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LATERAL EYE-MOVEMENTS TO POSITIVE AND NEGATIVE AFFECTIVE QUESTIONS: DIFFERENTIAL HEMISPHERIC SPECIALIZATION OR DIFFERENTIAL ATTITUDES TOWARD THE LEFT AND THE RIGHT?

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by

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Abstract

LATERAL EYE-MOVEMENTS TO POSITIVE AND NEGATIVE AFFECTIVE QUESTIONS: DIFFERENTIAL HEMISPHERIC SPECIALIZATION OR DIFFERENTIAL ATTITUDES TOWARD THE LEFT AND THE RIGHT?

by

Stephen D. Ramirez

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This study investigated the possible influence of positive and negative attitudes towards the left and right sides of the body, on lateral eye-movements in response to questions eliciting positive and negative affect. This hypothesis appeared viable because: (1) LEM research has been found to yield inconsistent results, thus, questioning the idea that LEM are indeed indicators of hemispheric activation; (2) the research supporting the Hemispheric Model which proposes that the two hemispheres are differentially lateralized for positive and negative affect can also be seen as somewhat contradictory; and (3) lateral attitudes involving the right and left hands have been quite prevalent in mankind for thousands of years.

Two groups of subjects, 20RHs and 20LHs, half of each group male and half female, were administered LEM questions designed to represent positive, negative and neutral affect. Several attitude and performance

measures were administered to assess differences in attitudes towards the two sides of the body. It was expected that in response to questions eliciting positive or negative affect, the subjects would move their eyes towards the direction they felt most positive or negative about respectively.

The results indicated that right handers felt significantly more positive towards their right side as compared to their left side, while left handers felt significantly more positive towards their left side as compared to their right. Thus, the dominance of the hand was a decisive factor in the determination of the lateral attitudes.

The results of the LEM section were not decisive. The RH group, in a highly statistically significant manner moved their eyes to the right in response to questions eliciting positive affect and towards the left in response to questions eliciting negative affect. The results were supportive of both the Hemispheric Model and the Lateral Attitudes Model. The results for the LH group tended to support the Lateral Attitudes Model but the results were not clearcut. There was a trend for the left handers to show an opposite pattern of eye-movements than the right handers in that they exhibited more left and fewer right LEMs for positive as compared to negative questions. In addition, a Sign test and a $\underline{t}$ test were marginally significant

in demonstrating a difference in response to positive and negative affective questions. Finally, a multiple regression analysis revealed that only handedness was predictive of LEM while the attitudinal variables were not.

These results as a whole suggest that the Lateral Attitudes Model may be a viable one as it pertains to LEMs. The opposite pattern of LEMs for the left handers does not easily fit the Hemispheric Model. Furthermore, the right handed LEM pattern is not as easily explained by the Lateral Attitudes Model as it is by the Hemispheric Model. Implications of the Lateral Attitudes Model were discussed. Recommendations for future research were offered.

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I. LITERATURE REVIEW

In 1961 an operation was performed in which the corpus callosum and all other connecting tracks between the left and right hemispheres were severed in order to attempt to control the spread of epileptic seizure activity from one hemisphere to the other in order to control an otherwise intractable epileptic illness. The operation, performed by Drs. Vogel and Bogen, was a success in that, for the most part, the seizures were greatly reduced in number or eliminated. In addition, the operation was of great theoretical interest because it offered the opportunity to study the functioning of each individual hemisphere in isolation from the other so that a clearer understanding could be gained about each hemisphere's specific abilities, deficits and mode of functioning.

Dr. Roger Sperry and his colleagues performed this research and stimulated great interest in hemispheric research. Thus techniques were developed to study hemispheric functioning in normals. These techniques proliferated and researchers began to study not only the cognitive aspects of cerebral lateralization but other areas as well such as mode of conciousness, creativity and the subject of this study, emotions, their relationship to lateral eye-movements and the implications this has for emotional asymmetries between the hemispheres.

The study of cerebral dominance and emotion has been

touched on or investigated by the use of many different research strategies such as sodium amytal studies (Terzian, 1964; Rossi & Rosadini, 1967; and Hommes & Panhuysan, 1971); lesion studies (Gainotti, 1972); and electroencephalagraphic studies of both normals and depressives (Davidson, Schwartz, Pugash & Bromfield, 1976; and d'Elia & Perria, 1973). On the whole, these data have supported the hypothesis that the dysphoric emotional states such as depression are lateralized to the right hemisphere and that the positive emotions such as joy and happiness are lateralized to the left hemisphere. These studies among others will be reviewed in an attempt to ascertain the status of this hypothesis at the present time.

In the area of laterality research, the study of lateral eye-movements (LEMs) was one of the original paradigms utilized to study the question of hemispheric asymmetry and emotion. Prior to this, the LEM technique had been utilized as a method of study of the verbal/spatial hypothesis which has received a great amount of support from many different lines of research (Kimura, 1974; Dimond & Beaumont, 1974; and Levy-Agresti & Sperry, 1968). This hypothesis states that the right and left hemispheres process information in two different modes. The left, or dominant hemisphere in a right handed individual, functions in the verbal mode, that is sequentially. It is primarily responsible for language pro-

duction and understanding. The right, or non-dominant hemisphere, processes information in a holistic fashion. It is primarily responsible for spatial tasks.

As LEM studies in this area accumulated, doubts arose as to the viability of the hypothesis that eye-movements were really indicators of right (spatial) or left (verbal) activation. Ehrlichman and Weinberger (1978) reviewed 19 experiments on LEMs and the verbal/spatial hypothesis and concluded that the results did not justify an unqualified acceptance of that hypothesis. They did state, although, that the LEM method did appear to give consistent but not decisive support to the hypothesis that emotions were lateralized to the right hemisphere. Subsequent to the writing of this paper, Schwartz (in press) demonstrated that if a person is asked a question eliciting negative affect, his eyes will shift to the left. If asked a question eliciting positive affect, his eyes will shift to the right. This study lends further support to the theory of laterality of emotion in the hemispheres. The question arises, though, why the discrepancy? The lateral eye-movement data, if it is truly tapping laterality effects, should produce data that is consistent with the verbal/spatial hypothesis. It follows from this reasoning that the methodology may not be tapping laterality effects at all. If this is so, it would call into question, in part, the

findings from other sources hypothesizing differential involvement of the left and right hemispheres. It is this question that this thesis will attempt to clarify.

In the following review, the LEM studies will be reviewed in order to gain a clearer understanding of the problems in the research.

The hypothesis offered states that the direction of the eye-shift, in response to a question eliciting negative affect will correspond to the side of the body a person feels most negative about. The reverse will hold true for the contrary. In response to a question eliciting positive affect, the eye-shift will correspond to the side of the body that a person feels most positive about. Thus, this thesis will attempt to offer an alternative to the hemispheric hypothesis in order to explain LEMs in response to questions which arouse emotions.

It is known that in many cultures, past and present, the left side and, in particular, the left hand, has been attributed with many negative characteristics (Fincher, 1977; Hardyck & Petrinovich, 1977; and Domhoff, 1969). This literature will be reviewed to demonstrate a basis for assuming differential attitudes concerning the left and right sides. Even though, who is to say that a negative attitude about a particular body part can affect a psychological process? To address this

question, Fisher's research (1965; 1979) on body image will be reviewed and this will demonstrate that one's view of one's body can significantly affect one's perceptual and judgmental processes.

Lateral Eye-movement Research

In this section, the research on lateral eye-movements will be reviewed. Particular attention will be focused on what hypotheses have been offered to explain this phenomenon. Since Bakan (1969) first proposed the hypothesis that lateral eye-movements (LEMs) were indicators of hemispheric activation, researchers in this area have continued to assume that this model is true (Gur, 1975; Gallin & Ornstein, 1974; and Ray, Georgiou & Ravizza, 1979). Only recently has it been noted that the LEM phenomenon has been found to be quite complex, dependant on factors other than the cerebral hemispheres (Richardson, 1978).

In 1961, Day reported that his patients would move their eyes in a consistent manner, either to the left or right, when asked a question that required some thought. Although this phenomenon had been reported earlier (Teitelbaum, 1954), Day (1964; 1969) continued to pursue this area of investigation. He concluded that persons who moved their eyes consistently to the left (left movers) were different in certain respects from people who consistently moved their eyes to the right (right

movers). He noted that these differences related to the ways in which the two groups experienced anxiety, as well as to their language and cognitive styles. Thus, personality variables appeared to be implicated.

Duke (1968) attempted to corroborate Day's observations experimentally. The results of his experiment demonstrated that in response to a question that required some thought, subjects did indeed move their eyes consistently either to the left or to the right 86% of the time. It is interesting to note that prior to the introduction of the hemispheric asymmetry hypothesis, Duke felt that gazing behavior was a rich, unexplored area. He had hypothesized that social interaction between experimenter and subject may have been a critical factor.

Bakan (1969) performed a study trying to relate the degree of hypnotizability to what direction a person would consistently move his eyes. He noted that Day's characterization of the left mover, as a subjectively oriented person was quite similar to Hilgard's description of a good hypnotic subject as someone who was internally focused. In his study, Bakan administered the Stanford Hypnotic Susceptibility Scale to 46 undergraduates, 28 males and 18 females. The subjects' lateral eye-movement behavior was then assessed, using five reflective type questions. The experimenter sat in front of the subject.

The results revealed that the subjects moved their eyes consistently to the left or right 85% of the time. They were then divided into two groups, according to their scores on the Hypnotic Susceptibility scale. High and low scoring groups were determined and the two groups were compared in terms of their eye-movement behavior. Direction of eye-movement and level of hypnotic susceptibility were significantly correlated. Low scores on hypnotic susceptibility were related to right movements, while high scores were related to left movements. Bakan also looked at three other variables, namely choice of college major, scores on the SATs and degree of visual imagery. He found that left movers were more likely to pick a humanistic major as opposed to a natural science major. In addition, they were more likely to score higher on the Verbal section of the SAT and to have clearer visual imagery.

In an attempt to explain his results, Bakan proposed the hemispheric asymmetry model. He states:

> The relationship between laterality of eye-movements, hypnotizability, and the other variables described can be considered in terms of functional asymmetry of the brain. The right or left eye-movements which are the subject of this paper are controlled contralaterally by activity in Brodmann's area 8, the frontal eye fields (Robinson, 1968). It may be that the left- or right-movement associated with the reflective process is symptomatic of easier triggering of activities in the hemisphere contralteral to the direction of eye movement. Differences in ease of triggering dominant or

> non-dominant hemispheres may in turn be related to a wide variety of individual differences in cognitive, personality and physiological variables. (p. 930)

Bakan continued citing evidence from Sperry's split brain studies which indicated that the non-dominant hemisphere is characterized by a pre-verbal, subjective, intuitive mode of operation. Thus, Bakan concluded that a relatively active right hemisphere, that could possibly be indicated by consistent left eye-movement, implies a syndrome consisting of greater use of pre-verbal activities, such as imagery; greater hypnotic susceptibility; greater interest in humanistic subjects; and less mathematical ability.

Kocel, Galin, Ornstein and Merrin (1972) reasoned that if Bakan's hypothesis was correct, LEMs should be responsive to different types of questions that were specifically designed to tap the differential capacities of the right and left hemispheres. They hypothesized that if the left hemisphere, in a right handed person, was dominant for verbal processes, questions tapping verbal abilities should cause a contralateral eye shift to the right. Furthermore, if the right hemisphere, in the same individual, is viewed as dominant for spatial functions, questions tapping spatial abilties should cause an eye shift to the left. They devised a list of 20 verbal or mathematical questions to tap the left hemisphere and

20 spatial or musical questions to tap the right hemisphere. Examples of their left hemisphere questions would be: (1) Solve the following arithmetic problem, 144/6x4; and (2) Define the word "economics". Examples of their right hemisphere questions would be: (1) There is a profile of George Washington on the quarter. Which way does he face?; and (2) Hum "Row Row Row, Your Boat. Unlike the Bakan experiment, subjects faced a homogeneous visual field. The subjects were 29 volunteers, 16 males and 13 females. Their results substantiated the hypothesis. Verbal questions elicited more right eyeOmovement and spatial questions elicited more left eye-movement.

Numerous studies began to appear in the literature utilizing lateral eye-movement measures to investigate laterality effects, or personality differences between consistent left and right movers. Kinsbourne (1972), performing an experiment similar to that of Kocel et al., reconfirmed her findings. Using three sets of questions, one numerical; one a group of proverbs; and the last a group of questions tapping spatial concepts, he found that in right handed subjects, verbal questions (proverbs) elicited more left eye-movements. Surprisingly, the numerical questions did not elicit consistent left or right movement. Kinsbourne concluded that his results constituted further substantiation of the hypothesis that the left hemisphere subserves verbal processes, the right

hemisphere subserves spatial processes and that these findings could be attained by the use of the LEM method.

