functions and he ascribes them to the right hemisphere, which "recognizes stimuli (including words), apposes or collates this data" (109) and "...has a capacity for comparing perceptions, schemas, engrams, etc." (111).

Although the term "apposition" is less well defined, it is as important as "proposition," thus "reflecting a belief in the importance of the right hemisphere" (111).

The common denominators and conceptual similarities of analytic/holistic, focal/diffuse, and propositional/appositional have been recognized by many researchers. For instance, we are informed that:

> The distinction between the left and right hemisphere has been described as: ...associative versus apperceptive, propositional versus appositional, and analytic versus gestalt. All of these dichotomies suggest that the processing and organizing of data, by the right hemisphere, is in terms of complex wholes, the minor hemisphere having a predisposition for perceiving the total rather than the parts. By contrast, the left hemisphere is seen to analyze input sequentially, abstracting out the relevant details and associating these with verbal symbols (Nebes, 1977, 102).

A similar and simultaneously clarifying comment has been made by Pelletier (1978):

> ...the division of labor ascribed to the left hemisphere is the making of categorical distinctions; it names, identifies, classifies, analyzes, describes, explains and reasons. By contrast, right hemispheric functioning is more fluid and diffuse...this...enables it to function in a holistic capacity with a much more free-floating format of comprehension...it makes its most important contribution in developing analogs of spatial

> topography, as in sorting figure from ground, in painting, or of an unfamiliar, uncategorized sensory configuration (95).

Finally, Bradshaw and Nettleton (1981) perceive that "focal/diffuse and serial/parallel are special cases of an analytic/holistic dichotomy" (51).

As will be noted, the classical verbal vs. visuo-spatial dichotomy is still included in these descriptions, but only insofar as it is relevant to specific cognitive processes, without being the determining factor of these processes.

Congruent with the approach in the contemporary literature the three dichotomies, analytic/holistic, focal/diffuse and propositional/appositional, will be treated as a single concept and labelled "analytic/holistic" in the remainder of this section of the thesis.

Since its initial formulations in the late 1960's and the publication of Ornstein's book in 1972, the analytic/holistic dichotomy has been investigated with increasing frequency, culminating in an in-depth review of the relevant research by Bradshaw and Nettleton in 1981. The review covers, in addition to a portion of the classical "verbal/nonverbal" literature, the research of auditory stimulation and acoustic patterns, musical abilities, speech encoding and articulation, visual stimulation, the psychological processing of human faces, motor functions and tactual tasks. The conclusions by the authors are that

> ...fundamentally...the left hemisphere is characterized by its mediation of discriminations involving duration, temporal order, sequencing and rhythm, at the sensory/tactual, visual, and above all, auditory/level, and especially at the motor level (for fingers, limbs and above all, the speech apparatus). Spatial aspects characterize the right, the mapping of exteroceptive body space, and the position of fingers, limbs, and perhaps articu-

> lators, with respect to actual and target positions. Thus there is a continuum of function between the hemispheres, rather than a rigid dichotomy, the difference being quantitative rather than qualitative, of degree rather than kind (51).

Bradshaw and Nettleton (1981) suggest also that

> If the left hemisphere is, relatively speaking, specialized for these analytic, time dependent, sequential functions, thus providing a suitable substrate for the subsequent development (maybe even invasion) of language processes, any consequent superiorities of the right may not be specialization per se, but may rather occur by default, through loss of processing space in the left hemisphere to the latter's more evolved functions (63).

The reactions in the "peer commentary" following the review by Bradshaw and Nettleton (B & N) were many and varied. An extensive sample of these reactions follows.

In support of B & N's hypothesis about LH functions, Corballis (1981) refers to additional studies that demonstrate the "sequential aspect of perception...tied to the LH through its prior involvement with motor sequencing" (69). Carmon (1981) relates the results of two of her own studies which subscribe to B & N's dichotomy. Furthermore, she agrees with a suggestion by the American philospher Alexander, that existence is viewed in the modes of space and time and that these dimensions account for all our perceptions. Therefore, she suggests that the research in cerebral perceptual strategies should be conducted accordingly, something that is also implied in the B & N review. However, Morgan (1981) perceives difficulties with the notion of a dichotomy between the "temporal-analytic" and "spatial-holistic," and asks "does a moving object represent a spatial series or a temporal?" (74) His answer is that "in fact, it is in the essence of movement

that it is both" (74), thus throwing doubt on the "usefulness of a grand scheme dividing space and time between the hemispheres" (75). Marshall's (1981) comment in this respect is that since "all action takes place in a unified temporospatial continuum, this does raise the issue of what puts the functions back together again (and where)" (73) if they were initially assigned to different hemispheres.

There is general agreement with B & N, that a continuum exists between hemispheric functions and that the differences are quantiative and not qualitative (e.g. Bryden & Allard, 1981; Corballis, 1981; Marshall, 1981), although Wyke (1981) comments that "the case for a continuum of function between the hemispheres on a purely qualitative basis remains open (since) a dichotomy based on a division of labour cannot be altogether abandoned or considered inadequate" (78-79).

Most of the many negative comments about the B & N review revolve around the difficulty involved in the lack of definition of "analytic" and "holistic." For instance, Cooper (1981), who praises B & N for their "remarkably ambitious attempt to integrate an overwhelmingly diverse set of studies" (69) is of the opinion that the review has not established the existence of

> ...one all-encompassing dichotomy that captures the essence of hemispheric specialization...with sufficient predictive value (since) one would need to develop a better means of classifying mental processing operations as analytic or global (69).

McKeever (1981) considers the drive to

> neatly subsume all the essential aspects of hemispheric functioning under some perfect dichotomy...an exercise in futility (74).

and he also deplores the use of "polar adjectives" for the characterization of some of the "graded differences" in the functioning cerebral hemispheres.

Even harsher judgments are expressed by Marshall (1981) who accuses B & N of "loose labelling," "a failure to specify formally the nature of the purported strategies," "slippery concepts" and "a crudeness of...base data...elicited from neurologically intact subjects" (72-73).

Brownell and Gardner (1981) also note the lack of definition of the two modes of processing and they consider the analytic/holistic distinction "vulnerable on empirical grounds...and also unsatisfactory as a theoretical construct" (64). The review "reveals a constantly shifting sense of what Gestalt or holistic processing might be" (74) is another observation made by Brownell and Gardner (1981). In a similar vein, Bertelsen (1981) suggests that in the relevant literature many a posteriori explanations are encountered about the nature of hemispheric functioning. Thus, B & N's conclusions, based on such explanations, lose credibility.

The general antagonistic stance toward the hypothesis of an analytic/holistic dichotomy in hemispheric functioning is well represented and summarized in this final passage taken from Cohen's (1981) comments:

> ...but B & N's thesis is weakened by lack of precision in definition and specification. Arguing backwards from the output to the classification, they conclude that left hemisphere processing is analytic, temporal, sequential, dynamic. Right hemispheric processing is holistic, Gestalt, global, imaginal, static. So, in fact their characterization is not really a dichotomy, but two conglomerates of partly related attributes.

> Many of these, and especially those attributed to the right hemisphere are not well defined, and the empirical consequences in terms of performance have proved hard to specify a priori (67).

Questions have also been raised about the neglect of B & N to discuss more fully a biological (evolutionary) explanation for the development of a dichotomy in functions and the notion of "more evolved functions" performed by the left hemisphere. In this respect Studdert-Kennedy (1981) remarks that "questions of mechanisms cannot or should not be separated from questions of phylogenetic origin" (76) and Cohen (1981) would have appreciated it if the proposed dichotomy (B & N) would have "shed light on evolutionary origins of specialization, or if it suggested relationships that explain the topographical layout of neurological hardware" (67).

Finally, Corballis (1981) who has written extensively about the biological basis for laterality (e.g. Corballis & Morgan, 1978; Morgan & Corballis, 1978) fully concurs with B & N suggestion that RH specialization occurs by default due to the more evolved, more pronounced, complex sequential skills such as speech by the LH.

In summary, it has been noted that several theories about differences in brain hemispheric functions were advanced in the late 1960's. The theories are similar in their emphasis on the hemispheres' processing mechanisms rather than on the attributes of the stimuli presented to the hemispheres. "Analytic" and "holistic" are terms that have been used for the description of these mechanisms; the former is associated with the LH and the latter with the RH. Considerable opposition has been expressed to the theories and the terms "analytic"

and "holistic" in that they are viewed as being vague and simplistic and cause of unwarranted conceptual dichotomizing of complex processing mechanisms by the brain hemispheres.

In the introduction of the thesis and again in this chapter questions were presented with the purpose of evaluating the congruency between the concepts contained in the individual dichotomies and those present in Ornstein's two modes of consciousness. These questions will now be applied to the analytic-holistic dichotomy.

1) Is the original dichotomy conceptually congruent with Ornstein's emergent evolutionist position vis a vis the body-mind problem.

The analytic/holistic dichotomy is the concept used most consistently by Ornstein in the description and explanation of the two modes of consciousness. As such it is one of the two major underpinnings of his theory, the other being the verbal-spatial dichotomy. The nature of relevant neuro-psychological research and resulting data is based on a monist view of the body-mind problem and therefore congruent with Ornstein's view in this respect. However, emergent aspects of the analytic/holistic dichotomy have not been researched and are not referred to in the literature. Therefore, the present state of knowledge is neither supportive, nor contradictory of the emergent aspects of Ornstein's modes of consciousness.

Indications (and they are not more than that) about a difference in levels between analytic and holistic functioning appear to contradict Ornstein. Some scientists suggest that the analytic mode is a more evolved function than the holistic mode. If "more evolved"

means "higher level of organization" this involves a view opposite to that of Ornstein, who considers the holistic mode to be of a higher level.

2) Can the original dichotomy be related to differences between the brain hemispheres in cognitive functioning?

The original sources for the analytic/holistic dichotomy related the differences in cognitive functions to the left and right brain-hemispheres, and Ornstein followed in similar vein. The comments on the B & N review seem to indicate that there is no clarity about the concepts of analytic and holistic functions (especially the latter). Therefore it does not appear to be valid either to ascribe these functions to specific brainhemispheres, the more so since the "continuum" qualities of the functions are emphasized.

3) Can the original dichotomy be related to sex differences in cognitive functions?

With the exception of the literature on the processing of emotional facial expressions, no sex differences in analytic/holistic processing have been reported in depth. The sex differences reported in relation to the verbal/spatial dichotomy appear to have resulted in the use of more balanced samples when "processing" is investigated, but results are seldomly reported on the basis of sex differences. Regarding the processing of emotional facial expressions, the "differential access to imagery rather than verbal codes, rather than sex and hemisphere differences per se, can account for (sex

differences) in results" (80) is a conclusion by Safer (1981).

Sequential-Simultaneous

One other neuropsychologically based dichotomy presented by Ornstein (1972) needs to be dealt with, i.e. the sequential vs. simultaneous processing concept by Luria (1966). The functions of such processing are similar to the common denominators expressed in the three dichotomies discussed previously (i.e. analytic-gest[illegible], focal-diffuse and propositional-appositional). However, Luria's (1966) sequential-simultaneous dichotomy can not be included in that group, since it is not based on left vs. right hemispheric functioning as the following quotation demonstrates.

> Analysis of the changes in the course of the higher cortical processes in patients with a lesion of the posterior (parieto-occipital) and anterior (fronto and fronto-temporal) regions of the cortex reveals profound differences in the character of the disturbances arising in the two cases. These differences are revealed mainly by the fact that lesions of the posterior (parieto-occipital) regions of the brain lead to disturbance of the ability to integrate individual visual or tactile stimuli into simultaneous and, in particular, spatially organized groups, whereas lesions of the anterior (frontal and fronto-temporal) divisions lead to disturbance of the ability to integrate individual motor and acoustic stimuli into successive, serially organized groups (125).

As will be noted, the sequential-simultaneous dichotomy is based on a back-to-front distinction of functions in both hemispheres.

1) Is the original dichotomy conceptually congruent with Ornstein's emergent evolutionist position vis a vis the body-mind problem? The sequential-simultaneous dichotomy is conceptually similar to

the "analytic-holistic." In relation to the body-mind problem, the observations made previously about the analytic-holistic modes of processing are therefore also applicable to the sequential-simultaneous dichotomy. However, Luria does not discuss the two forms of processing and their interrelationships in terms of "emergence" or differences in levels of organization.

2) Can the original dichotomy be related to differences between the brain hemispheres in cognitive functioning?

As stated previously, Luria's (1966) dichotomy is not based on left versus right hemispheric functions, but rather on a back to front distinction of functions in both hemispheres. In this regard, Das, Kirby and Jarman (1979) commented, while referring to Ornstein's and Luria's dichotomies, that

> some of them (such as the left hemispheric/right hemispheric and successive processing/simultaneous processing dichotomies) relate to structures which are simply not the same. To suggest that they are similar (and they may be in function) is to avoid the conclusion that they are different in actuality (156).

3) Can the original dichotomy be related to sex differences in cognitive functions?

Luria did not discuss sex differences when he presented his modes of processing. There has been no research in this respect.

Active-Receptive

Deikman's (1971) concept of an active versus receptive mode is also organismically based but, as Luria's (1966), has not been related

to differences in hemispheric functioning. However, neuropsychological phenomena are included in the relevant descriptions.

> This paper will present a model in which psychological and physiological variations are viewed as manifestations of two basic organismic states or modes that are coordinated to a particular function...the action mode is a state organized to manipulate the environment. The striate muscle system and the sympathetic nervous system are the dominant physiological agencies. The EEG shows beta waves and baseline muscle tension is increased. The principal psychological manifestations of this state are focal attention, object-based logic, heightened boundary perception, and the dominance of formal characteristics over the sensory... (68).
>
> In contrast, the receptive mode is a state organized around intake of the environment rather than manipulation. The sensory-perceptual system is the dominant agency rather than the muscle system, and parasympathetic functions tend to be most prominent. The E.E.G. tends toward alpha waves and baseline muscle tension is decreased. Other attributes of the receptive mode are diffuse attending, paralogical thought processes, decreased boundary perception, and the dominance of the sensory over the formal (69).

The previous passages express combined physiological/psychological states of "make happen" versus "allow to happen" by the organism.

1) Is the original dichotomy conceptually congruent with Ornstein's emergent evolutionist position vis a vis the body-mind problem?

The descriptions of Deikman of the active and receptive state are representative of a "monist" position and therefore similar to those by Ornstein. However, Deikman appears to lean towards the "double-aspect" variety of "monism" in that both "psychological and physiological variations are manifestations" of organismic states.

The manifested variations appear to decide whether a state is active or passive, but Deikman does not discuss the possibility of

differing levels of organization between the two modes.

Emergent qualities of the two states are not discussed either, although at one point in his article Deikman observes that "we have tended to think of the more unusual receptive states as pathological or "repressive" (69). If so, this would be contrary to Ornstein's notion of an "emerging higher level" (holistic, receptive) mode of consciousness.

Deikman suggests also that

> the receptive mode may provide a way of "knowing" certain aspects of reality not accessible to the action mode. The "knowing" ...is usually a non-verbal experience, although it maybe later translated into words in order to be shared with others (84).

That statement is in agreement with the one by Ornstein regarding the translation of knowledge from one mode into another. For that reason it encounters similar objections to those voiced against Ornstein in this respect.

2) Can the original dichotomy be related to differences between the brain hemispheres in cognitive functioning?

Deikman does not relate the active and receptive states to differences in brain hemispheric functions. Conceptually it might be possible to do so, however, the difficulties discussed under "analytic/holistic" of this chapter appear to make that a futile exercise.

Several other discrepancies with Ornstein's formulations about the physiology of consciousness exist. Firstly, Deikman associates the sensory-perceptual system with the receptive (holistic) mode, while

Ornstein relates that system to the opposite side of the dichotomy, i.e. the analytic mode (active in Deikman's terminology). Secondly, in Ornstein's dichotomy, the functions of the entire autonomic nervous system are part of the holistic mode. Deikman views that system in terms of its two components, and links the sympathetic system (active during arousal) with the active (analytic) mode and the parasympathetic system (active during quiescence) with the receptive (holistic) mode.

3) Can the original dichotomy be related to sex differences in cognitive functions?

Deikman did not discuss sex differences when he presented the active-receptive dichotomy. There has been no significant research in this regard.

Right (side of the body)-Left (side of the body)

Domhoff (1969-1970) relates that on the basis of folklore in Western thinking, the

> ...Left was characterized as bad, dark, profane, female, unclean, night, west, cursed, limp, homosexual, weak, mysterious, low, ugly, black, incorrect, and death, while the Right meant just the opposite - good, light, sacred, male, clean, day, east, straight, erect, heterosexual, strong, commonplace, high, beautiful, white, correct, and life (146)

The organismic foundation

> for the Left-Right dichotomy seems to follow from an inborn bilaterality, for all known cultures are right-handed to varying degrees. It would thus be natural that the less useful hand would be considered "bad" and that "good" and "bad" could be symbolized by Right and Left. However, according to those who have studied handedness, the predominance of right-handedness is not an obvious given to be accounted for genetically...In an unbiased world left-handedness would be as common as right-

handedness, for the play of chance factors would be equal for the two sides (144).

It is difficult to understand why Ornstein would include this superficial dichotomy based on "folklore" in Western thinking, as support for his concept of two modes of consciousness. The quality of the dichotomy is such, that the three evaluative questions are impossible to answer with academic clarity.

1) Is the original dichotomy conceptually congruent with Ornstein's emergent evolutionist position vis a vis the body-mind problem?

The dichotomy can not be discussed in those terms, since it consists of a conglomerate of value laden adjectives. Therefore, the answer is "no."

2) Can the original dichotomy be related to differences between the brain hemispheres in cognitive functioning?

"Inborn bilaterality of handedness" may appear to establish some legitimate basis for the descriptions included in "Left" and "Right," if it were not, that none of the descriptions is in legitimate terminology of cognitive functions. Also, Domhoff appears to be mistaken in ascribing a role to "the play of chance factors" for the develoment of handedness, since Corballis and Morgan (1978) and Morgan and Corballis (1978) have written convincingly in favour of a biological basis of laterality.