Further support came from the study of individual differences between right and left movers. For example, it was demonstrated that right movers were more responsive to verbal cues and left movers were more responsive to spatial cues (Crouch, 1976). In another study, it was found that left movement was related to creativity (Harnad, 1972). Thus, it was shown that among mathematicians, 10 of whom were professors and 24 who were students, that the 19 who were consistent left movers were rated as more creative by their associates; used more imagery; and were more artistically diverse than the 13 right movers. This finding was seen as implicating the right hemisphere in the process of creativity. Combs, Hoblich, Czarnecki and Kamler (1977) like Bakan found that LEMs were related to choice of college major. Right movers were more likely to choose language related majors (implicating the verbal left hemisphere) while left movers were more likely to be involved in the visual arts (implicating the more holistic and presumably more creative right hemisphere).

Certainly, on the whole, these studies as well as others that have obtained similar findings, appear to make a clear and consistent statement. Right movers who are theoretically more prone to utilize the left hemisphere, and thus verbal analytic processes were: (1) more

likely to be more responsive to verbal cues; (2) to choose language majors; and (3) to be less creative. Left movers, on the other hand, supposedly more dependant on the right hemisphere, which functions in a holistic manner, were: (1) more responsive to spatial cues; (2) more likely to choose visual-arts majors; and (3) to be more creative.

As stated previously, Ehrlichman and Weinberger (1978), however, have shown that for almost every study directly or indirectly substantiating the hemispheric asymmetry model as it relates to LEMs, another study has been conducted which does not. Hiscock (1977b) attempted to correlate eye-movements made in response to 20 verbal as well as 20 visual-spatial questions to performance on tests of verbal-spatial abilities; responses to questions focusing upon imagery and verbal processes; self- report measures of values and interests; and choice of academic major. Subjects were 81 right handed males. The author concluded that "the unequivocally negative findings stand in opposition to the concept of lateral eye-movement tendency as an index of individual differences in cerebral function" (p. 52).

Ehrlichman, Weiner and Baker (1974) attempting to explain some of the methodological discrepancies in the LEM literature (this will be dicussed further later) found that LEMs were not related to question type as

Kocel et al. (1972) and Kinsbourne (1972) had stated.

Barnat (1974) attempted to relate left and right eye-movements to personality differences as measured by the Rorschach. He was interested in seeing if a diffuse cognitive orientation would be related to left eye-movement and if a focused cognitive organization could be related to right eye-movement. He found no significant relationship. He also looked at the relationship of LEMs to choice of college major and vocational preference and, unlike Bakan (1969) found no relationship.

In summary, it would appear, that the data obtained from the lateral eye-movement studies reviewed here, bearing on the hemispheric asymmetry hypothesis, are contradictory and cannot be seen as clearly in support of that hypothesis. Ehrlichman et al. (1978) cite four additional reports that failed to confirm the hypothesis, namely, Ehrlichman (1977); Galin & Ornstein, experiment 1 (1974); Rodin & Singer (1976); and Tucker et al. (1977), as well as one study that obtained the opposite results (Wolf-Dorlester, 1976). One question remains, though, could these differing results be due to methodological considerations?

Ehrlichman and Weinberger (1978) considered this in their review of the literature. If one examined the LEM literature, one is struck by the differing methodologies that researchers have employed in their investi-

gations. Different sets of questions have been used to elicit LEMs. In addition, physical and social settings have varied. In studying the different questions used in the studies reported on, Ehrlichman and Weinberger concluded that this factor could not account for the discrepant results. They indicated that the same group of questions had been used in experiments achieving successful results as in those that had not. They did state, however, that further research would be useful in identifying those questions (if any) that would reliably elicit left and right eye-movements.

Differences in the physical and social settings of the experiment can in some cases cause different LEM behavior but this does not appear to be responsible for the inconsistent LEM results (Ehrlichman & Weinberger, 1978). It has been found that the pattern of the LEMs would differ depending upon the position of the experimenter, that is, whether he is in front or behind the subject (Gur, 1975; Gur, Gur & Harris, 1975). If the experimenter sat in front of the subject, the subject would tend to move his eyes consistently to the left or to the right. Alternately, if the experimenter was placed behind the subject or was absent from view, differential left and right movement would occur, theoretically reflecting verbal/spatial processes. Gur (1975) hypothesized that this was occuring because the

face to face situation was anxiety producing for the subject. The anxiety would result in the subjects' LEMs to move in his or her preferred direction regardless of the question type. If the experimenter was not present, the effects of the verbal/spatial questions on LEM were operative.

Hiscock (1977a) attempted to test this hypothesis by manipulating anxiety as an independent variable. One group of subjects was told that their performance on the experiment was of no particular importance. The second group was informed, in contrast, that their performance would be reflective of their intelligence and that the scores would be posted. The results indicated that anxiety had no effect on the pattern of LEMs or on the verbal/spatial difference. The visual presence or absence of the experimenter did affect the pattern of eye-movements as Gur et al. (1975) had found although there were no significant verbal/spatial differences related to question type regardless of the paradigm used. Thus, it would appear that the presence or absence of the experimenter does affect the pattern of LEMs, but that, however, the absence of him does not insure that the verbal/spatial difference will be attained.

Ehrlichman and Weinberger looked at other factors in the setting of the experiment that could possibly explain the discrepant results. Subject-experimenter dis-

tance, experimental cover story and the subject's being made aware of his eyes, were investigated. The authors had noted that the distance between subject and experimenter, when noted, varied greatly from experiment to experiment. They expressed the possibility that if the subject-experimenter distance was too close that the verbal/spatial differences could be attenuated. The critical distance appeared to be between 1.22 and 1.5 meters. Thus, they suggested that the distance between experimenter and subject should be above 1.22 meters to maximize any verbal/spatial differences.

Another claim that was investigated was that question-specific LEMs can be obtained only if the subject is not made aware of his eyes (Kinsbourne, 1974; Schwartze, Davidson & Maer, 1975; and Gur et al, 1975). This factor, however, does not appear crucial because as Ehrlichman et al point out, differential effects have been obtained under conditions where the subject has been made aware of his eyes (Gallin & Ornstein, 1974; Kocel et al., 1972; and Schwartz et al., 1975).

Finally, another factor that has been considered important in obtaining the hypothesized results is the plausibility of the cover story. Ehrlichman et al. reviewed the various cover stories used and found that none of them revealed the nature of the experiment and that all appeared to be of equal quality. Thus, it was

concluded that this factor was not critical.

In summary, it would appear that while methodologies do differ from experiment to experiment, these differences cannot explain the disparite results received. Of all the factors reviewed, differences in question sets, the subject being made aware of his eyes, experimental cover story, experimenter position and the subject-experimenter distance, only the last one may have any validity. Only future research can confirm this. It should be noted, however, that while these factors have not been shown to affect the results bearing on the hemispheric asymmetry hypothesis, they all should be considered carefully in the design of a LEM experiment in order to improve the consistency of the interpretation of the results.

In concluding their paper, Ehrlichman and Weinberger stated that it appears that the unquestioned acceptance of the hemispheric asymmetry model cannot be realized at this time. They report that there are many different theories that can explain eye-movements equally as well, or even better. In illustration, Goffman (1964) has argued that direction of gaze serves as a signal by which the interactants regulated their basic orientations to each other. Neilson (1964) also felt that gaze behavior served as a signaling device. Kendon (1967) filmed a conversation between two indivi-

duals in order to monitor eye-movement behavior. He found that the stare and gaze aversion served as signals regulating the exchange and maintenance of the speaker role. At points where the speaker and listener were about to exchange roles, the speaker would stare at the listener until he looked away. The aversion of gaze was the signal of the listener to the speaker that the listener was about to begin speaking. Certainly this basically describes the behavior that is evident in a LEM study in the experimenter in front condition. During the session, the experimenter stops speaking after the question is finished. He is looking at the subject in order to gauge his eye-movement. At this point, the subject averts his gaze for a moment and begins to speak. Although this theory does not account for directionality, as we have found neither does the asymmetry model in a consistent manner.

Another point the authors considered in their questioning of the asymmetry model was the oversimplification of the neurophysiological base for explaining LEMs and its apparent inability to explain all the findings. In illustration, the fact that vertical eye-movements appear to differentiate between verbal and spatial questions equally as well as horizontal eye-movements is a serious argument against accepting the hemispheric asymmetry model. Nine studies have found that up movements are a statistically significant response to spatial questions

while downward movements are similarly related to verbal questions. As Ehrlichman et al. state, integrating this finding of the relationship between vertical LEMs and verbal/spatial questions, in a neurophysiological theory of lateral eye-movements as it related to hemispheric activation, would be quite difficult. Furthermore, Aschoff (1974) has stated that the "command center" has yet to be located. He points out, however, that it appears that the cerebellar vermis is involved in saccadic eye-movement, especially prior to their onset. If this is true, the cortex, while important in the production of LEMs, would not be seen as the initiator of them, thus dealing the hemispheric asymmetry model a severe blow.

Thus, in conclusion, there appears to be, at the moment, no definitive basis to assume that LEMs are related to asymmetrical hemispheric activation. The results of these studies have been contradictory and this cannot be attributed to differences in methodology. In addition, there are alternate theories that can explain LEMs equally well. Finally, the neurological underpinning for the theory has little or no firm experimental support.

Research On Emotional Asymmetry and the Hemispheres

Recently, much interest has been expressed in the hypothesis that the cerebral hemispheres each subserve different emotions. Different experimental strategies have been employed to investigate this area, such as:

(1) effects of anesthetization of the right or the left hemisphere; (2) behavioral response of patients to cerebral insult; (3) ear asymmetries in response to emotional auditory stimuli vs. non-emotional stimuli; (4) facial asymmetry studies; and (5) lateralization of EEG responses to emotional stimuli.

These data have generally been seen as consistent with the view of depression or negative affect being mediated by the non-dominant hemisphere, while euphoria or positive affect has been viewed as subserved by the dominant hemisphere. The review of the literature, however, will demonstrate that the data from these studies is not as clear as one would assume.

Sodium Amytal Studies

The sodium amytal technique was developed in order to determine which hemisphere of the brain was dominant for speech (Wada, 1949). It entails an injection of sodium amytal, usually 100 mg at 5%, into the left or right carotid artey. If an aphasia develops then the physician can know, with a fair amount of certainty, that speech is lateralized in that hemisphere which is ipsilateral to the injection.

In 1959, it was found that some patients receiving the amytal injection at times developed a specific emotional reaction to it (Terzian, 1964). If the dominant hemisphere was anesthesized, a depressive-catastrophic

reaction ensued. The patient in the throes of this reaction, expresses a sense of guilt, of nothingness and of indignity. He worries about his future and the future of his family. In contrast, if the non-dominant hemisphere is anesthesized, a euphoric reaction follows which Terzian reports can, at the time, reach maniacal proportions. The patient appears as if he doesn't have a care in the world. He smiles and laughs and displays a considerable sense of well being.

Terzian noted that the depressive-catastrophic reaction usually occurred after the aphasia had dissipated or at least had begun to dissipate. In addition, the patient appeared to be amnestic for it and for the contralateral hemiplegia that was also found to be a result of the injection. Furthermore, the reaction did not always occur. If it did, it varied in intensity from very slight to quite robust among the different pateints.

Perria, Rosadini and Rossi (1961), in an attempt to validate and standardize the amytal procedure, administered injections of amobarbital sodium to 30 patients with varying illnesses such as tumors, epileptic seizures or strokes. The doses ranged from 2.5 to 100 mgs. EEG was recorded throughout the experiment at the following sites: Frontal-polar; central occipital; inferior frontal central; and medial-temporal-occipital. Two observers recorded critical data including emotional reactions

during the entire experiment. Thus, the observers were probably not blind to the side of the injection. Results showed that EEG changes for the most part began to occur within 4 seconds from the beginning of the injection. Fast, low amplitude waves followed the smallest effective dose (5 to 10 mgs.), while very slow, high amplitude waves followed the larger dose (100 mgs.). These EEG shifts usually disappeared after approximately five minutes. Furthermore, they were usually limited to the hemisphere injected but four patients did exhibit bilateral EEG shifts.