3) Can the original dichotomy be related to sex differences in cognitive functioning?

On the basis of answers to (1) and (2) the answer is "no."

Time, History-Eternity, Timelessness

Ornstein referred to the following passage by the physicist Oppenheimer (1953), when he included Time-Timelessness in the list of tentative dichotomies:

> These two ways of thinking, the way of time and history and the way of eternity and timelessness are both part of man's effort to comprehend the world in which he lives. Neither is comprehended in the other or reducible to it...each supplementing the other - neither telling the whole story (75).

Oppenheimer then continues by using physical phenomena for illustration:

> ...an electron must sometimes be considered as a wave, and sometimes as a particle - a wave, that is, with the continuous propagation and characteristic interference that we learn to understand in the optics, or as a particle, a thing with well-defined location at any time, discrete and individual and atomic... The more nearly the first way of thinking is to a situation, the more wholly inappropriate the second, so that there are in fact no atomic situations in which both impulse and position will be defined well enough to permit the sort of prediction with which Newtonian mechanics has familiarized us (75-76).

The specific state of the electron is dependent on the method of acquiring knowledge, for we have

> the option of realizing one or the other of two wholly dissimilar states for the electron...(which)...can not be objectified in a manner independent of the means chosen for observing or studying it (79-80).

Thus, the nature of matter depends in actuality on a "definition of

the nature of the observation" (77) or on "the very nature of the experiment itself" (80).

The implication is that if different human organisms (individually or in groups) use essentially different methods of acquiring knowledge, the nature of the knowledge acquired will also differ. This may be of importance for sex differences in conscious experiences and will be elaborated on in the last chapter of the thesis.

1) Is the original dichotomy conceptually congruent with Ornstein's emergent evolutionist position vis a vis the body-mind problem?

Oppenheimer applies his observations about the equivalency between matter and the mode of knowing, to phenomena of consciousness in the following manner

> ...should an understanding of the physical correlates of elements of consciousness indeed be available, it will not itself be the appropriate description for the thinking man himself, for the clarification of his thoughts, the resolution of his will, or the delight of his eye and mind at works of beauty. Indeed, an understanding of the complementary nature of conscious life and its physical interpretation appears to me a lasting element in human understanding and a proper formulation of the historic views called psycho-physical parallelism (89).

The "dualistic" tone is also emphasized in

> Whether a physico-chemical description of the material counterpart of consciousness will in fact ever be possible, ...we may be sure that these analyses and these understandings, even should they exist, will be as irrelevant to the acts of decision and the castings of the will as are the trajectories of molecules to the entropy of a gas (90).

Clearly, the previous passage could not have been written by an "emergent evolutionist" because in that philosophical framework the

"acts of decision" and "casting of the will" would be qualities or processes emerging meaningfully from, but also equated with the "physico-chemical descriptions." With regard to the body-mind problem, parallelism (and thus dualism) is at the core of Oppenheimer's position. However, the dualism does not seem to be of the "material body" and "immaterial mind" variety, but rather of a body "known materially" and a mind "known immaterially."

Oppenheimer suggests that the processes of obtaining knowledge, may interfere with the nature of what is being investigated. He considers it possible that

> ...complete physico-chemical study of...structures in biological processes...might not be compatible with the undisturbed course of life itself (88).

and in relation to psychological phenomena, that these

> might be altered by the effort to probe them, as a man's thoughts are altered by the fact that he has formulated and spoken them (82).

Also, we have learned that the "translation" of one way of thinking in another is not possible according to Oppenheimer, since "neither is comprehended in the other or reducible to it..." (75). The latter observation is essentially contrary to Ornstein's vision of modes of knowing. Thus, another incongruency between the time-timelessness dichotomy and the concept of two modes of consciousness it is supposed to support, has come to light.

2) Can the original dichotomy be related to differences between the brain hemispheres in cognitive functioning?

Oppenheimer did not present his dichotomy in relation to brain-hemispheric differences in cognition. In view of the comments following the B & N review, it appears invalid to attempt an explanation of "Time-Timelessness" on the basis of such a relationship.

3) Can the original dichotomy be related to sex differences in cognition?

Oppenheimer did not present "Time-Timelessness" in relation to sex differences in cognition. At this date there appears to be no research on this topic.

Intellectual-Sensuous

Blackburn (1971) comments on Intellectual-Sensuous complementarity in science.

> A complex part of nature (such as a coral reef, a cell, or a city) is, metaphorically, many-dimensional. It is brought under scientific scrutiny by projecting it into simpler, under-dimensioned space, within which it can be grasped and quantified. The...generalizations are drawn according to the logical and mathematical rules appropriate to the quantification space. Physical implications of the mathematical model are subjected to quantitative test under controlled conditions. To the extent that experiment confirms theory and suggests new theoretical steps, science progresses (33).

The previous intellectual and scientific methods are contrasted by Blackburn with the

> ...epistemology of direct sensuous experience, subjectivity, and respect for intuition - especially intuitive knowledge based on a "naive" openness to nature and to other people (28).

The term "sensuous" is used in the following sense:

> ...that is, the response of the whole body, including the senses, to phenomena. Usually, such a response is, of course, not susceptible to quantification. It is also dependent on subjective factors such as mood and attention, but it is undeniably a source of information about the world around us (28, footnote).

Other important characteristics of the "abstract quantitative" and "direct-sensuous" models of knowledge and their interrelationship are the following:

> Which description of nature one gives depends entirely on one's method of knowing (35). Each description is "rational"; that is, language is used according to the same consistent logic in either description, with no appeal to revealed truth or mystical insight...(and)...because they refer to a (presumably) single reality, complementary descriptions are not independent of each other (but) neither model (of knowing) can be subsumed into the other (31).

1) Is the original dichotomy conceptually congruent with Ornstein's emergent evolutionist position vis a vis the body-mind problem?

For support of his dichotomy Blackburn (like Oppenheimer) refers to the particle versus wave state of electrons, conditions that depend on the nature of the observation. Unlike Oppenheimer, he does not use that illustration directly for the discussion of consciousness within the framework of the body-mind problem. However, in relation to that problem, the phrase "because they refer to a (presumably) single reality, complementary descriptions are not independent of each other" (31) is significant, since it represents the "double aspect" view of "monism." As such, it is not similar to Ornstein's emergent evolutionist position. In addition, double aspect monism allows for meaningful complementarity of two modes of knowing, since they function at the

same level. Thus, it avoids the difficulties inherent in the complementarity of Ornstein's modes of consciousness. Other differences with Ornstein involve the location of "subjectivity" and sensory functions at the holistic (sensuous) pole of the dichotomy. The limiting characteristics of one's sense organs and nervous system, which "select" from information input is cause for Ornstein to attach the label "subjective" to the opposite, analytic mode. Thus, in Ornstein's view the role of the senses is restrictve, while Blackburn considers sensory experience more "liberating."

Blackburn also denies the "mysticism" of sensuous (holistic) knowing and labels it "rational." One could expect this to be a basis for possible "translation" of that mode into the intellectual (analytic). However, Blackburn does not allow for such a translation, for sensuous responses are "usually...not susceptible to quantification" and "neither model can be subsumed into the other."

By contrast, Ornstein attaches mystical qualities to holistic (sensuous) knowing, but contrary to Blackburn, considers "translation" into the other mode not only feasible, but also desirable.

2) Can the original dichotomy be related to differences between the brainhemispheres in cognitive functioning?

Blackburn did not present his dichotomy in terms of hemispheric functions. He is not clear at all about an organismic connection of the "intellectual" mode, but relates the "sensuous" knowing to the "whole" body.

3) Can the original dichotomy be related to sex differences in cognition?

Blackburn does not discuss his dichotomy in terms of sex differences. No research is available in this respect.

Causal-Acausal

Jung's formulations about causal and acausal principles underlying natural phenomena are difficult to understand. However, the essence of the dichotomy is most clearly expressed in the following quotations.

> Natural laws are statistical truths, which means that they are completely valid only when we are dealing with macrophysical quantities. In the realm of very small quantities prediction becomes uncertain, if not impossible, because very small quantities no longer behave in accordance with the known natural laws.
> The philosophical principle that underlies our conception of natural law is causality. But if the connection between cause and effect turns out to be only statistically valid and only relatively true, then the causal principle is only of relative use for explaining processes and therefore presupposes the existence of one or more factors which would be necessary for an explanation. This is as much to say that the connection of events may in certain circumstances be other than causal, and requires another principle of explanation (446-447).

That other principle is contained in the concept of "synchronicity" (not synchronism!), a "hypothetical factor equal in rank to causality as a principle of explanation" (450). Jung describes this acausal connecting principle also as a "meaningful coincidence in time" (457). Synchronistic events are

> ...relatively independent of space and time; they relativize space and time...so that it looks as if an event which has not yet occurred were causing a perception in the present. But if space and time are relative, then causality too loses its

validity, since the sequence of cause and effect is either relativized or abolished (457).