Perria et al. observed the same emotional reactions found by Terzian (1964). Following dominant hemisphere anestnetization a depressive-catastrophic reaction occurred while after non-dominant anesthetization a euphoric reaction ensued. These data might appear superficially to link dysphoric emotions to the non-dominant hemisphere and positive emotions to the dominant hemisphere but the timing of the EEG changes reported above does not allow one to come to this conclusion definitely. Since in the majority of the cases the EEG was normal prior to the emotional reaction, one cannot determine which hemisphere was responsible for the emotional reaction (Nebes, 1974; Sackeim, Weiman, Gur & Greenberg, 1980). Thus, the data support a model of differential involvement of the hemispheres in emotion but does not allow one to link type of

emotional reaction to a specific hemisphere.

In a later paper Rossi and Rosadini (1967) reported their work in this area up to that point. They state that out of 175 amytal injection, 53.7% resulted in the described reactions. The other patients displayed no emotional reaction at all. In addition, out of 63 right handed patients, 15 patients displayed emotional reactions that were the opposite of the expected result. A depressive-catastrophic reaction occurred in 5 patients after their non-dominant hemisphere was anesthesized while 10 pateints displayed a euphoric reaction after their dominant hemisphere was anesthesized. These results certainly serve to cloud interpretation of the data even further in terms of linking positive affect with the dominant hemisphere and negative affect with the non-dominant. This is because only slightly more than fifty percent of the injections produced the hypothesized result. Furthermore, the occurance of reactions, opposite to that expected, points to a perhaps more heterogeneous or complex picture of emotions and the hemispheres than the theory offered describes.

An unpublished report by Milner (1967) further clouds the issue. Milner, in a discussion of the Rossi and Rosadini paper, states that in her amytal research she observed emotional reactions to the injections but they appeared to be related to the temperament of the

individual and they did not follow the pattern described in the previous research. One hundred and four were studied. They received injections to both hemispheres on separate days. An analysis of the results revealed that: (1) 39% of the patients showed identical mood changes regardless of side of injection; (2) 37% appeared to be more cheerful after the left sided injections while 24 % appeared to be more cheerful after right sided injections; and (3) catastrophic-depressive reactions were very rare in that only five were elicited, three from left and two from right sided injections. Lastly, the mood data revealed that jovial patients appeared to become euphoric, while placid patients did not show much of any change.

Thus, in summary, while it appears that amytal studies are somewhat supportive of the hypothesis of an emotional specialization of the hemispheres, no firm conclusion can be gained as to a link between type of emotion and side of brain.

Emotional Reactions to Cerebral Insults

It has been documented that if a person suffers an insult to the left side of his brain, he may respond to such an insult in what is called a catastrophic manner (Golstein, 1939; Gainotti, 1969; 1972). This reaction is quite similar to the reaction that a patient may have to anesthetization of the left hemisphere by the use of

amytal (Terzian, 1964; Gainotti, 1972) in that he will despair about his future; appear depressed; and, at times, break into tears. In contrast, insults to the right hemisphere result in what has been termed as an indifference reaction (Denny-Brown, Meyer & Horenstein, 1952). This is characterized by an indifference to one's condition; tendencies to joke in a happy-go-lucky, devil may care way; and a denial of illness. It has been contended that these emotional reactions are due to neurophysiological properties of the two hemispheres in that the insult, whether it be physical or chemical, releases certain as yet unknown neural mechanisms (Rossi & Rosadini, 1967). Thus, the hypothesis states that the two hemispheres are each specialized for spearate emotional reactions. Golstein (1939) and Gainotti (1969), however, contend that the reactions, especially the catastrophic one, is a psychological reaction to the stress caused by the insult. The etiology of the indifference reaction is less clear.

In order to gain a clearer picture of the reaction and its causes, Gainotti (1972) examined a total of 160 patients (80 with left sided lesions and 80 with right sided lesions. The etiology of the lesion was vascular or neoplastic. The subjects were given a complete neuropsychological battery. During the testing, the subjects' verbalizations were transcribed verbatim.

Emotional reactions and mood were noted. In rating the catastrophic-depressive reaction, Gainotti looked at two separate aspects of it. The catastrophic elements such as crying and swearing were rated separately from the depressive sepects such as expressions of discouragement, preoccupation with incapacity and rationalization. The indifference reaction was rated when indifference, joking, anosognosia or denial and minimization were present.

The results indicated that the catastrophic reaction was significantly related to left hemisphere dysfunction while the indifference reaction was significantly related to right hemisphere dysfunction. Interestingly, while the catastrophic reaction, in itself, was related to left sided insult, depressive mood was not. Furthermore, when the left lesion group was subdidivided into those that were aphasic and those that were not, the non-aphasic group showed less of a catastrophic reaction than the aphasic group. This difference was significant for crying spells, anxiety reactions, vocative utterances and refusals to participate in the test. Subjects diagnosed with Broca's aphasia were the mose sharp and violent in their outburst. For example, 68 % burst into tears suddenly "in short circuit" as Gainotti put it. These crying bouts were transient, only lasting for a couple of minutes at most. At times a slight stimulus

was enough to trigger an emotional storm of tears, vocative utterances and refusals to continue with the exam but these outbursts also were rather short lived and vanished quickly. The transient nature of these emotional outbursts and the lack of any concrete precipitant led Gainotti to hypothesize that they were caused by neurophysiological factors. Amnestic aphasic patients were characterized as having many more anxiety reactions (50%). Bursts of crying were much less frequent, but when they were manifested, they lasted much longer and appeared to be related to emotional stress. Wernicke's aphasics showed a tendency to weep, and 25% of them appeared to be unaware of their language problem. Swears, curses and other vocative utterances were the most frequent in this group (50%). While unclear as to the etiology of the emotional reaction of the Wernicke's group, the author felt that these were probably of psychological origin. Finally, within the right sided damage group, neglect was highly correlated with the indifference reaction.

In summary, in interpreting his results, Gainotti felt that while psychological factors appeared to be the major cause of the catastrophic reaction for the amnestic and Wernicke's groups, physiological factors appeared to be implicated for the Broca's group. In addition he felt that locus of lesion within the hemisphere could

determine if the reaction had a physiological or psyhological base. He based this on his finding that each aphasic group, causation of which is due to a different lesion site, demonstrated a different emotional reaction. It should be noted that since Broca's lesion is caused by a frontal lesion, Gainotti's impression of a physiological base for the reaction of the Broca's aphasics corresponds with Davidson, Schwartz, Saron, Bennett and Goleman's (1978) finding that the frontal lobes are primarily responsible for the emotional disparity between the hemispheres.

Gainotti considered several explanations for the indifference reactions and found all but one lacking. Hacaen and Angelergues (1963) postulated that the two hemispheres function in two distinct modes. In the dominant hemisphere, sensory data undergo a complex conceptual elaboration via the language system. In contrast, the non-dominant hemisphere where language is not highly represented, processes senosry data in a more primitive way "so that it retains its immediateness and rich affective value (p. 53)." Thus the left hemisphere is seen as intellectual and the right as emotional. Gainotti stated that since emotion is seen as an implicit aspect of the right hemisphere, it is not surprising that an abnormal mood reaction would occur.

Gainotti thus comes to the conclusion that the

differing emotional reactions to left or right cerebral insult do not represent lateralization of emotion in the hemisphere. The catastrophic reaction, for the most part, is seen as a psychological reaction to stress while the indifference reaction is seen as a manifestation of the mode of operation of the non-dominant hemisphere. Certain findings of the study also call into question the hypothesis. For example, the hemispheric literature on emotion states that depression appears to be the dysphoric affect that presumably is lateralized to the right hemisphere (Davidson et al., 1978). But if one accepts the findings of the Gainotti study, the fact that the left lesioned group was not, in fact, depressed as defined by feelings of discouragement, statements about incapacity during and before testing, use of rationalization, and finally attempts to glorify the past, speaks against the hypothesis. The catastrophic reaction that the left lesioned patients experienced, Gainotti feels was due mainly to psychological reactions to the insult. In terms of the Borca's aphasics, he did state that this could be due to physiological reasons. Crying, however, can occur as an automatic response with no component of dysphoric feeling attached to it (Sackeim et al., 1980). Thus, the study does little to support the emotional specialization hypothesis.

It has been demonstrated that patients with temporal-

parietal lesions of the right hemispheres have a deficit in comprehending affective speech tones, depicting the emotion of happiness, sadness, anger or indifference in which the content of the speech is neutral (Heilman, Scholes & Watson, 1975). If this is true, it would suggest that the right hemisphere is specialized for the processing of affective input.

Tucker, Watson and Heilman (1977) performed an experiment in order to determine if this comprehension deficit was: (1) a discrimination problem, that is an inability to distinguish affect tones; or (2) an association problem in which the patient can tell the difference between the tones but cannot classify them; or (3) both discriminative and associative. The subjects for this experiment were 11 self-reported right handed patients suffering from neglect due to lesions of the right parietal-temporal area. These subjects were compared to 7 right handed conduction aphasics with left sided lesions of generally unknown locus.

The results indicated that the right lesion group's ability to discriminate between sentences of neutral content, read in different tones of happiness, sadness, anger or indifference, was far below that of the aphasic controls. These data tend to suggest that the right or non-dominant hemisphere when damaged is totally unable

to process emotions be they positive or negative.

Schlanger, Schlanger and Gerstman (1976) performed an experiment comparing the performance of 20 right hemisphere damaged subjects with 20 high and 20 low verbal aphasic controls on a test to discriminate between happiness, sadness and anger. They found no significant difference between the right lesion group and the aphasic group, although there was a significant difference between the high verbal and low verbal aphasics. The results are in contradiction to the Tucker et al. (1977) study. The difference, however, may be due to the fact that while all the subjects in the Tucker et al. study were suffering from neglect, none of the subjects who were in the Schlanger et al. study were. Tucker et al., in citing the Schlanger et al. study, noted this difference. They also noted that only three subjects in the Schlanger et al. study had temporal-parietal lesions. However, this difference does not appear to be a crucial one since only 4 out of 11 patients in the Tucker et al. study had lesions in this specific site.

The main difference appears to be that the Tucker et al. group of subjects were suffering from neglect, while the Schlanger et al. study group was not. Thus, neglect may be a necessary correlate for the presence of a deficit in the processing of emotional stimuli in the auditory mode. The presence of neglect may also bear on

on the issue of the etiology of the indifference reaction for patients suffering from right hemisphere damage. Heilman and Watson (1977) have hypothesized that a Cortico-Limbic-Reticular Activating Loop exists and that a lesion anywhere along this loop is responsible for the symptom of neglect. For quite some time, the limbic system has been considered a center for emotional arousal (Thompson, 1967; Rose, 1976). In light of the above, Gainotti (1972) found that the indifference reaction, resulting from right hemisphere damage, was highly correlated with the presence of neglect. Although he discounted the possibility that neglect was responsible for the indifference reaction, considering the proposed loop, it is possible that the presence of neglect may be related to the indifference reaction in an unforseen way. Specifically, if the hypothesized Cortico-Limbic-Reticular Activating Loop does exist the presence of neglect may indicate a disruption of the limbic connections to the cerebral hemisphere. Considering the role of the limbic system in emotion, it is possible that disconnections between it and the cortex could be responsible for the indifference reaction of the right hemisphere.

Sackeim, Weiman, Gur and Greenberg (1980) investigated uncontrollable emotional outbursts that were due to lateralized insults of the brain. They were interested in determining if there was a relationship between

side of lesion and type of emotional reaction evidenced, that is, if it be primarily positive or negative. A group of judges were used to study past case histories and from them, determine side of lesion; type of emotional outburst; and any other data that was felt to be important in coming to a valid conclusion. Three different clinical syndromes were studied: (1) pathological laughing and crying; (2) cases of hemispherectomy; and (3) uncontrollable outbursts related to epileptic seizures with a unilateral focus.

Pathological laughing or crying was the first condition examined. Patients suffering from this disorder show spontaneous emotional displays. These displays are uncontrollable and appear to have no relationship to circumstances in the patient's life or environment. Furthermore, any cognitive or motor effects of the brain damage usually appear some time after the emotional outburst has begun to occur.

Due to these factors, the authors reasoned that a study of this condition could prove helpful in determining the nature of lateralization of emotion in the hemispheres. One hundred and nineteen cases were reviewed by the judges. When examining only those cases in which the lesions were predominantly unilateral, left sided lesions were significantly associated with crying outbursts while right sided lesions were significantly associated with

laughing outbursts. The authors concluded from these results that while the study demonstrated differential emotional reactions do occur as a result of unilateral brain damage, it cannot determine which hemisphere is related to either laughing or crying outbursts. This is because it was impossible to determine if the lesion causing the outburst was releasing ipsilateral or contralateral mechanisms subserving emotion (this important point will be discussed in more detail later). In addition, another difficulty involves the question which may be raised suggesting that the study did not deal directly with the issue of the lateralization of emotionality. The authors indicate that it has been reported that some patients suffering from this condiction do not feel the associated affect of joy or sorrow while they are in the throes of their laughing or crying fits. Thus, two subdivisions exist in the patient population, those who feel the associated emotion and those who do not. This factor was not controlled for in this study due to the fact that the information was not included in the case history. The authors, themselves, state that if all the patients who have the condition did not feel the associated affect, then it could not be used to substantiate the hypothesis. The fact that this factor was not controlled for does not negate the findings but it does diminish the confidence one can have in them.

The second group of case studies that were examined were those involving hemispherectomy, that is total removal of the left or right hemisphere. For these cases, the question of lateralization is a moot point, because only one hemisphere is present. A total of 19 cases were reviewed; 15 cases of right sided hemispherectomy and 5 of the left. The results indicated that 12 of the right sided hemispherectomies resulted in a euphoric reaction; one experienced no reaction; and one became depressed. As the authors claim, the results of the right hemispherectomy cases reviewed support the view that the left hemisphere subserves positive emotion. The same cannot be claimed for the left hemispherectomy group. The few cases reviewed (left hemispherectomy in adults is rare due to language representation there) are not even suggestive.

The third group of case studies reviewed concerned patients who demonstrated uncontrollable crying and laughing observed during seizure or ictal phenomenon. As in the study of pathological laughing or crying, at times the outburst was associated with the appropriate mood, but at times it was not. A total of 103 cases were reviewed but due to the low percentage of crying outbursts (6 cases), analysis of the results centered on the laughing outbursts or gelastic epilepsy as it is called.

Of the 91 cases of gelastic epilepsy reviewed, 40 cases were determined to have left sided lesions, 18 had

bilateral and 19 had right sided lesions. In 14 cases, the locus of the lesion was undeterminable. Another analysis was performed to determine if there was a difference between those epileptics whose seizures were idiopathic (not attributable to any damage sustained by the individual) and those that were symptomatic of some other induced pathological process. There was no statistical difference between the two groups. Both groups had twice as many laughing outbursts associated with left sided foci as compared to the right. Interpretation of this data, however, is confounded by the question which can be posed, that is: Are these lesions producing their effects ipsilaterally or contralaterally? It should be noted that the results of the seizure study are the opposite of those reviewed in the study of pathological laughing or crying. In the former study, laughing outbursts were found to be associated with left sided lesions, while in the latter, laughing outbursts were associated with right sided lesions.

In an attempt to resolve this discrepancy, Sackeim et al. cite a large body of evidence stating that lesions that lead to seizure activity "reflect the excitation of brain centers ipsilateral to the focus. (p. 30)" The authors explain the opposite results of the study on pathological laughing and crying by stating that these lesions termed silent or destructive "produce uncontrol-

lable laughing by a release of inhibition of centers in the contralateral side of the brain" (p. 35), although they offer no experimental support for the latter contention. They conclude, nevertheless, based on this data, that the right hemisphere is responsible for subserving negative affect.

A study, however, performed by Mazzucchi and Parma (1979) compromises the Sackeim et al. (1980) data and the formulations based on it. Two groups of right handed temporal lobe epileptics, one with and the other without clinically evident lesions, were studied using a dichotic listening task to see if they differed in terms of dominance on a task of identifying digits and bi-syllabic words. The results indicated that those patients whose epilepsy was a result of a clinically evident lesion tended to prefer the ear ipsiltaeral to the side of the lesion regardless of site of focus. Thus, this suggests that these lesions would tend to produce their effects ipsilaterally. On the other hand, those epileptics who had no clinically evident lesions preferred the ear contralateral to the side of the focus (75% with left focus; 80% with right focus). This would suggest that the effect of the "lesion" is contralateral to the side of the focus.

Sackeim et al. did divide their epileptics into two groups, those whose seizures were symptomatic of

clinically evident lesions and those whose epilepsy was idiopathic, that is, no physical lesions was identifiable. He found, however, that there was no difference between these two groups, contrary to the results obtained by Mazzucchi and Parma. This discrepancy is difficult to reconcile. If the Mazzucchi et al. findings are valid, however, this argues against accepting the results of the Sackeim et al. study without reservation. This is because again, one cannot be certain for approximately 40% of the sample of epileptics as to whether the lesion is producing its effect ipsilaterally or contralaterally.

In summary, the Sackeim et al. paper strongly suggests that the hemispheres are differentially implicated in terms of type of emotion subserved. However, the data suggesting the specific direction of the emotional laterality are not as clear-cut. The fact that patients with hemispherectomies tended to become euphoric does suggest a positive emotion bias for the left hemisphere. The data from the study of cases of laughing and crying outbursts associated with either left or right lesions or as components of seizure activity cannot be seen as conclusive in that the issue of locus of effect of these conditions cannot be determined with assurance.

Dichotic Listening Studies

The dichotic paradigm has been used in an attempt to

elicit emotional biases between the left and right hemispheres. There are many different variations of this technique but basically the procedure consists of sending a stimulus through one ear while the other ear is engaged in another manner. Depending on the material presented, dominance of one of the hemispheres will be demonstrated by a slight superiority in performance of the ear contralateral to that hemisphere.

Carmen and Nachshon (1973) investigated ear differences in judging human non-verbal emotional sounds. Three different emotional sounds were presented: crying; laughing; and shrieking. These were produced by either an adult male; a female; or a child. This resulted in nine person vs. emotion combinations. The subjects were 25 right handed normals recruited from the university. Sex was not specified. The task was to indicate the emotional state they were hearing by pointing to one of nine corresponding drawings that were placed in front of them.

The results indicated a significant left ear advantage. Interesting the left ear advantage was strongest for crying sounds. A slight right ear advantage was found for adult male laughter and a child shrieking. An analysis of variance, comparing effects of speaker vs. emotion expressed vs. ear, however, was found to be non-significant. Thus, this study suggests

a right hemisphere specialization for the perception of emotional stimuli but not a differential specialization.

Safer and Leventhal (1977) contrasted emotional tone with semantic meaning. They were interested in seeing if there would be a left ear advantage for emotional tone and a right ear advantage for semantic content. Seventy-three subjects from an introductory psychology class (36 males; 37 females) heard passages that were constructed to be identical except that the semantic content was varied in order to express positive, negative or neutral content. These passages were read in three different tones of voice, either happy, objective or angry. Thus, a matrix of nine different tone x content combinations were constructed. The subjects were asked to judge if the passage was positive or negative. The experimental design was constructed in such a way that the subjects had a free choice in terms of which cues to use, the semantic cues or the tonal cues. It should be noted that a dichotic paradigm was not used. Subjects heard the passages either through one ear or the other with no output in the opposite ear.

The results indicated that tone was used to judge the emotional state when the passage was heard through the left ear while content was used when the passage was heard through the right.

A second experiment was performed in order to inves-

tigate the possible basis for the results obtained in the first experiment. Haggard and Parkinson (1971) had previously performed a dichotic listening experiment in order to separate task and stimulus factors in perceptual lateralization. They found that the nature of the tasks appeared to be more important in producing the ear asymmetry than the nature of the stimulus. In order to investigate this further, Safer and Levelthal asked subjects to objectively rate both the tone and content. If the hemispheres are lateralized for evaluation of content vs. evaluation of emotional tone, the subjects should judge content better via the right ear and tone via the left. If on the other hand, task dterminants induce hemispheric cominance, an ear advantage would develop if the task favored one hemisphere regardless of the stimuli used.

In order to accomplich this, a task that favors the left hemisphere was used. This task required that the subject analyze and store both the semantic and emotional stimuli before rating the emotion. Half the subjects heard the stimuli through the left ear and half through the right. Furthermore, half were asked to rate the tone first while half were asked to rate the content first. The results of the experiment reveal that the subjects were equally accurate in rating both tone and content when heard via the right ear. This dinding supports

Haggard and Parkinson's finding that task demands are more involved in perceptual asymmetries than stimulus factors. Safer and Leventhal point out, however, that their data supports the specialization model in that when subjects were asked to rate the content first via the left ear, many subjects found this difficult to do.

In summary, there is some suggestion that the right hemisphere is specialized for the processing of emotional stimuli. It is s strong possibility, however, that the nature of the task could create a "pseudo-dominance" which appears like a true dominance but in reality is not.

Up to this point, these studies have attempted to demonstrate a right hemisphere superiority for the processing of emotional stimuli. Although different emotions such as happiness and anger have been used in the attempt to obtain laterality effects, none of the studies have demonstrated dominance for specific emotion types although there was some suggestion of such a dichotomy in dominance found in the Carmen and Nachson (1973) study where the strongest left ear advantage was found for crying sounds and a slight right ear advantage was found for laughter. This result is congruent with the hypothesis postulating a left or dominant hemisphere lateralization for positive affect and a right or non-dominant hemisphere advantage for dysphoric affect. A study using the dichotic method has obtained results that

are contradictory to this hypothesis.

Beaton (1979) played white noise through one ear and music or poetry through the other. Three passages of music, all unfamiliar to the subjects and all rated as expressing different emotional qualities and three poems, all unfamiliar and again reflecting a wide range of emotions were used as stimuli. The subjects were 24 females and 24 males who were all strongly right handed. The task was to judge the music and poems along three dimensions: Pleasant-Unpleasant; Cheerful-Depressing; and finally, Soothing-Irritating.

The results indicated that the subjects rated both the music and the poetry as significantly more pleasant when heard through the left ear. For the Cheerful vs. Depressing rating, there was no significant difference between the left and right ear scores but the pattern of results resembled that of the Pleasant-Unpleasant dimension, that is, stimuli heard through the left ear was judged as more cheerful. Finally, while the music was judged as more soothing when heard through the left ear, the poetry showed no particular ear preference pattern. One could sat that the reason that the music was rated as more pleasant was that it was perceived more accurately via the left ear. The right hemisphere has been shown to be specialized for music. However, the author answering this objection by stating that this would be

plausible if only pleasant passages were played. A musical segment however that was rated unpleasant prior to the study was rated as more pleasant when heard via the left ear. In addition, the objection does not explain why the poetry, a verbal stimulus, was rated as more pleasnt by the non-dominant hemisphere.

The author concluded that the best explanation of these findings is that the right hemisphere "is more disposed to seeing the bright side of life" (p. 108). This finding runs counter to the prevailing opinion hypothesizing a right hemisphere specialization for dysphoric affect. Diamond, Farrington and Johnson (1976) presented films to the right and left hemisphere and that they were seen as more negative by the right hemisphere. This contradiction is difficult to reconcile but these findings do raise questions concerning the nature of the laterality of emotional states in the hemispheres as hypothesized. As further validation, this study could be replicated just with the use of verbal materials.

Facial Asymmetry Studies

The study of facial asymmetry is another method researchers have utilized in an attempt to demonstrate the lateralization of emotion between the hemispheres. It has been known for sometime that the two sides of the face are not exactly symmetrical in composition (Wolff, 1933; 1943; McCurdy, 1949). Prior to the tremendous

upheaval of interest in the lateralization of function between the hemispheres it was hypothesized that the asymmetry could be a clue to personality factors (Lindzey, Prince & Wright, 1952). With the revival of interest in laterality, this asymmetry took on a different meaning. The face is the main communicator of emotion and with several studies suggesting that emotion was lateralized it appeared possible that facial asymmetry could be related to emotional asymmetry between the hemispheres. Perhaps a stronger impetus to investigate this possible relationship came from findings suggesting that the right hemisphere was responsible for the recognition of faces (Hilliard, 1973; Geffen, Bradshaw & Wallace, 1971). This finding, taken in conjunction with the findings suggesting a right hemisphere involvement in emotion, provided further impetus to perform this research.

Sackeim, Gur and Saucy (1978) were interested in investigating whether facial asymmetries could be reliably ascertained. Of particular interest to them was the question of whether or not the left and right sides of the face were asymmetrical in emotional expressiveness. Four separate groups of subjects, each composed of 20 to 26 males and females, were asked to view a group of 54 slides. The slides represented full face photographs of males and females attempting to represent seven different

emotions. Each pose was represented in three different varieties. One was the original photograph. The other two were a left and right side somposite of the pose, i.e., the picture represented the left or right side of the face with its mirror image as the other side. The subjects were asked to rate on a scale of 1 to 7, the intensity of expression of emotion being expressed in each slide.