Therefore synchronicity can take one of the following three forms:

> a. The coincidence of a certain (mental) content with a corresponding objective process which is perceived to take place simultaneously.
> b. The coincidence of a subjective (mental) state with a phantasm (dream or vision) which later turns out to be a more or less faithful reflection of a "synchronistic" objective event that took place more or less simultaneously, but at a distance.
> c. The same, except that the event perceived takes place in the future and is represented in the present only by a phantasm that corresponds to it (457).

Jung discusses the concept of synchronicity in relation to the body-mind problem. Rather lengthy quotations are again necessary to provide an adequate picture of his views.

> ...we must ask ourselves whether the co-ordination of (mental) and physical processes in a living organism can be understood as a synchronistic phenomenon rather than a causal relation...The assumption of a causal relation between psyche and physis...is difficult to square with experience: either there are physical processes which cause (mental) happenings, or there is a pre-existent psyche which organizes matter...it is hard to see how chemical processes can ever produce (mental) processes and...one wonders how an immaterial psyche could ever set matter in motion...The synchronicity principle possesses properties that may help to clear up the body-soul problem. Above all it is the fact of causeless order, or, rather, meaningful orderedness, that may throw light on psycho-physical paralellism. The "absolute knowledge" which is characteristic of synchronistic phenomena, a knowledge not mediated by the sense organs, supports the hypothesis of a self-subsistent meaning, or even exprsses its existence (453).

1) Is the original dichotomy conceptually congruent with Ornstein's emergent evolutionist position vis a vis the body-mind problem?

The passages quoted are representative of a dualistic view and therefore not congruent with Ornstein's position. Since interaction

(causality) between body and mind does not appear to be feasible in Jung's view, he applies the synchronicity principle, i.e. "the meaningful coincidence in time" as an explanation for the co-occurrence of physical and mental phenomena. One could be pressed into viewing the synchronicity principles as the third principle in a tripartite philosophy of reality, if it were not that Jung equals that principle in "rank" with that of physical causality. Besides, he does not consider the synchronicity principle to be "standing outside empirical nature" in the manner of e.g. a co-ordinating God.

Another difference between Jung's and Ornstein's concepts exists. Both space and time are associated with causality as well as acausality by Jung, although the latter is to be viewed "relatively" independent of space and time. However, Ornstein associates time with the analytic (causal) and space with the holistic (acausal) mode of consciousness respectively. Therefore, the space-time dimension as presented by Jung can not be a supportive component of Ornstein's two modes of consciousness.

2) Can the original dichotomy be related to differences between the brainhemispheres in cognitive functioning?

The very essence of synchronicity is its non-relationship with cortical events as is clearly expressed by Jung.

> I am only too conscious that synchronicity is a highly abstract and "irrepresentable" quality. It ascribes to the moving body a certain psychoid property which, like space, time and causality forms a criterion of its behaviour. We must completely give up the idea of the psyche's being somehow connected with the brain, and remember instead the "meaningful" and "intelligent" behaviour of the lower organisms, which live without a brain (452).

3) Can the original dichotomy be related to sex differences in cognitive functions?

Jung does not present causual-acausal in a context of sex differences and no research has been produced in this respect.

Most of the dichotomies presented in this first group, i.e. verbal-spatial, analytic-holistic, sequential-simultaneous, active-receptive and intellectual-sensuous, can be interpreted as being based on a monist position and in this respect they are congruent with Ornstein's position in relation to the body-mind issue. However, none of the authors who originated the dichotomies of the first group has taken an "emergent evolutionist" stance and the description of the dichotomies can not be interpreted in such a framework either.

Therefore, a discrepancy with Ornstein's formulations relevant to the issue exists. In addition, the time-timelessness and causal-acausal dichotomies have a foundation essentially different, i.e. dualistic, from Ornstein's modes of consciousness.

The right-left dichotomy is of such a nature that meaningful interpretation is not possible within the context of the thesis.

Group II

Argument-Experience

Roger Bacon, one of the early founders of contemporary science, wrote in 1268 A.D., in his Opus Majus:

> ...I now wish to unfold the principles of experimental science, since without experience nothing can be sufficiently known. For there are two modes of acquiring knowledge, namely, by reasoning

> and experience. Reasoning draws a conclusion and makes us grant the conclusion, but does not make the conclusion certain, nor does it remove doubt so that the mind may rest on the intuition of truth, unless the mind discovers it by the path of experience; since many have the arguments relating to what can be known, but because they lack experience they neglect the arguments, and neither avoid what is harmful nor follow what is good. For if a man who has never seen fire should prove by adequate reasoning that fire burns and injures things and destroys them, his mind would not be satisfied thereby, nor would he avoid fire, until he placed his hand or some combustible substance in the fire, so that he might prove by experience that which reasoning taught. But when he has had actual experience of combustion his mind is made certain and rests in the full light of truth. Therefore reasoning does not suffice, but experience does (593).

As will be noted, the term "reasoning" in this quotation replaces "argument" in the dichotomy presented by Ornstein. Reasons are that Ornstein used a different and only partial translation of the relevant passage.

1) Is the original dichotomy conceptually congruent with Ornstein's two modes of consciousness?

In relation to facets of science as described by two modes of consciousness, Ornstein stated that "science is the very essence of the analytic mode..." (57). Bacon describes two complementary aspects of scientific method, i.e. hypothesizing, theory building, etc. (reasoning) and physical verification (experience). Both reasoning and experience as described by Bacon, belong to the analytic mode in Ornstein's framework and not to the analytic and holistic mode respectively, which is their place assigned by Ornstein. Thus, Ornstein has created a dichotomy dissimilar to the one intended by Bacon.

2) Can the original dichotomy be related to sex differences in cognitive functions?

In view of the meaning of the original dichotomy and present knowledge in this respect, the answer is "no."

Explicit-Tacit

In The Study of Man, Polanyi (1959) describes the explicit and tacit forms of knowledge in the following manner.

> ...in my view, human knowledge is of two kinds. What is usually described as knowledge, as set out in written words or maps, or mathematical formulae, is only one kind of knowledge; while unformulated knowledge, such as we have of something we are in the act of doing, is another form of knowledge. If we call the first kind explicit knowledge, and the second, tacit knowledge, we may say that we always know tacitly that we are holding our explicit knowledge to be true. If, therefore, we are satisfied to hold a part of our knowledge tacitly, the vain pursuit of reflecting ever again on our own reflections no longer arises... Tacit knowing appears to be a doing of our own, lacking the public, objective, character of explicit knowledge. It may appear therefore to lack the essential quality of knowledge ... but ... I deny that participation of the knower in the shaping of knowledge must invalidate knowledge, though I admit it impairs its objectivity (12-13).

To learn more about the nature of tacit and explicit knowledge and their relationship from the following passages:

> The structure of tacit knowing is manifested most clearly in the act of understanding. It is a process of comprehending: a grasping of disjointed parts into a comprehensive whole (28).

and

> We cannot comprehend a whole without seeing its parts, but we can see the parts without comprehending the whole. Thus we may advance from a knowledge of the parts to the understanding of the whole (29).

1) Is the original dichotomy conceptually congruent with Ornstein's two modes of consciousness?

It appears that the contrast between explicit and tacit knowing is similar indeed to that of analytic and holistic knowledge. The "scientific" and "nonscientific" characteristics of the respective modes are recognizable. Also, the emergent aspects of the "tacit" mode to a possibly "higher" level of understanding is implied by the use of the term "advance." However, Polanyi associates "objectivity" with the explicit (analytic) mode, whereas Ornstein links objectivity with the tacit (holistic) way of knowing. The "objectivity" of the explicit mode as proposed by Polanyi is in the objectivity of scientific method, which in Ornstein's descriptions belongs to the same pole of the dichotomy (i.e. analytic) but is labelled "subjective" by him. By contrast, Ornstein considers the holistic (in Polanyi's terms "tacit") mode to be objective, possibly because it is a more general, "all encompassing" mode of knowing, less biased by characteristics of sensory organs and the brain.

2) Can the original dichotomy be related to sex differences in cognitive functions?

Polanyi did not discuss sex differences and present knowledge does not indicate "explicit-male" versus "tacit-female" modes of knowing.

Lineal-Nonlineal

Primarily on the basis of studies of the language of Tobriand Islanders, Lee (1950) arrives at the perception that they "codify, and probably apprehend reality, nonlineally in contrast to our lineal phrasing" (128). The author also assumes that

> ...a member of a given society not only codifies experienced reality through the use of the specific language and other patterned behavior characteristics of his culture, but that he actually grasps reality only as it is presented to him in his code. The assumption is not that reality itself is relative; rather that it is differently punctuated and categorized, or that different aspects of it are noticed by, or presented to the participants of different cultures (128).

In contrast to our lineal language, Lee (1956) presents the following examples of the non-linearity of the language of the Tobriand Islanders.