The results were that the left side composites were judged to express emotions more intensely than the right sided ones. Across different types of emotion, all were seen as more intense in the left composite except for the emotion of happiness. A post hoc analysis found that only anger and disgust were judged as significantly more intense ($p = .01$) in the left composites.

Sackeim et al. conclude from these results that the right hemisphere is dominant for emotion. They state that neuroanatomically while both hemispheres have ipsilateral and contralateral nerves that innervate the right and left facial muscles, some evidence has been found suggesting greater right hemisphere control over the left side of the face.

In discussing their results, Sackeim et al. make the distinction between voluntarily posed emotional expression as studied in this report and those that are involuntary or spontaneous. It is pointed out that the

locus of control could be different for the two. Thus these results cannot as yet be generalized to what would appear to represent a more important parameter in testing the hypothesis of greater right hemisphere involvement in the expression of emotion. This is so because one would want to demonstrate that under more natural conditions which represent normal functioning, the asymmetry in facial expression remained.

A number of researchers have recently published criticisms of Sackeim et al.'s study on methodological grounds. Sackeim and Gur (1980), in turn, have published a rejoinder to these criticisms. Both will be presented simultaneously. Ekman (1980) proposes several arguments that speak against accepting Sackeim et al.'s hypothesis. He states that the two sides of the face differ in the size of muscles, in the amount of fatty deposits and in the neural supply from the facial nerve nucleus to the facial muscles. Since this was not controlled for, he argues, the results obtained by Sackeim et al. cannot be interpreted as being soley due to lateralized impulses from the two hemispheres.

Another point made by Ekmain is that Sackeim et al. did not accurately describe the method by which the photographs were taken. These photographs were supplied to them by Ekman and Friesen (1975; 1976). Ekman (1980) reports that the subjects, for the most part, did not

attempt to pose for the specific emotions wanted, but were asked to perform specific actions with their faces such as "lower your brow so it looks like this etc." (p. 170). Ekman states that because the photogrpahs were taken in this manner, generaliztion to the spontaneous expression of emotion should be done with caution.

He further substantiates his contention by pointing out that the only set of photographs that represented spontaneous expressions, the happiness set, was the only set with which Sackeim et al. found no asymmetries. The possibility that no difference was found because facially expressed positive emotions may not be asymmetrical is discounted. A study (Ekman, Hager and Friesen, in press) found that asymmetrical deliberate smiles are usually more intense on the left as opposed to right. In addition, it was found that spontaneous smiles are usually not asymmetrical.

In response, Sackeim et al. (1980) state that they never meant to generalize the results of their initial study to involuntary or spontaneous emotional expression. It is surprising that Ekman would make this criticism because this point is quite clearly stated in the Sackeim et al. paper. Indeed it appears that Ekman, himself, has missed the significance of his argument. If, as Ekman states, the poses were constructed feature by feature,

it should be considered that the results do not hold for deliberate poses either. What represents the facial expression of anger for Ekman et al. (1975; 1976) may not be the same for the person posing for the photograph. In addition, the model was unaware of what emotion he was being directed to portray. The photographs, thus, appear to be stereotyped representations of emotions and not posed expressions in the real sense. The photographs viewed in this light are unnatural and any conclusions, such as differential hemispheric innervation of facial muscles during the expression of emotion, should be looked at with caution.

Ekman stated that facial structural asymmetries were not controlled for by Sackeim et al. They, in turn, responded to Ekman's argument by indicating that no objective data are known that would substantiate the claim that these asymmetries exist. Both researchers received personal communications from the same facial surgeon to support their arguments. Sackeim et al. further substantiated their claim by citing a study by Burke (1971) on children in which, across 48 subjects, the mean difference in size between the two sides of the face is less than 1 mm. This is the same paper used by Ekman to substantiate his claim. However, it would appear that the use of children's measurments to support data for adults may not be useful. Facial structure changes as the child

grows up and the final state of the face could be quite different than it is at some early point in the developmental process. The personal communication from the facial surgeon does not appear decisive because statements made by him were used on both sides of the argument. In total, it would appear that this point remains unresolved.

Nelson and Horowitz (1980) published another criticism of the methodology reported in the Sackeim et al paper. Nelson and Horowitz indicate that, in their opinion, the Sackeim et al conclusion is, "probably premature" (p. 834). They selected 34 out of 110 slides used in the Sackeim et al experiment on the basis of their measurability to attempt to determine the equality of the two sides of the faces portrayed. Measurements were taken from where the head and the ear merge to the vertical midline of the face. The 34 stimuli selected encompassed all six expressions used and 7 out of the 14 posers. It was found that the left side was significantly smaller than the right side ($p. = .001$). Based on this finding, Nelson and Horowitz suggest that the left was seen as more intense, not because of differential right hemisphere involvement, but because the left side of the face, in these photographs, provides a smaller area on which to distribute the same features.

Sackeim et al (1980) measured all their photographs

at two different points. One, The distance between the external canthi and the midline and the second was, the width of the face on both sides to the midline at its widest horizontal plane, at or below the level of the eyes. Both measurements yielded no significant difference in the size of the two sides of the faces portrayed in the photographs. Sackeim et al conclude from this that Nelson and Horowitz's results could be due to small sample variation or to the method of measurement.

Based on Sackeim et al's measurements, it would appear that the Nelson et al contention is answered satisfactorily. I t would prove useful to know however, how much of the variance the 34 photographs measured by Nelson et al contributed to the emotion intensity ratings in the original Sackeim et al study. It seems plausible to consider that the ratings on these photographs, which are demonstrably asymmetrical, could be responsible for the significant results obtained, given the accuracy of the measurements.

Spinrad's (1980) criticism is that in the example set provided in the article, the full face photograph from which the composites were made is not evenly illuminated. The left side of the face is more in shadow than the right side. This would make the left side composite appear darker and more dramatic. This she claims could influence the subjects to judge the expression as

more intense despite any actual facial difference.

Sackeim et al. (1980) state that preliminary testing showed that subjects could not distinguish via illumination, the left and right side composites. Further, testing showed that there were illumination differences, but that these were in the opposite direction. Left sided composites were judged as brighter. The differences in illumination were not correlated with the differences in the mean ratings of emotional intensity. Thus, it would appear that the illumination difference did not influence the emotional intensity ratings.

The criticism made by these five researchers, while not completetly compromising the results and conclusions presented in the Sackeim et al. (1978) paper, do lead one to consider them with more caution. Two points remain troublesome: (1) the methods used to express the emotion expressed in the photographs may not represent what could be considered a naturally expressed affect; and (2) the variance represented by the 34 photographs measured by Nelson et al. (1980) is uncontrolled for and could be responsible for the significant results obtained.

Campbell (1978) utilized tachistoscopic presentation of chimeric faces in order to ascertain whether a face looked happier with a smile on the left or on the right when viewed by right handed subjects. Thus, this

study is designed to investigate perceptual asymmetries of facially expressed emotion. In the second part of the experiment, composite mirror reversed images such as those used in the Sackeim et al. (1978) study were employed in order to ascertain if facial expression of emotion was asymmetrical.

For the first segment, photographs of ten men and ten women, all right handed, were taken when they were asked to smile and when they were asked to relax. The photographs were then cut down the midline and a smile half was combined with a relaxed half, and then rephotographed. The negatives were reversed and mirror images of these half smile- half relax photographs were reprinted. The photographs were presented fovially (midline at the fovial point). The subjects (12 male and 12 female) saw two photographs with a 200 msec. delay between them. Presentation time was 150 msec.

The results indicated that for right handed persons, the smile on the left (viewer left) made the person look happier. This effect was more pronounced for the photographs of the men as opposed to those of the women. It is interesting that when the subjects viewed the mirror reversals of the photographs, preference for the left smile was significantly increased. This suggests that in actuality either the smile on the left side of a person's face is more prominent or

that the relaxation pose is more prominent on the left. Regarding the left smile, this is so because the left smile chimeric (viewer left) was composed from the right side of the sitter's face. When mirror reversed, the smile from the left side of the sitter's face is now on the viewer's left. Since the only variable changed is the orientation of the sitter's smile, an increase in the rating should be due to the left side of the face looking happier. This hypothesis is explored further in the second part of the experiment, that is, the hypothesis that the left side of the face expresses a greater degree of emotion.

Mirror reversed composites of right sided and left sided smiles and right sided and left sided relaxed faces were judged in pairs in a free viewing situation by a total of twenty-four subjects (11 females and 13 males). For the smile set (a left and right composite), the subjects were asked which picture looked happier. For the relaxed set, the subjects were asked which pictures looked more miserable.

The results indicated that the left smile composites were viewed as both more happy and as more miserable. It would appear that then persons do express emotions on their faces asymmetrically.

These findings implicate, to a fair degree, right hemisphere involvement in emotion, in terms of the

perception of emotion and its expression on faces. Campbell believes that her findings concerning the asymmetry in perception of emotion on faces in unambiguous. These findings, in fact, replicate those of another study (Gilbert & Bakan, 1973). However, the findings which support differential hemispheric involvement in the facial expression of emotion, are regarded as inconclusive at this time. She states that other factors, such as psychological rather than neurological ones, could explain the results she obtained. Campbell cites a study done by Levy (1976) in which asymmetrically composed pictures were viewed in normal and mirror reversed orientations. The preferred picture, aesthetically, was the one with more pictorial weight on the right side. Levy interprets this as a way of producing pictorial balance in the right visual field, to the dominant impression in the left visual field which is viewed by the more spatially oriented right hemisphere. Similarly, Campbell suggests that the best smile may not be a symmetrical one. It may be the one that is seen more in the right visual field, as a balance to the left, thus leading a person who has learned this via social learning to smile more with the left side. This is just a speculation and could be tested by studying the smiles of left handers. If hemispheric control is pre-eminent, left handers should not demonstrate the same left smile as right handers, due to the higher variance of cerebral

dominance in left handers.

Schwartz, Ahern and Brown (1979) have performed a study that directly bears on the question of asymmetrical expression of affect facially. Facial electromyography (EMG) was recorded from the left and right zygomatic and corrugator facial muscles in response to reflective questions designed to elicit different affects and also during voluntary facial expressions. The subjects were 20 undergraduates (10 male and 10 female) who were all right handed. They were asked sixty questions designed to elicit four different affects plus a neutral position. The affects were happiness, excitement, sadness and fear. In addition, they were asked to voluntarily generate facial expressions representing the same four affects. Thus, both involuntary and voluntary production of emotion was of interest. An emotion intensity scale was used to rate the effectiveness of the involuntary emotion condition. The zygomatic muscle was selected because it had been previously determined (Schwartz, Fair, Salt, Mandel & Klerman, 1976) that it was sensitive to manipulations of negative emotional imagery. Furthermore, it was hypothesized that right sided activity would reflect positive emotion and the left, negative emotion.

The results of the emotion intensity rating of the 60 questions revealed the the intended primary emotions

were elicited. It should be noted, however, that while the neutral questions were rated as the least emotion producing, they created strong laterality effects. In both voluntary and involuntary conditions, left muscle output exceeded right muscle output. In fact, in the involuntary condition, this difference was greater for the neutral questions than for any of the other questions. The authors hypothesized that the neutral questions may have inadvertently caused negative stress, thus causing more left muscle activity.

Different muscle groups did react as predicted in response to the questions eliciting positive and negative affect. The zygomatic muscle group decreased in output as one proceeded from positive to negative affect. In contrast, the corrugator muscle group increased in output as one proceeded from negative to positive affect. Furthermore, the differences were significant in both the involuntary and voluntary facial expression conditions.

The laterality prediction was supported but only for the zygomatic muscle group in the involuntary condition. Positive emotions elicited greater right zygomatic muscle out while negative emotion elicited greater left output. The other conditions showed rather eratic, non-significant patterns of asymmetry. The authors attempt to explain these findings in terms of neuroanatomical

data but conclude that enough is not known to come to any clearcut conclusions. For example, a case is made on neuroanatomical grounds, that muscles of the lower face, such as the zygomatic, may be better in studying lateralized effector responses in the voluntary expression of emotion. This is because these muscles appear to have greater contralateral connections from the motor cortex (Kuypers, 1958; Courville, 1966). This, however, as they point out, does not explain why they received significant results for the same muscle region in the involuntary condition.

The authors conclude that thes results do lend support to the hypothesis of differential hemispheric involvement in emotion, with the right hemisphere subserving positive emotion and the left, negative. Nevertheless, they caution that the mechanism involved in the laterality is not known at the moment, be it psychological or neurological and if it is neurological, whether it functions at the cortical and/or subcortical level.