> A Tobriand word refers to a self-contained concept. What we consider an attribute of a predicate, is to the Tobriander an ingredient. Where I would say..."The gardener is good," the Tobriand would include both "gardener" and "goodness"; if the gardener loses the goodness, he has lost a defining ingredient, he is something else, and he is named by means of a completely different word....There are no adjectives in the language; the rare words dealing with qualities are substantivized. The term "to be" does not occur; it is used neither attributively nor existentially, since existence itself is contained; it is an ingredient of being. Events and objects are self-contained points in another respect; there is a series of beings, but no becoming. There is no temporal connection between objects... neither is there a temporal connection made - or, according to our own premises, perceived - between events; in fact, temporality is meaningless. There are no tenses, no linguistic distinction between past or present. There is no arrangement of activities or events into means and ends, no causal or teleologic relationships. What we consider a causal relationship in a sequel of connected events, is to the Tobriander an ingredient of a patterned whole. He names this ingredient u'ula (137).

1) Is the original dichotomy conceptually congruent with Ornstein's two modes of consciousness?

The codification of reality through the media of lineal versus non-lineal processes is indeed analogous to the analytic and holistic modes of knowing and thus congruent with Ornstein's co[illegible]

However, it should be noted that Lee uses primarily analytic (lineal) and holistic (non-lineal) language processes as support for her contention of bi-modal codifications of reality and Ornstein uses, in this instance, these language processes in support of both his modes of consciousness. That is contrary to the position Ornstein maintains throughout The Psychology of Consciousness in which he expresses that "the concepts of causality, linear time and language are the essence of the (analytic) mode" (61). Ornstein does not differentiate between analytic-lineal and holistic-non-lineal language, rather he actively and consistently identifies all forms of language, almost by definition, with the analytic mode only, except in this instance when Lee's proposed dichotomy fits his concept of two modes of consciousness.

2) Can the original dichotomy be related to sex differences in cognitive functions?

Lee does not discuss her concept in terms of sex differences and no relevant research has been published. Scrutiny of existing research related to sex differences in linguistic skills does not reveal better female performances on holistic (non-lineal) oriented language skills and better male performances on analytic (lineal) oriented language skills. Females simply perform better on all language skills.

The Creative: heaven, masculine, Yang, light, time
The Receptive: earth, feminine, Yin, dark, space

The creative-receptive dichotomy presented in this section has its origin in the I Ching. Legge (1964) informs that:

> The word I (Change) has given its name to the book known as the I Ching. The system of the book has as its basis the eight trigrams, which symbolize the eight fundamental elements or factors of the universe and the different attributes that should be suggested by and associated with them. Then the eight trigrams were combined until there were sixty-four hexagrams, each symbolizing one or more phenomena of the universe, either natural or human. Together, all the hexagrams were supposed to represent symbolically all the possible situations or mutations of creation, a universe in miniature (XXXIX).

Two primal forces, i.e. the Yang (the virile, positive element, the male) and the Yin (the docile, negative element, the female) are contained in the first (Ch'ien) and second (K'un) hexagrams which symbolize the "creative" and "receptive," respectively. Their full descriptions are as follows:

> The first hexagram is made up of six unbroken lines. The unbroken lines stand for the primal power, which is light-giving, active, strong and of the spirit...Its image is heaven. Its energy is represented...as motion. Time is regarded as the basis of this motion. The power represented by the hexagram is to be interpreted in a dual sense...in relation to the universe...the strong, creative action of the Deity. In relation to the human world, it denotes the...holy man or sage, the ruler or leader of men, who through his power awakens and develops their higher nature (127).

By contrast the second hexagram

> ...is made up of broken lines only. The broken lines represent the dark, yielding, receptive primal power of Yin. The attribute...is devotion; its image is the earth. It is the perfect complement of the creative, not the opposite. It represents nature... earth... space... the female-maternal. However, as applied to human affairs, the principle of the complementary relationship is found not only in the relation

> between man and woman, but also in that between prince and minister and between father and son. Indeed, even in the individual this duality appears in the coexistence of the spiritual world and the world of the senses (128).

1) Is the original dichotomy conceptually congruent with Ornstein's two modes of consciousness?

It is difficult to understand why Ornstein would use the metaphors as serious support for his concept. The adjectives associated with "The Creative" and "The Receptive" are not of the level of descriptive relevancy that is evident in most other dichotomies used for support of bi-modal consciousness. It is impossible to ascertain how the analytic and holistic mode can be interpreted meaningfully in terms used to describe "The Creative" and "The Receptive" respectively.

A possible exception is the time-space dichotomy which was discussed (and disputed) as a viable concept during the presentation of analytic-holistic processing. However, in this instance Ornstein accepts a time-analytic versus space-holistic dichotomy, whereas he was equally in favour of Jung's dichotomy which saw both time and space located at the analytic as well as holistic pole of the causual-acausal dichotomy.

Also, the relationship between the creative (male) and receptive (female) is opposite to that of the analytic and holistic modes. The position of prince and father vis a vis minister and son imply some form of superiority (higher level of functioning?) attributed to the former two. In Ornstein's scheme the minister and son (holistic mode) would have to take that position.

2) Can the original dichotomy be related to sex differences in cognitive functions?

Ornstein places the Yang and Yin phenomena in the Universe at the correct poles of his modes of consciousness. One can question the "cognitive" qualities of terms as e.g. heaven and earth, but above all, and with the sincere respect that is due ancient Chinese philosophy, no exclusive relationships have been demonstrated to exist between e.g. "heavenly creativity" and males or "earthly receptivity" and females.

In the second group of dichotomies, explicit-tacit and lineal-non-lineal are conceptually congruent with Ornstein's two modes, while argument-experience is not. The creative-receptive dichotomy is of such a nature that meaningful interpretation is not possible.

Conclusions

Whereas at "face-value" most of the dichotomies appear to fit Ornstein's two modes of consciousness, upon close scrutiny they become demonstrably incongruent. The foremost, but not only, reason for the discrepancies consists of Ornstein's need to declare the "cosmic" mode to be emerging from the "ordinary" mode of consciousness, while essentially also differing from it, since the former is of a "higher" level than the latter. Some implications of the foregoing discrepancies and a more general treatment of the problems involved in dichotomous conceptualizations constitute the final section of this chapter..

In addition to the previous major discrepancies between the two modes of consciousness and the original dichotomies, other, significant errors have been committed by Ornstein, in that he has ignored or misinterpreted the meanings of dichotomies, or of important components, which constitute an integral part of them. In this respect the following errors come to mind: (1) the misplacing of "verbal" and "spatial" in relation to the sexes, (2) the "back to front," instead of "left versus right" of sequential and simultaneous processing as proposed by Luria, (3) the importance of the role of the sensory system in the holisitic and not the analytic mode, (4) the differences in the interpretations of "subjective" and "objective," (5) inconsistencies in the location of time and space at the poles of a dichotomy, and (6) the lack of recognition that Lee's lineal-non-lineal dichotomy involves a perception of language not congruent with his own. The resulting contradictions and inconsistencies may not invalidate the inclusion of specific dichotomies in the chart, but their presence does weaken the support for Ornstein's concept.

The reader will now also be aware that neither the two modes of consciousness, nor the poles of the original dichotomies, have been or can be clearly identified with specific hemispheres. The early indications from neurophysiological research in the late 1960's used by Ornstein for support, have been insufficiently confirmed by subsequent findings. Many unanswered questions remain, as is attested to by the peer commentary on both the McGlone (1980) and Bradshaw and Nettleton (1981) reviews. The assigning in 1982 of specific hemispheres to bi-modal forms of cognition, or to dichotomous conceptions that

originated decades and even centuries earlier, is clearly not justified. Therefore, one can validly question the wisdom of even a "tentative" assignment of brainhemispheres in such a manner, as is proposed in The Psychology of Consciousness published in 1972.

Through the investigation of possible associations between the human organism's sex and specific modes of consciousness, it has become evident that, with the exception of the verbal-spatial and LH-RH, none of the dichotomies has been sufficiently researched to provide support for the inclusion of "male" versus "female" in Ornstein's chart. Besides, the literature in the two areas that have been investigated, promotes a non-binary classification of sex differences in cognition. Above all, the problem remains that Ornstein associates verbal abilities with the analytic, linear, male mode of consciousness and spatial abilities with the holistic, non-linear, female mode. Research data have convincingly demonstrated the opposite occurs i.e. stronger verbal abilities characterize females, and better spatial abilities characterize males.

Also, if Ornstein is correct in his interpretation of the emergent evolutionist position, the consequences are that females are more inclined to function at a holistic, i.e. higher, more evolved level of consciousness than males are. In this regard, it is useful to remind the reader of the value-laden adjectives associated by Domhoff with "male" and "female" respectively and included by Ornstein in his text; the incongruencies are significant, and in no way can they be honestly overlooked.

In actuality, Ornstein's The Psychology of Consciousness is of no assistance in understanding sex differences in modes of consciousness. The inclusion of the Domhoff and I Ching dichotomies reinforces stereotypical thinking and many of the other dichotomies have been demonstrated to be of no genuine relevance to understanding sex differences.

It is important to note that Ornstein labels his two modes of consciousness "a tentative dichotomy" and that it is based on "tendencies" and "specializations" and "not at all (on) binary classifications." Such a description leaves him with the flexibility to choose for inclusion in his chart whatever dichotomy appears to fit his concept of two modes. However, in view of the following definition of a dichotomy, its "tentativeness" is questionable.

> On the hypothesis that opposites always come in pairs, every class can be divided into two sub-classes, which not only exclude each other, but also exhaust the membership of the individual class. Such division is called dichotomy (Great Books of the Western World, 1952, 3, 324).