The bearing that this study has on the results obtained by Sackeim et al. (1978) should be reviewed. Sackeim et al. found that emotion was expressed more intensely on the left side of the face. The stimuli were considered posed expression by the authors. Earlier in this literature review, it has been contended that these expressions of emotion cannot be viewed as posed or

voluntary expressions of emotion because as Ekman (1980) stated, the sitters for the photographs were asked to create the expression feature by feature. It was concludeded that the Sackeim et al. findings were compromised because the stimuli were unnatural. Schwartz et al. (1979) comment that it is surprising that they did not obtain significant laterality effects in the posed condition given the fact that Sackeim et al. (1978) did. It is now suggested that the difference in results is due to the fact that Sackeim et al.'s stimuli were unnatural. In the Schwartz et al. study, subjects were directly asked to express, facially, happiness, sadness, etc. This is the only crucial difference. If there were laterality differences when people voluntarily pose, the presumption would be that the Schwartz et al. data would support this. Since it did not, it is possible that the positive results Sackeim et al. obtained were due to some other variable such as the one suggested. The two studies are not comparable in methodology, thus this conclusion is tentative at this time, but the discrepancy in results presented does merit consideration.

Borod and Caron (1979) hypothesized that the right side of the face would have greater involvement in the expression of emotion because it is believed that the lower two-thirds of that side receives its primary innervation from the contralateral hemisphere, which is domi-

nant for other forms of motoric laterality. Based on this they also hypothesized that facial expression would be more lateralized for right handers as opposed to left handers. In addition, facedness (lateralized facial expression) would be positively correlated with handedness and footedness.

Fifty-one subjects (31 right handers and 20 left handers) were filmed making the following expressions: mild greeting; disapproval-scolding; confusion-perplexity; threatening-tough guy; horror-fright; flirting-"come hither" look; crying-grief; silly clowning; and disgust-bad smell. The subjects were coaxed into making the expressions by being given a hypothetical situation that would produce the desired emotion and by being shown a photograph of a person expressing that same emotion. A practice session was held and then, the experimental session was conducted during which the subjects were filmed making the nine expressions. A week latert, the subjects were assessed for handedness, footedness and eyedness. Subsequent to this, three judges rated the degree of muscle involvement on the two sides of the face on a -7 to +7 scale. The judges viewed the film in slow motion and also viewed the individual frame that expressed the emotion the best.

The results indicated, contrary to the hypothesis, that the left side of the face was more involved than the

right. The result was significant only for the right handers and only for the tough guy pose. There was a trend in the same direction for the crying pose. Finally, handedness, footedness, and eyedness did not correlate with facedness. The authors concluded that the data was consonant with studies implicating the right hemisphere in the production of emotional expression.

It would appear that these studies in general do tend to support to a degree, the hypothesis of right hemisphere involvement in emotion. The difficulty appears to be in the interpretation of the data in an unambiguous fashion. It does appear that people do express emotion more intensely on the left side of the face but what is the cause of this? The neurological rational is not clear at this time(Campbell, 1978). On the other hand, the perceptual asymmetry of facial emotion, as demonstrated by Campbell (1978) and Gilbert et al. (1973) appears to support the righ hemisphere hypothesis in a clearer manner. Furthermore, this data is indirectly supported by two studies demonstrating LVF superiorities for the detection of emotional expression Suberi & Mckeever, 1977; Ley & Bryden, 1979).

Lastly, the question of differential emotional involvement in emotion, that is right hemisphere subserving negative emotion, is given some support from the Schwartz et al. study. The problem however, remains to

ascertain the neurological underpinning.

EEG Studies

The EEG has been used extensively in laterality research. Many studies have been performed that have received EEG indices of hemispheric asymmetry (Morgan, Mcdonald & Mcdonald, 1971; Galin & Ornstein, 1972; McKee , Humphrey & McAdam, 1973; Butler & Glass, 1974; Davidson, Schwartz, Pugash & Bromfield, 1976; and Ehrlichman & Wiener, 1978). Most of the above studies have investigatet asymmetries reflecting verbal/spatial processes but increasingly the EEG has been used to study the nature of emotional asymmetries as well. Some crticism have been made of the methodologies employed in these studies and of the manner of the interpretation of the results obtained but by and large, the technique has been seen as promising (Donchon, 1977). In this section, there will be a review of the findings of the EEG studies as they pertain to the emotional lateralization of the hemispheares.

Davidson, Schwartz, Pugash & Bromfield (1976) had subjects generate covert affective and non-affective states while their EEG activity was being monitored. The subjects were twelve males and eight females who were students. They did not have any family history of familial left handedness. For the emotional trials, the subjects were asked to relive scenes that they had, on a

previous questionaire, rated as being very intense. Half of the affective trials consisted of happy, contented scenes while for the other half, subjects were to imagine scenes involving anger. For two of the non-affective trials, the subjects were asked to relive in their minds a typical day using either verbal or visual strategies. For the other two trials they were asked they were asked to perform a covert verbal and a covert visual task. EEG was recorded from the parietal lobes (P3 and P4) referenced to vertex and filtered fo alpha. The results indicated a significant right hemisphere activation during covert emotional trials as computed using the ratio score R-L/R+L. This finding however, was significant only for the females in the study. The authors stated that to their knowledge, this was the first demonstration of an EEG asymmetry induced by emotions in normal subjects and that it indicated a right hemisphere involvement in emotional processes.

Davidson, Schwartz, Saron, Bennett and Goleman (1978) performed a study in which they investigated frontal vs. parietal EEG asymmetries induced by positive vs. negative affect. Their hypothesis was that positive affect would be associated with greater left frontal activation as compared to negative affect. No parietal asymmetries were expected, despite the fact that they had been attained in the previous experiment. The subjects, seven

males and nine females were asked to respond to films previously rated to vary in emotion content. They were to do this by the manipulation of a pressure sensitive knob. They were to press down on the knob if they disliked what they were watching and let up on it if they liked what they were watching. Moreover, during the viewing of the films, EEG was recorded bilaterally from the frontal and parietal lobes. Alpha power was recorded and R-L/R+L ratio was computed. The most positive and negative EEG epochs were chosen for statistical comparison.

The results indicated that positive affect was significantly correlated with left frontal activation. As predicted, the parietal leads showed no significant differences. Even though, during the processing of negative and positive affect the right parietal lobe showed some activation, with higher activation during those epochs where negative emotion was being experienced. This is shown by the parietal scores read across negative and positive affect. When they were compared to zero, a difference approaching significance ($p = .08$) indicating relative right hemisphere activation in the parietal region, was acheived. When only frontal alpha was examined, alpha power was greater over the left for negative affect (indicating right hemisphere activation) and greater over right during positive affect (indicating left hemisphere activation.

The data gained from this experiment does suggest that in normals the hemispheres differentially subserve positive and negative affect and that the frontal lobes are principally implicated in this asymmetry. The authors also offer a possible explanation of the previous findings implicating the right hemisphere exclusively in subserving all of the emotions. They state that an important characteristic of emotional processing is the multi-modal nature of emotional input. Thus, emotion is seen as an amalgamation of visceral, cognitive and sensory elements that is possibly integrated simultaneously and in parallel. The authors point to a body of data suggesting that the right parietal lobe chiefly is responsible for parallel processing of information. Thus, it is not surprising that the parietal lobe would show some activation during the processing of emotion irrespective of valence.

Harmon & Ray (1977) designed a study in order to attempt to answer the question of emotional asymmetries between the hemispheres. Forty right handed subjects (20 males and 20 females) were asked to recall events in their lives in which they had felt either sad, fearful, angry or happy. For the negative affect condition, the most powerful memory from either the sad, fearful or angry category was selected. A calm, pleasant memory from the happy category was always chosen as the positive affect condition. For thirty-five second while the EEG was being

recorded, the experimenter retold the story to the subject, coaching him to feel as much as possible the emotions which he had experienced at the time of the event. EEG was read at both temporal lobes. All frequencies between 3 and 30 hz were analyzed. Mean amplitude was the dependant measure.

The results of the study indicated that the left hemisphere increased in power during the positive affect condition and decreased during the negative affect condition. The right hemisphere showed no significant effects. The decrease in power during the negative affect condition over the left hemisphere signifies that it is most involved in negative affect. These results are the opposite of those attained by Davidson et al. (1978). What can account for this difference?

One possibility is that EEG was recorded at two different sites: frontal and parietal sites were used in the Davidson et al. (1978) study, while temporal leads were used in the Harmon and Ray study. Thus, they are not exactly comparable. It should be noted that while Davidson et al.'s findings have been replicated, Harmon and Ray's have not. Tucker and Stensile (1978), recording at frontal, central, parietal and occipital sites, obtained significant differences in response to positive and negative emotional stimuli only at the frontal sites. The difference was in the same direction as

hypothesized in the Davidson et al. study. It is unfortunate that temporal leads were not used so that a more direct comparison with the Harmon and Ray study could be made.

Another point suggested by Davidson et al. (1978) is that the verbal coaching used by Harmon and Ray (1977) might have contaminated the results. On face value, this appears to be a valid criticism in that the verbal stimuli during EEG monitoring may have unduly activated the verbally oriented left hemisphere. This, however does not appear to be a valid criticism in that the verbal coaching resulted in EEG changes in the same hemisphere and the only factor that was different was the type of emotion trying to be produced. Perhaps the verbal coaching was responsible for the lack of response in the spatially oriented right hemisphere but it cannot explain the shifts in amplitude over the left. It would appear, thus, that Harmon and Ray's finding must be considered valid at this point. If it is substantiated, this would tend to suggest that the relationship between positive and negative affect and the hemispheres is more complex than it originally appeared to be.

Cacioppo, Petty and Synder (1979) were interested in determining if differences in affective response of the hemispheres was due to a true emotional specialization, heightened sugestibility of the right hemisphere (Bakan,

1969), or lastly, to differences in style of information processing. Originally, sixty right handed men were to be used but due to lost data, analysis was performed on a sample of 50. In order to hide the true intent of the experiment the subjects were told that their job was to evaluate the sound quality of a tape. Furthermore, the subjects were told, in order to insure that the message they were hearing did not affect their judgments of sound quality, that they were to rate how positively or negatively they felt about the message that they had heard. Each subject heard one tape which varied from subject to subject on how agreeable or disagreeable the message was, and how personally relevant or irrelevant it was. A neutral message was also played which served as a control. The authors hypothesized that if the hemispheres were differentially lateralized for emotion: (1) the neutral stimulus should be evaluated more negatively for those subjects showing more nondominant hemisphere involvement. These subjects should also display more negative attitudes to both types of statements be they in agreement or disagreement with them; (2) if the nondominant hemisphere is more suggestible than the dominant hemisphere as Bakan (1969) has suggested, the authors predicted the opposite results. Involvement of the nondominant hemisphere should then lead to more agreement with both statements regardless of the

subjects' agreement or disagreement with them; or (3) if the affective response is due to the information processing styles of the two hemispheres, personal relevance of the message (high or low), which the authors claim increases pertinent information processing activity, should interact with hemispheric involvement. In addition, in that the neutral stimulus has no personal relevance to the subject at all, no differences would be expected in the EEG regardless of which hemisphere was involved.

EEG leads were attached to both parietal lobes (P3-P4), referenced to linked ears. Data was filtered for alpha (8-13 hz) sampled 100 times per second and then digitized. Hemispheric involvement was calculated by the use of a ratio (R-L/R+L). In order to calculate for each subject the degree of dominant or nondominant activation during the tasks, a median split was calculated of the ratio scores.

The results of the study supported the position that the affective responses were due to different information processing styles of the two hemispheres. The degree of personal relevance affected the subjects' responses to the messages in a significant manner. Those persons who displayed dominant hemisphere involvement tended to agree more with the statements they were basically in agreement with and disagree with those they were basically in disagreement with when personal relevance was high rather

than low. Persons displaying minor hemisphere involvement tended to disagree with both statements they agreed with and those they did not. On the surface, this appears to agree with the stated emotional asymmetry model. This only occurred, however, when the issue was highly relevant. If the results were due only to a generalized negative view of the world, personal relevance should not affect the judgments of the message. In addition, the neutral stimulus was not rated any differently, regardless of left or right hemisphere involvement. The authors also looked at hemispheric involvement prior to the message. They reasoned that if the difference was attributable to the manner the stimulus is cognitively processed, then the extent of hemispheric lateralization prior to the stimulus should be a poor predictor of affective response since the prestimulus interval was cognitively quiescent. A median split of prior hemispheric activity failed to account for a large portion of the variance on all measures yet hemispheric activity during the stimulus did.