The implication is that a dichotomy "is" or "is not" and that "tentativeness" must be excluded as a possible quality of a dichotomy. The problem arises because Ornstein does not elaborate on important conceptual problems inherent in the use of logical opposites. The following will clarify.

As stated previously, consistent themes within the neuropsychological literature suggest that, although LH and RH functional specializations exist, these specializations are not to be interpreted in an "either-or" fashion, rather they must be viewed on the basis of a

continuum. Thus, differences are of a quantitative (degree) and not of a qualitative (kind) nature. However, quantity and quality are not necessarily clearly distinguishable properties of a substance or process. It is useful to illustrate this briefly by means of dichotomies in Ornstein's chart.

For instance, a dilemma is posed by the consideration that a dichotomy can be thought of as two concepts at opposite poles of a co[redacted]um or as two mutually exclusive opposed concepts, without a [redacted]ing continuum. Ornstein includes both kinds of dichotomies in his chart. Light and dark can be thought of as opposites on a continuum; one can visualize a quantitative change from light to dark (or vice versa) eventually resulting in a qualitative difference between the two phenomena. One can even think of Verbal and Spatial in this manner, once it is realized that verbal (language) processes are involved with, or mediate, spatial cognitions and vice versa. In addition to such polarities resulting from a continuum, Ornstein does include, contrary to his denial, dichotomies of a binary, i.e. mutually exclusive nature as for instance causal-acausal and sequential-simultaneous. One can not think, in such instances, of a quantitative change from one pole towards the other, eventually resulting in a qualitative difference between the two concepts. The differences are there "a priori." This discredits Ornstein's claim that his two modes of consciousness are based on "tendencies" only.

Related to the previous are problems with the "logic" of the "oppositeness" of dichotomous terms and concepts used by Ornstein. For instance, Time is presented as the opposite of Timelessness

(Oppenheimer) and Space (I Ching), while Spatial is not at the opposite pole of Temporal, but rather of Verbal. Intellectual is posed face to face with Sensuous (Blackburn) and Intuitive (many sources), and Receptive is contrasted with Active (Deikman) and Creative (I Ching). The mutual exclusivity of sub-classes in a dichotomy is obviously not adhered to by Ornstein. Compared to those included in Ornstein's chart, terms like e.g. Destructive and Passive, would also appear to be appropriate opposites for Creative and Active, respectively.

It is recognized that Ornstein was not the originator of these dichotomies and that allowance should be made for specific definitions and descriptions by individual authors. However, it would have been illuminating had Ornstein drawn the readers' attention to various modes of logical opposites. In this respect, one can think of, for instance, Aristotle's fourfold classification of correlative opposites (double and half), contrary opposites (black and white), opposites of negation and affirmation (just and unjust) and opposite of possession (sight and blindness).

Also arguments have been brought forward about the priority or fundamentality of quantity versus quality. In the context of the mind-body issue a question may be posed about the priority of quantitative differences in the structure and mass between LH and RH, when compared with the qualitative functional differences they are identified with. One's position in relation to the body-mind problem, or to the nature of the specific phenomenon under study might be the deciding factor in determining the priority of quantity versus quality of substance and processes. However, Ornstein ignores such problems.

Other issues interrelated in the quantitative and qualitative aspects of dichotomous dimensions of consciousness involve those of "attribute" versus "independent entity" and "experienced reality" versus "verbalization." For instance, are "analytic" and "holistic" meaningful only when descriptive of the cognitive processes of an individual and experienced by him/her? as expressed in e.g. "John feels he is a holistic thinker, but Mary says she thinks analytically." Or, are "analytic" and "holistic" also meaningful as non-experienced, verbalized entities in themselves?

The previous is meant to demonstrate that many considerations influence the relationships one perceives between quantity, quality and dichotomy. The reader of an exposition of modes of consciousness, which includes terminology such as "tentative dichotomy," "binary classification" and "complementarity" would have benefitted had a context pertinent to the concept of dichotomy been provided as part of such an exposition. This is even more important since many of the considerations presented here are relevant for the discussion of sex differences also. Regrettably, Ornstein has not provided any background information about the issues involved in logical opposites and dichotomies.

It is realized that Ornstein's position on the body-mind problem as presented in the thesis, is not of his own making. One could argue that the assigning of a particular philosophical position is a precarious undertaking and could be in error. However, it is difficult not to declare Ornstein an "emergent evolutionist," for in spite of the lack of clarify in his presentations, The Psychology of Consciousness

abounds with the emergent monist position. As demonstrated previously, that position is discrepant with dichotomies included in Ornstein's chart. Those discrepancies have important theoretical implications.

For instance, both the dualist and non-emergent monist positions allow for complementarity of conscious functions which are located at the opposite poles of a dichotomy. After all, whether body does or does not equal mind, does not prevent either form of consciousness to complement its counterpart, as long as the functions are of the same phenomenal level or order, and neither dualism nor non-emergent monism excludes that possibility. The feasibility of "translation" from one mode into the other within such a framework may very well depend on the modes being either at the opposite poles of a continuum or mutually exclusive. The translation of one pole on a continuum in the terminology of its opposite may be possible, but that is inconceivable for two concepts that have no connection by means of a continuum and thus are mutually exclusive.

By contrast, a higher level of consciousness which, according to the emergent monist position, has evolved through the "breaking down or repressing of the structures" (Ornstein, 1972) or the "combination of the structures" (Bunge, 1980) of its lower counterpart can, by definition, not be complementary to the latter and therefore not be translated into it either. In spite of the incongruency, Ornstein presses for such translations and explanations to take place, i.e. the higher mode must be understood and investigated through the methods of the "ordinary" mode. In addition, he accepts through the inclusion of their dichotomies in his chart, both Deikman's positive and

Oppenheimer's and Blackburn's negative positions about the feasibility of such translations and explanations. There are obvious inconsistencies in Ornstein's approach.

The specific version of Ornstein's emergent evolutionist position poses another theoreteical problem. If the holistic-RH mode "suppresses" and "breaks down" the structure of the analytic-LH mode indeed, and if "function equals structure" is a valid monist position, one logical consequence is the physical "deterioration" of the LH during the functioning of RH consciousness.

In conclusion, Ornstein's proposal for the existence of two modes of consciousness, based on the dichotomous concept he presents in his charts, has to be refuted. It appears that a simple and therefore attractive "analytic versus holistic" concept resulting from neuropsychological investigations in the late 1960's, gave rise to the rather "grandiose" notion of two modes of consciousness. It should not be forgotten that the original analytical-gestalt, focal-diffuse and propositional-appositional concepts all derived from clinical (especially commissurotomized) cases. As indicated previously in the thesis, such cases do not provide data from which generalizations about the entire population can be made.

Ornstein has also attempted to "force" support for his concept through mis-interpretations of similar concepts in psychological and philosophical literature. Upon close scrutiny many of these concepts are demonstrated to be incongruent with (or irrelevant to) the analytic-holistic dichotomy. Above all, the validity of "analytic" and "holistic" as such have come under attack as the result of 15 years of

neuropsychological research conducted since their inception. This is not to deny that a concept of two modes of consciousness is worthy of investigation. Rather it is thought that such obviously complex matters deserve a philosophical and scientific treatment of greater scope and depth than that provided by Ornstein. This is especially important since any data involving sex differences are socially sensitive and become even more so when simple explanations are offered for that complex issue. When the simple explanations appear in a text that is popular, especially among university students, there is reason for concern. That concern, among other motivations, induced the writing of this thesis.

CHAPTER VI

FINAL COMMENTS

Introduction

In the introduction of the thesis it was noted that the meaning of "the sexes are equal," "the opposite sex" and "that is typically masculine or feminine" is frequently not clear in spite of extensive debates surrounding such statements and phrases. In Chapter III the political aspects of the biology versus environment issue were discussed in relation to research in sex differences, while biological and environmental explanations for the observed sex differences in verbal and visuo-spatial cognitive functions were also presented. It was hoped that clarification would be obtained about the concepts of "masculinity" and "femininity" and their interrelationship, through the exploration of Ornstein's concept of two modes of consciousness. However, his limited treatment of the subject matter prevented the occurrence of such clarification. In view of Ornstein's failure it is thought to be meaningful to conclude the thesis with a discussion of "masculinity" and "femininity," the opposing aspects of the concepts and their biological and environmental origins. Such a discussion will take place through the following arguments:

a) the present female-male controversies are due to unequal social values associated with "masculine" or "feminine."

b) remedies aimed at the antagonistic situation come primarily in the form of attempts at the integration of "masculine" with "feminine" and not through the equal valuing of the two concepts. In other words, the emphasis is on "both men and women are masculine as well as feminine and therefore equally valuable" rather than on "men are masculine, women are feminine and masculinity and femininity are equal in value."

c) the attempts at integration consist of the promotion of the concept of "psychological androgyny" and of identical social and intellectual educational processes.

d) however, "psychological androgyny" may be conceptually inviable and it has not been demonstrated to promote greater personality integration through the incorporation of "masculinity" and "femininity." Besides, the education of "masculine" in terms of "feminine" (or vice versa) may be to some extent impossible.

e) thus, it can be thought that the solution of male-female controversies is more likely to occur through the changing of values associated with "masculine" and "feminine;" however, this will also be difficult to accomplish since value systems are strongly entwined with educational processes.