The study's findings offer an intriguing and perhaps more parsimonious explanation for the data received on lateralization of emotion. Affective response is tied to type of cognitive processing. Hacaen and Angelergues (1963) have offered a similar hypothesis. Thus, this study seriously questions if a true emotional asymmetry

exists between the two hemispheres. It should be noted that findings cannot be compared directly to those of Davidson et al. (1978) or Harmon and Ray (1977) because of the different sites used to record the EEG. Nevertheless they offer a different explanation of emotionality and the hemispheres that merits further research.

Flor-Henry (1976; 1978) proposed a theory of the organization of the cerebral mood system. His data base comes mainly from subjects suffering from schizophrenia, manic-depressive psychosis, psychotic depression and temporal lobe epilepsy. Flor-Henry hypothesizes that:

> The neural substrate for emotion, normal and abnormal, is predominantly nondominant, but its regulation is a function of both the dominant and nondominant regions-for different emotions. The right and left controlling systems are themselves under active reciprocal interaction through transcallosal neural inhibition. In this manner, anger, euphoria, paranoid mood is evoked when the nondominant hemisphere no longer controls the dominant systems, together with verbal-motor disinhibition. When on the other hand the nondominant regions are no longer under dominant control, the emotional catastrohpic reaction, dysphoric emotions of anxiety or sadness are released. When the cerebral disorganization is principally restricted to the non-dominant hemisphere, the depressive phase of the manic-depressive syndrome supervenes. At a certain threshold the dominant hemisphere becomes activated, triggering the manic phase. If the contralateral pertubation becomes more extensive, reaching the dominant temporal regions, then the thought-disordered manias or schizo-affective states are induced (Flor-Henry, 1979; p. 694).

Thus, Flor-Henry's hypothesis is basically in good

agreement with the prevailing thought on emotional asymmetry. The right hemisphere while responsible for emotionality in general is particularly involved in the dysphoric states. The dominant hemisphere, because of its association with mania, primarily subserves positive emotion. As Davidson et al. (1978) suggest, Flor-Henry also believes that localization of these processes is primarily frontal, although the temporal area is implicated also.

Flor-Henry (1976) studied 20 psychotic depressives, 21 manics and 20 schizo-affective schizophrenics comparing these against 23 normal controls. EEG was recorded during an eyes open condition and during the administration of the Wechsler Adult Intelligence Scale (WAIS). The Vocabulary sustest is considered sensitive to dominant hemisphere dysfunction, while Block Design is considered to tap nondominant hemisphere functioning. The sites selected were temporal and parietal (T3-T4; P3-P4), referenced to vertex. The coefficient of variation of EEG was calculated.

The results suggest that in depressives, as compared to normals, there is an abnormal organization of the right hemisphere reflected by reduced right parietal power and increased right parietal variability. There is bitemporal disorganization but this is more extensive on the right. In addition, the data suggest a shift in hemispheric dominance. This was indicated by right

parietal activation during the verbal task.

The EEG findings on the manic group, as compared to the normals, suggest that as in depression, there is bilateral disorganization, but unlike the depressives, the dysfunction is more extensive over the left hemisphere. Flor-Henry based his conclusions on his finding of a failure of left hemisphere activation during verbal tasks and a shift of verbal-linguistic functions to the right hemisphere as evidenced by the negative right/left power ratio over both the temporal and parietal lobes during verbal tasks and a reduction of right parietal power during the same tasks.

Templer and Connolly (1976) tested Flor-Henry's hypothesis that depression was associated with non-dominant hemisphere dysfunction. They were also interested in testing his hypothesis that schizophrenia was associated with dominant hemisphere dysfunction. The authors used two subtests of the WAIS to assess the degree of dysfunction of the hemispheres. The Similarities subtest was used to assess dominant hemisphere dysfunction, while Block Design was used to assess non-dominant dysfunction. The subjects consisted of 52 females and 113 males who were past and present psychiatric patients. The subjects were rated for the presence of depression by the use of the Depression scale of the MMPI. The results of the study indicated that

there was no relationship between psychiatric diagnoses and measures of hemispheric dysfunction. The authors state that while this study does not disprove Flor-Henry's contention, it does show the need for further research. This is because Flor-Henry had attached great significance to the verbal vs. performance difference on the WAIS among schizophrenics and manic depressives.

d'Elia and Perris (1973) studied hemispheric involvement in depression, using a variability measure of mean integrated amplitude (MIA) of EEG. The subjects were 18 psychotically depressed men and women, who were given shock treatments by electrical or chemical means. EEG was read bilaterally at centro-parietal sites before and after treatment in order to see what changes in wave patterns occured if any. EEG indices were then compared statistically to scores on a depression scale which was administered prior to shock treatment and four days subsequent to its termination.

The results of this study demonstrated that the psychotic depressive subjects were characterized by a L/R ratio of MIA averaging approximately .89 before treatment and .99 after treatment. Whereas prior to treatment, 77% of these psychotic depressives had a L/R ratio below 1.0, after treatment this percentage dropped to 56%. It should be noted that the ECT treatment did, indeed, result in an actual decrease in depression rating

score. A significant negative correlation between L/R ratio of MIA and depression score was noted both before and after treatment. Moreover, the authors report that the within patient variance of MIA was significantly lower on the left as compared to the right and that, following treatment, this measure remained relatively constant on the right while a significant increase was achieved on the left.

Based on these findings, the authors conclude that the dominant hemisphere appears to play a more significant role in depression than the nondominant. This is because depression scores decreased following treatment and the primary EEG findings reveal that this decrease is related to changes in dominant, rather than nondominant hemisphere functioning. This finding has benn substantiated in later experiments in the same laboratory (d'Elia and Perris, 1974).

Deglin and Nikilaenko (1975) also report evidence implicating the left hemisphere in depressive states. Forty patients with diagnoses of varaious degrees of depression or schizophrenia were used as the subjects. They received 8 to 12 ECT treatments, alternately to the left and right hemispheres in the anterior portion of the brain. EEG was recorded at 17 sites prior to ECT and for one to two hours after. Mood was assessed by three psychiatrists who were not blind to which side

of the brain was receiving the administration of ECT. Disagreements were decided by physicians who were unaware of the site of ECT.

The results indicated that after right sided ECT, the patients responded in a euphoric, at times hypomaniacal way. Left sided shock resulted in a deepening of the depression.

The EEG changes after ECT were as follows. Ten to forty seconds after the induced seizure, a flattening of EEG over the entire cortex was observed. This was followed by a low voltage polymorphic dysrhythmia. Against this background, one to three minutes later, a burst of generalized delta appeared, sinosoidal in shape. Within a minute the delta burst became continuous and replaced all pre-existing wave patterns. After a period of dominance, the delta burst became localized in the fronto-temporal zones. Intervals between them initially were occupied by theta waves and later were filled by alpha activity. The disappearance of the delta waves was followed by alpha waves which became increasingly synchronized. As amplitude and regularity increased, alpha spread widely over the entire cortex.

Both hemispheres recovered in this manner with the recovery of the non-shocked hemisphere occuring more rapidly. The difference in the rate of recovery of

the EEG caused an interhemispheric asymmetry (IHA) of electrical activity of occur. Deglin et al. (1975) delineated three types of asymmetries: (1) Alpha and delta present over both hemispheres but alpha predominating over the intact hemisphere and delta over the shocked one; (2) alpha present in some degree over the intact hemisphere but absent over the shocked one where delta predominated; and (3) delta present over both hemispheres but predominently over the shocked one.

The authors state that delta rhythms can be seen as indicators of the functional inhibition of cortical structures, while alpha rhythms are seen as indicators of activation of thalamocortical structures of the brain. Thus, the three interhemispheric asymmetries are seen as representing different patterns of activation and deactivation of the two hemispheres. Furthermore, the emotional shifts were noted to occur, for the most part, in conjunction with the IHAs.

The authors point out that since ECT applied to the right hemisphere improved the mood of the subjects and ECT to the left hemisphere worsened the mood of the subjects, this appears to substantiate the hypothesis that negative affect is associated with the right hemisphere and positive affect with the left. They do indicate, however, that the relationship between type of emotional shift and type of IHA puts the above

hypothesis in question. This is because positive emotional shifts following right sided ECT were correlated only with selective dominance of alpha over the left hemisphere. Thus, improvement of mood was connected to activation of the left hemisphere. Therefore, the locus of effect of the ECT was not the right hemisphere but the left. Conversely, negative emotional shifts, subsequent to left sided ECT, were associated with alpha over the right and delta over the left hemisphere. The authors thus come to the conclusion that it is the left hemisphere that is pre-eminent in the organization of mood in that its activation or deactivation is responsible for mood changes in the human being.

It should be pointed out that the Deglin et al. study can be seen as supportive of the hypothesis associating positive affect with the left and negative affect with the right hemisphere. This is because improvement in mood was related to the activation of the left hemisphere, while worsening of mood was association with the activation of the right.

Perhaps a view that sees both hemispheres responsible in some yet unknown interactive manner is the answer. Flor-Henry (1976) has suggested an interactive model, but unlike Deglin et al. (1975), he states that the right hemisphere is primarily responsible for mood. It is clear, however, that the mechanism of emotion and

its association with the cerebral hemispheres is not fully understandable at this moment. One point that appears increasingly clear is that the relationship is a complex one.

Monakhov, Perris, Botskarev, Von Knorring and Nikiforov (1979) performed a sophisticated EEG study of depressive patients in order to attempt to relate a more delineated symptom analysis of depression to several indices of the EEG. Twenty-two subjects, eight males and fourteen females, were tested. These subjects were rated for depth and symptomatology of depression by the use of a twelve item depression scale which yields two scores, degree of anxiety-depression present and degree of psychomotor retardation. Patients, on the basis of this scale, were also subdivided into two groups, those exhibiting low anxiety and those exhibiting high anxiety.

EEG was read bilaterally from the following regions, frontal (F3-F4), parietal (P3-P4) and occipital (O3-O4), each side referenced to the ear lobe. Analysis of the EEG recordings was done along several dimensions by means of computer analysis. Percent and amplitude characteristics of beta, alpha and theta wave forms were first obtained. These characteristics were then analyzed separately in terms of their distribution in each hemisphere. The second part of the analysis

was aimed at determining specific "patterns of electrical activity, EEG syndromes" (p. 147), as the authors call them, in order to attempt to differentiate between subjects whose clinical pictures differed as defined by the depression scale administered.

The results of this study indicated that the relationship between the syndrome of depression and laterality is quite complex. Almost all of the items on the scale, which represent different aspects of depression, correlated with specific EEG indices in the frontal, parietal and occipital regions of both hemispheres. The exception was psychic anxiety which was not related to any EEG activity. Furthermore, no simple hemispheric laterality was found in that these correlations were equally distributed among the two hemispheres. Only three items on the scale were lateralized exclusively to one or the other hemisphere. They were depressed mood and thoughts of suicide which correlated with EEG variables over the right hemisphere and depressed ideas which only correlated with percent beta over the precentral region of the left hemisphere. This lack of specific laterality extended to the total score of the depression scale, when it was related to separate EEG characteristics of the two hemispheres. Thus, the results of this part of the analysis suggest that the

differences between the two hemispheres are not as pronounced as are the differences of specific EEG factors within each hemisphere.

Further statistical analysis was performed in order to determine the intercorrelations between separate EEG characteristics within the right and left hemisphere, and between the hemispheres for those subjects who evidenced high anxiety as opposed to low anxiety as determined by the depression scale. Thus, between the left and right hemispheres it was found that there is a tendency for both high and low anxiety groups to evidence more intercorrelations between separate EEG variables over the right hemisphere. If this is looked at in terms of region monitored, patients with high anxiety manifested many more intercorrelations between EEG variables in the right precentral region as compared to the left. This difference is in the same direction for the low anxiety group but it is not as pronounced.

Finally, if one looks at systems of correlations among separate EEG variables for high anxiety and low anxiety groups, one does get some laterality differences in that a predominance of intercorrelations over the left hemisphere for the high anxiety group was found. For patients experiencing low anxiety, the predominance of intercorrelations was found in the right hemisphere. If this is studied by region the greater amount of inter-

correlations for the high anxiety group is found in the left precentral region. For the low anxiety group, there is a predominance of intercorrelations within separate regions of the right hemisphere. The authors conclude from these findings that those patients who are more severely ill (high anxiety group) manifested more left hemisphere involvement.

The results of this study appear to suggest that the relationship between mood and the cerebral hemispheres is a complex one. It is striking that if the findings are examined individually, support is found for a number of different positions. The relationship between high anxiety and left precentral activity supports the findings of d'Elia et al. (1973) and Deglin et al. (1975). The finding, however, that the amplitude of beta over the right precentral region is related to depressed mood appears to support those researchers that have hypothesized that the right hemisphere subserves dysphoric emotion (Davidson et al., 1978; Sackeim et al., 1980).