Masculinity, Femininity and Valuing

"Masculine" and "feminine" have been described as qualities regarded to be characteristic of men and women respectively (Webster, 1960). The origin of these qualities has been considered to be "more

or less" rooted in anatomy, physiology and early experience (Constantinopole, 1973) distinguishing between the sexes in appearance, attitudes and behavior. Constantinopole (1973) referred to the prevalence and frequency of the two terms "masculinity" and "femininity"

> their hallmarks and salience in personal development, are widely discussed in relation to both individuals and groups, and it often seems that value judgements are implicit in both general and professional applications of the terms (390).

In the early 1970's a number of researchers investigated the descriptive terminology associated with "masculinity" and "femininity." The reader will be interested in the list of terms "distilled" from their efforts. Feminine individuals have been considered to be: subjective, intuitive, passive, tender minded, sensitive, impressionistic, yielding, receptive, emotional, conservative, non-competitive, conforming, socially oriented in general and specifically in achievement motivation. Feminine interests have focussed on literature, music, fine arts; these are also oriented towards social services and involved with commercial, secretarial and health oriented occupations. Feminine reading interests have been considered to consist of fiction, biographies and short stories about "real" people.

In contrast, masculine characteristics have been viewed as: aggressive, independent, dominant, self-sufficient, confident, objective, analytic, hostile, less affectionate, and occupationally oriented in achievement motivation. Masculine interests have been described as being: mathematical, scientific, political, computational and historical. Masculine activities were stated to be vigorous and the content of masculine reading materials adventure stories, sports

and mysteries (Angrist, 1972; Bardwick, 1971; Broverman, Vogel, Clarkson & Rosen Krantz, 1972; Maccoby, 1972; Peoples, 1975; Sherman, 1971, Sorenson & Winters, 1975).

The previous description and those by Domhoff and I Ching in Chapter V of the thesis will cause the reader to agree with Constantinopole (1973) that "value judgments are implicit." In this respect Lambert (1978) relates that the valuing of sex differences by society is influenced by the perception of their causes.

> Biological (usually meaning intrinsically determined) differences are often regarded as more reasonable bases for unequal social rewards than are differences that result from variations in the environment, which are held to have more of a claim to compensatory special treatment (114).

However, Lambert rightfully questions the moral justification of such social attitudes since, "...one does not deserve one's genes or hormones any more than one deserves accidents of birth, such as social class" (115).

In addition to the observations made in Chapter IV about the political (socio-economic, philosophical) influences on and impact by the study of sex differences, it is at this point useful to relate some of the feminists' viewpoints regarding values implicit in relevant research methodology.

In an unpublished paper, Malmo (1978) reviews the literature and quotes Eichler (1977):

> I shall here consider such research feminist that regards women as subjects rather than objects; it does not treat men as the norm and women as a deviation of the norm (410).

The importance of Eichler's (1977) consideration is confirmed in view of the change noted in interpretations of brain hemispheric functions that took place as a result of a more equal representation of the sexes in samples of subjects (see p. 115).

Similar concerns are expressed about the inevitable male bias, due to historically male originated, conducted and interpreted research on, for instance, the "Psychology of Women," which by one feminist author is considered to be a "conceptual monstrosity...because it implies the need for a special set of laws and theories to account for the behavior and experience of women" (Parlee, 1975, 120). This male bias is perceived to effect and therefore thought to require a re-evaluation of, for instance, conceptual frameworks, problem formulations and operationalization of terms, the distortion of facts, the omission of problems and the improper reporting of sources.

On the other hand Malmo (1978) also presents the views of other feminist authors, who suggest that the experience of women be studied from "within," i.e. phenomenologically, and that "feminine researchers place the methodological and theoretical models of science within their social and political contexts" (27). Contrary to Parlee (1975), Malmo (1978) seems to suggest that something distinct does exist about "The Psychology of Women," but if there is to be a bias in the study of the subject matter, it should at least be a female bias. One can question where this leaves an "objectively scientific" study of sex differences; possibly it is "a priori" impossible, as suggested in the introduction of the thesis.

One final quotation from Unger (1979) once again confirms the relationship that is so frequently perceived to exist between valuing

and the study of sex differences.

> ...characteristics of behaviors as sex specific is particularly questionable in view of the abundant evidence that the social judgement process almost always results in the equations, male=superior, female=inferior (1092).

The biological structures predisposing the sexes to mutually exclusive interactions with their environment qualify as one possible source for sex differences in "masculinity" and femininity." In this respect one has to refer to the known qualitative differences in anatomical and physiological structures and biochemical processes related to reproduction. The implications are that three experiences belong only to women, i.e. the menstrual cycle, the growth of a child within her culminating in the birth process, and breast feeding. Vallé and Kruger (1980) describe the lasting effects of these experiences on the consciousness of women. In relation to the menstrual cycle they find that the female body

> does not progress in a steady, constant straight line, it fluctuates...hormones create different states of awareness which each monthly surely follow one upon the other. In the feminine consciousness, time is perceived not simply as a straight line, but also as a cycle, a constant returning to the beginning, a repeating theme with variations (38).

The authors emphasize two conscious experiences associated with pregnancy and childbirth

> One is a creativity which involves providing the environment and watching with great patients, what is to emerge; the second is knowledge of what it means to give to another (38).

The giving to another is an "innate sense" since the pregnant body "becomes a state of selflessness" and the creativity of childbirth is

not "masculine" but "feminine" in nature in that "the final outcome is unknown and the creative process involves letting go rather than doing" (38). Vallé and Kruger (1980) think that all women at least identify with that process if not actually experiencing it.

The nurturing of an infant also effects the consciousness of women permanently. Since mother's breasts are full and uncomfortable at feeding time

> the feeding relieves not only the child's hunger, but also the mother's discomfort. This symbiotic relationship...enhances a women's understanding of the importance and possibility of mutually fulfilling relationships (38).

Thus, if Vallé and Kruger are correct, biological sex differences may cause psychological experiences unique to females. In the context of Aristotle's classification, the relevant female-male dichotomy involves opposites of negation or affirmation, that is, to be "masculine" really means to be "non-feminine." Therefore the dichotomy is based on mutually exclusive poles, similar to causal versus acausal, but different from light versus dark, which involves opposites on a continuum.

All other experiences and related behaviors appear to be at least potentially available to both sexes, although under the influence of biological sex differences and/or sex stereotyping they may not only be encountered more frequently in one sex, but therefore also be considered to be more appropriate for one sex rather than the other. The resulting "maseulinity" and "femininity" can be viewed as poles on a continuum.

Psychological Androgyny

Evans' (1975) investigations have demonstrated the extreme theoretical positions that have developed vis a vis the biology versus environment controversy in relation to sex differences. She found that the "new biologists" emphasize human's primate heritage of innate aggression, territoriality, male dominance and male-male bonding over male-female bonding (necessary for reproduction only) while the "new feminists" deny the existence of sex differences (except reproductive ones), hold males solely responsible for the oppression of women and devalue the need for nuclear families.

Both views are not only extreme but also limiting and dehumanizing and therefore, contemporary attempts at countering such thinking or at the depoliticizing of the concepts of "masculinity" and "femininity" are frequently expressed through the proposition that both males and females should strive for and even be educated towards "androgyny." Singer (1977) has written compellingly and sympathetically about androgyny "which in its broadest sense can be defined as the One which contains the Two; namely the male (andro-) and the female (gene-)" (6). The expression by both males and females of their masculine as well as feminine characteristics through psychological androgyny is encouraged since it is thought that a better integrated personality will be created in the process.

The feasibility of psychological androgyny appears to depend on one's view of "masculinity" and "femininity" as being either opposite or merely differing concepts. Therefore "masculinity" and "femininity"

and their relationship to psychological androgyny will presently be discussed in a context of issues similar to that previously associated with dichotomies.

If "masculinity" and "femininity" are viewed as poles of a behavioral continuum, difficulties arise with regard to their integration into psychological androgyny. The following will illustrate. If the "masculine" is to become more "feminine," and vice versa, the "feminine" more "masculine" one can visualize the gradual change from the poles along the continuum to its center. However, the question arises if and at what point a quantitative change in "masculinity" becomes a qualitatively differing "femininity" (and vice versa). Not only that, but at the centre point of the continuum a state of indifferentiation and not integration, i.e. psychological androgyny exists.

The problem appears to be solved when "masculinity" and "femininity" are viewed as independent, not opposing clusters of traits, which are no longer associated with either the female or male sex. For instance, and again in Aristotle's terms, "dominance" would not have the contradictory "submission" as its opposite, but rather its negation, i.e. "non-dominance." Psychological androgyny could then be viewed as the true integration of all traits or behaviors. However, at the moment that androgyny in its "pure" form is realized "masculinity" and "femininity" and therefore "androgyny" itself, cease to exist as meaningful concepts. Bem (1974) who has put great effort in the demystification of "masculinity" and "femininity" through the development of new measuring devices, expresses the inevitability of this conclusion quite well.

> ...if there is a moral to the concept of psychological androgyny, it is that behavior should have no gender. But there is an irony here for the concept of androgyny contains an inner contradiction. ...the concept of androgyny necessarily presupposes that the concepts of femininity and masculinity themselves have a distinct and substantive content. But to the extent the androgynous message is absorbed by the culture, the concepts of femininity and masculinity will cease to have such a content ...thus, when androgyny becomes reality, the concept of androgyny will have transcended (Bem, 1979, 1054).

However, psychological androgyny does not cause conceptual difficulties only. The original contention that it would be a cause for greater personality integration through higher self-esteem and a better self-concept has not been substantiated by research either. A short review follows.

The concept of self, which has been described as used as a viable concept

> ...a point of stability, a frame of reference...an object to oneself as well as to others...a source of action, motivation, or discretion (Bardwick, 1971, 154-155).

have been studied in relationship to psychological health, masculinity, femininity and androgyny. The importance of the inclusion of measures of self concept in such a context has been recognized by many investigators (e.g. Berzins, 1979; Korman, 1970; Vogel, 1979), but the investigations have produced inconsistent results. For instance, Edwins, Small and Gross (1980) found individuals who scored low on measures of "masculinity" and "femininity" to have poorer self-concepts than those who scored high in "androgyny" and "masculinity" while no difference was obtained between the latter two groups. The conclusion is that "masculinity" rather than a balance between "femininity" and

"masculinity" is crucial to personal adjustment. Heilbrun and Pitman (1979) hypothesized that androgyny would allow for greater sex role flexibility which is more conducive to adaptive behavior. They found androgynous males to be more flexible than androgynous females and the degree of androgyny to be positively correlated with sex role flexibility in females, but not in males. Orlofski and Windle (1978) found, by contrast, androgynous, masculine and feminine individuals all to score high in personality integration. Flaherty and Dusek (1980) demonstrated androgynous and masculine individuals to be more capable of instrumental roles than undifferentiated females, while androgynous and feminine individuals performed better in expressive roles than undifferentiated males.

Finally, Kaplan (1979) points to dangers of psychological androgyny in Western culture, since

> ...it is questionable that androgynous women are perceived in the same favourable manner as androgynous males, particularly in traditional context. The consequences of internal and external conflicts created by moving toward androgyny or devaluation of feminine characteristics can not be dismissed lightly (223).

Thus, neither conceptually, nor in practice does "psychological androgyny" assist in the clarification of "masculinity" and "femininity" and as such it appears to be an invalid means towards the solution of contemporary difficulties in male-female relationships.

Education and Valuing

Aside from the conceptual and practical difficulties with "psychological androgyny" as a clarifying and problem solving concept, it can be questioned whether the "masculine" can be educated in terms of the "feminine" (and vice versa) and then be integrated with it. Such questioning rests on the previously encountered theoretical considerations, that different modes of consciousness can only be understood in the "terminology" of their own experience. It is valid to ask whether the observation that knowledge is equatable with the nature of acquiring knowledge is true for all forms of knowledge and observation. In other words, is Oppenheimer's (1953) observation that the electron "sometimes must be considered as a wave and sometimes as a particle" depending on "a definition of the nature of the observation" or "the very nature of experiment", universally applicable to knower-known relationships? If so, does this mean that human organisms either as individuals and/or in groups, must be differently conscious of their reality? This could be the case, since human organisms are instruments in the knower-known relationships, instruments whose biological and environmental differences (both quantitative and qualititive) may predispose them for different modes of acquiring knowledge or conscious experience. Finally, does this therefore mean that some forms of conscious experience can be obtained only through its own mode of communication? While applying the previous to sex differences in conscious experience and obtaining knowledge, it must first be re-

emphasized that more commonalities than differences exist among human beings.

However, Bem's (1979) presupposition that "the concepts of femininity and masculinity themselves have a distinct and substantive content" may become acceptable when one allows firstly for unique female and male, biologically and environmentally determined experiences and secondly for their interaction with experiences that are common to both sexes. In the interactive process the impact of the former will "colour" the latter differently for each sex. If one wants to go beyond that possibility, it can be suggested that women and men use different interpretative screens, resulting from some different biology-environment interactions, through which they experience their realities. If the, admittedly speculative, consequences are considered it would mean that females and males experience their realities most frequently as being very similar, less frequently in different nuances of a quantitative nature, but also qualitatively and mutually exclusively different. Thus certain segments of conscious experience would be unique to each sex and efforts at "translation," "explanation" or even "understanding" in the frame of reference of the other sex would be inherently impossible and therefore futile.

It has also been realized that "ways of knowing" (learning, studying, educating) are closely connected with "ways of valuing." For instance, the concerns for the development of the "other" consciousness, RH or holistic modes of cognition and subjective approaches in investigation all stem from a growing dissatisfaction with life in Western cultures which is identified with the impersonality of tech-

nology, science and materialisms and thought to be manifested through the narrow perspectives from which psychologists study man. The not surprising link between a culture, its values and the kind of scientific endeavours it engages in is well expressed by Osborne (1981) in relation to science in general:

> Materialism embodies values...which are incompatible with values implicit in alternative ways of knowing...the evolution of scientific paradigms is a socio-political process involving conflicting values (274).

and in relation to Psychology specifically:

> The narrow metaphysical perspectives of Western psychology seem to result from the avoidance of the subjective human phenomena that constitute part of its raison d'etre and from the implicit value judgment that psychology should be a natural rather than a human science (275).

Similar observations have been made by Ornstein (1972), Tart (1975), Bogen (1977) and Pelletier (1978).

The realization that "ways of knowing" are entwined with "ways of valuing" has consequences for the studying of masculinity and femininity. For, if certain segments of their conscious experiences are indeed unique to each sex, then the values inherent in these experiences would also be mutually exclusive to each sex.

Differences by the sexes in valuing have been associated with sex differences in the relationship between "self" and the external world. For instance, Gilligan (1977) perceives that the male conception of adulthood favours

> the separateness of the individual self over its connection to others and (leans) more toward an autonomous life of work (482),

while the female "self"

> is so much more embedded in relationships with others and (leans) toward the interdependence of love and care (482).

Gilligan suggests that these sex differences in the relationship between "self" and the external world leads to differences in moral development and judgments. In contrast to existing theories of moral development and not corporated into them, are the moral dilemma's of females which come in terms of conflicting responsibilities. Each stage in development represents

> a more complex understanding of the relationship between self and other...a re-interpretation of the moral conflict between selfishness and responsibility. The development of women's moral judgments appears to proceed from an initial concern with survival, to focus on goodness, and finally to a principled understanding of non-violence as the most adequate guide to the just resolution of moral conflicts (515).

One will miss in this account the emphasis on abstractions such as rules, authority and standards encountered in e.g. Kohlberg's stages of moral development, considered to be male originated and oriented by Gilligan. She expresses succinctly what the writer of the thesis considers to be an essential difference between "male" and "female" moral judgments.

> The blind willingness to sacrifice people to truth, however, has always been the danger of an ethics abstracted from life (515).

The consequences of the relationship between "self" and the external world have also been commented on by Weil (1973)

> The ultimate distinction...is the one between "self" and "not-self"; the sense of "I" distinct from everything else in the universe is the very root of ego-consciousness. Further in the ego's own terms, all that is not-self is potentially threatening...consequently, persons who have not yet learned to let go of ego-consciousness must experience...existential loneliness (and with it) the inevitable conviction that one is surrounded by a hostile universe (125).

If Weil is correct, it constitutes a revealing comment on the dangers inherent in the male ego, a comment that is in agreement with the popular conception that men's egos are "larger" and more vulnerable than those of women. Be that as it may, it can not be denied that one's biological sex is intrinsically involved in the development of a concept of self. It is noteworthy in this respect also, that viewpoints have been expressed and documented indicating that, in addition to environmental influences, biological differences between the sexes are a cause for differences in their value system (e.g. Lambert, 1978; Shainess, 1972; Wilder, 1977).

As such and without referring to it, both Gilligan's and Weil's perceptions about sex differences in valuing and its relationship to the self are remarkably congruent with Witkin's (1954, 1962) theory of self-nonself segregation which has been found to be applicable to all psychological domains, i.e. cognitive, affective and social. Research by Witkin and his coworkers has demonstrated consistently that males function in a manner indicative of greater segregation of their "self" from the environment than is the case for females. (Goodenough and Witkin, 1978; Van Leeuwen, 1978; Witkin, Faterson, Goodenough & Karr, 1962; Witken & Goodenough, 1977).

In summary, we have not only seen that societies value "masculinity" and "femininity" differentially, but also that males' and females' value systems are dissimilar in orientation possibly due to differences in segregation between self and the environment. In addition, it was discussed that some modes of knowing or obtaining knowledge may be mutually exclusive to either sex due to essential differences in biology-environment interactions. Thus, specific conscious experiences and their intrinsic values may be available to one sex only at the exclusion of the other sex. This implies the possible existence of different modes of conscious experiences for females and males respectively, however, that possibility is based on premises which differ from those offered by Ornstein in 1972.

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