It should be pointed out that the Monaknov et al. (1979) study may have some methodological weaknesses that, while not negating the importance of its findings, does not allow one to accept them with total confidence unless further replication is provided. Principally, the clinical symptoms and signs, such as depres-

sive ideas, depressive mood, etc., were defined by only one item each on the Depression scale that was used in the study. The entire scale may have demonstrated validity in identifying the syndrome of depression, but it cannot be assumed that an individual item of the scale can account for all the variance of the symptoms that it is purported to represent. Nevertheless, the study findings should be considered an important addition to the research on emotional laterality.

Summary and Conclusions

Ten studies have been reviewed in this section on EEG measures of emotional asymmetry. Some of the studies support the hypothesis that the nondominant hemisphere subserves dysphoric affect while the dominant hemisphere is responsible for positive affect (Davidson et al., 1978; Flor-Henry, 1976; 1979). Other studies have received support for the opposite contention, that is, that the dominant hemisphere is responsible for negative affect (Harmon & Ray, 1977; d'Elia & Perris, 1973). Cacioppo et al. (1979), while receiving results that appear to support the hypothesis of right hemisphere involvement in dysphoric affective states, note that the results are not due to an emotional lateralization of the hemispheres but to their styles of processing information.

The most support, however, appears to be for the

hypothesis implicating the right hemisphere and specifically the right frontal area in the subserving of dysphoric affect. These findings have been replicated by Tucker et al. (in press) using frontal, central, parietal and occipital leads. Monakhov et al (1979) report findings relating depressed mood to right frontal EEG changes and therefore further substantiate the hypothesis. The finding by Cacioppo et al. (1979) relating affective responses to differing styles of information processing is certainly a finding that necessitates further investigation. The fact, however, that the EEG readings were taken at the parietal lobes does not constitute direct refutation of the emotional asymmetry hypothesis. In addition, it should be noted that differing recording sites were utilized in the other studies which obtained different results from those of Davidson et al. (1978). Harmon and Ray (1977) recorded EEG from the temporal lobes while d'Elia and Perris (1973) obtained their recordings from centro-parietal sites. Thus, these also cannot be seen as a direct refutation of the Davidson et al. (1978) hypothesis.

But perhaps there is another way of explaining the data. The Monakhov et al. (1979) results describe quite a complex picture of depression and its relation to the cerebral hemispheres, with both the left and the right hemispheres equally implicated. Many authors have

commented on the complex relationship that may exist between emotion and the cerebral hemispheres (Sackeim et al., 1980; Davidson et al., 1978; and Cacioppo et al., 1979). Still others have warned against accepting too simplified a view of hemispheric specicalization in general (Broadbent, 1974; and Ornstein, 1978). Although it remains to be demonstrated, the possibility exists that even though different sites were selected in the various investigations, perhaps each study was examining different aspects of the mediation of emotion in the hemispheres. Emotion, certainly, is quite a complex phenomenon that interacts with many different systems (Izard, 1972).

It would appear then that while the theory linking positive affect to the left hemisphere and negative to the right has the most experimental support at the moment, the issue of emotional lateralization is far from closed.

LEM Studies of Emotionality

By 1975 it had been hypothesized that the right hemisphere perhaps played a special role in the mediation of emotion. The results of these studies such as Gainotti's (1972) were interpreted as demonstrtaing an emotional specialization for the hemispheres, expecially for the right. Gallin (1974) hypothesized that the right hemisphere possibly functioned in what Freud termed a primary process mode. Since primary process

is intimately linked to emotion, another connection was made between emotion and the right hemisphere. Since LEMs were seen as indicators of hemispheric activation, it was felt that this hypothesis could be tested by using questions that elicited affect (Schwartz, Davidson & Maer, 1975). They hypothesized that questions eliciting affect would result in more left movement as compared with questions that did not. They composed a set of forty questions which constituted four different categories of ten questions each. The categories were: Verbal Non-Emotional; Verbal Emotional; Spatial Non-Emotional; and Spatial Emotional. In order to insure as much as possible that the results received were not contaminated unknowingly by verbal or spatial factors, the questions were matched for imagery and affective value. Lateral eye-movement behavior was assessed with the experimenter sitting in front of the subject. Two experiments were performed involving basically the same procedure. The first experiment used ten right handed subjects while the second utilized fourteen right handers. Since the results of both experiments yielded similar results the data from both were collapsed.

The results indicated that the Spatial Emotional questions elicited the greatest amount of left movement and the fewest right movement. The Verbal Non-Emotional questions resulted in the most right eye-movement and

the fewest left eye-movement. The Verbal Emotional questions induced the second highest number of left eye-movements while the Spatial Non-Emotional questions placed third in amount of left eye-movements found. While the difference between the Spatial Emotional and Verbal Non-Emotional was significant on both the number of right and left eye-movements produced ($p = .01$), the difference between the Verbal Emotional and Spatial Non-Emotional questions was not. The overall difference for Emotion vs. Non-Emotion by left vs. right was also signific nt ($p < .005$).

The authors then concluded that the results of this study constituted further support for the hypothesis of a right hemisphere specialization for emotion.

In an attempt to replicate their findings, Davidson, Schwartz and Weinberger (1977) studied the lateral eye-movement behavior of 50 right handed male undergraduate students. In addition, they were interested in exploring if asymmetrical autonomic activity could be induced using emotional vs. non-emotional questions. LEMs were assessed with the experimenter in front as in the last experiment. However, only 20 questions covering the four categories were used. Electrodermal activity as measured by skin resistance was recorded bilaterally from the palms of each hand. Fourteen of the 50 subjects evidenced bi-direction of eye-movement in response to the questions.

For these subjects only was the data supportive of the hypothesis implicating the right hemisphere in emotion. The other subjects' eye-movements were unidirectional, in that seventy percent or more of their eye-movements were either towards the left or the right. This had occured in the previous experiment but to a much lesser degree. While 25% of the subjects exhibited unidirectional eye-movements in the previous study, in the present experiment, 74% of them evidenced such movements. It is possible that having the experimenter sit in front of the subject caused the unidirectional LEM behavior.

Tucker, Roth, Arneson and Buckingham (1977) performed an experiment to study the effects of psychological stress on hemispheric activation. The authors hypothesized that stress should lead to greater emotional arousal and thus, greater right hemisphere activation. LEMs, in response to emotional vs. non-emotional questions as used by Schwartz et al. (1975), were utilized as the indicator of hemispheric activation.

Forty-two subjects (20 males and 22 females) participated. Stress was manipulated by telling the subjects that while some of the questions were only to be used to calibrate the equipment, other questions would be able to discriminate their level of intelligence and

and personality stability.

The stress vs. non-stress conditions were counterbalanced. An anxiety questionnaire was used to determine if the stress manipulation was effective. As in the previous experiments, the experimenter faced the subjects.

The results indicated the left eye-movement was significantly related to emotional question type. The stress manipulation as hypothesized increased left eye-movement across both neutral and emotional question types. Furthermore, for those subjects that evidenced unidirectional eye-movement behavior either to the left or the right, stress manipulation increased left eye-movement for both groups. Finally, while left eye-movement was increased for both sexes in response to the stress manipulation and to the emotional questions, the result due to stress was only significant for males while only question type resulted in a significant difference for the females. A recent study, however, has not been able to substantiate the Tucker et al. (1977) findings. Berg and Harris (1980) performed a study in order to investigate if anxiety was responsible for unidirectional eye-movement in the experimenter in front condition. In addition, they were interested in investigating if stress increased left eye-movement as Tucker et al. (1977) had hypothesized.

Forty-eight right handed males participated in

the study. Three conditions were employed: (1) the experimenter in front condition; (2) an experimenter behind non-stress condition; and (3) an experimenter behind stress condition. LEMs were measured in response to 10 verbal and 10 spatial questions.

The results indicated that none of the hypotheses could be supported in that neither experimenter position nor stress was related to the direction of eye-movement. Furthermore, direction of eye-movement was not related to question type. Of specific interest, however, was the finding that stress did not cause more left eye-movement as Tucker et al. (1977) had found. These results thus question their finding that anxiety is related to right hemisphere activation. Indeed, these findings question is LEMs are related to hemispheric activation in any manner.

As has already been noted in this paper, a number of reports have been published purporting a relationship between the right hemisphere and negative affect and the left hemisphere and positive affect (Davidson et al., 1978; Diamond et al., 1976; 1977; and Sackeim et al., 1980). Ahern and Schwartz (1980) attempted to substantiate this hypothesis using a LEM measure.

Twenty subjects (10 male and 10 female), all right handed, were told they were to participate in a study on pupillary diameter and its relationship to affect.

This instruction, which could decrease bidirectional gazing behaviors by calling attention to the eyes, was used to call attention away from the face. A measure of facial muscle asymmetry in response to affective vs. non affective questions was also taken. The authors did not want voluntary muscle responses to contaminate the involuntary ones. It had been previously shown that facial muscle activity was related to type of emotional response (Schwartz et al., 1976).

Sixty questions were used for this study in a 2 x 5 matrix (6 questions in each cell). The verbal/spatial dimension was manipulated with happiness, excitement, sadness, fear and a neutral condition. Thus, two types of positive affect were investigated (excitement and happiness) as well as two types of negative affect (sadness and fear). The subjects faced a camera lens directly. The experimenter sat in another room and read the questions to the subject giving him 15 seconds before he had to respond.

The results indicated that overall emotion was related to eye-movement behavior but not in a consistent way and only in part as hypothesized. As hypothesized, the excitement questions in both verbal and spatial modes were responded to with more right eye-movements and less left eye-movements as compared to the fear questions which demonstrated the opposite pattern.

However, the sadness questions, in both modes, were responded to with the least amount of left and the greatest amount of right movements of all the emotion questions. This is the opposite pattern from that which the hypothesis would have predicted.

The contradictory nature of these results does not allow one to conclude that LEMs are an indicator of differential emotional involvement of the two hemispheres. The finings of Berg and Harris (198) also lead one to this conclusion. The results of several LEM experiments (Schwartz et al., 1975; Davidson et al., 1977; and Tucker et al., 1977) have supported a right hemisphere involvement in emotion. However, these findings can also be explained by the theory being proposed in this dissertation, that is, that the subjects moved their eyes towards the right because they had more positive feelings towards the right side and that they moved their eyes to the left because they had more negative feelings towards it. All the subjects in the past three experiments cited were right handers. Right handers would be expected to feel more positively towards their right sides and more negatively towards their left. Pilot work for this dissertation is supportive of this contention. In the next section, it will be demonstrated that people, indeed, do have differential attitudes towards their

right and left sides.

Attitudes Towards the Right and the Left

"Be it resolved that all LEFT-THINKING citizens, mindful that their BIRTHLEFT has been denied them, shall henceforth stand up for their LEFTS: We call upon each one of them to support this BILL OF LEFTS..." (De Kay, 1966; p. 56).

Perhaps this "manifesto" expresses quite succintly what left handers have felt for almost the entire period of recorded history. That is, that they have been considered something less than second class citizens all because they use their left hand to perform most tasks instead of their right.

In this section, the reasons why human beings all over the world have looked on the "left" as something to be ridiculed and avoided, will be investigated. The meanings of the terms, right and left, and their derivations will be looked at for the various languages around the globe. Then the cultural and societal beliefs concerning the left and the right will be investigated to determine the reasons left has been considered as bad and right has been considered as good. Much of this data will concern cultures or periods far removed from present day society. Thus, one might argue that these attitudes are not applicable to this society. It will demonstrated, however, that the same dichotomous view

of left and right is, indeed, part of present day society. Indeed, it will be shown that in the twentieth century, physicians and researchers have tended to view left handedness as root, or causal agent associated with many ailments from mental retardation to alcoholism.

As Barsley (1967) reports, the Oxford Dictionary, in summing up the meanings of the adjective "left handed" classifies it as ambiguous, doubtful and questionable. In medical language, it was seen as spurious. Although considered obsolete, the following meanings are also included: crippled, defective, awkward, ill omened, and finally, characterized by underhanded dealings. It should be pointed out, however, that left defined as clumsy and awkward survives today in Roget's Thesaurus where one of the synonyms for unskillful, along with stuttering and stammering, is left handed. Indeed, the English word, left, is derived from the Anglo-Saxon word "lyft" which is an offshoot of the Old Dutch meaning for weak or broken. Conversely, the English antecedent for "right" is the Anglo- Saxon "riht" which means straight, erect or just (Fincher, 1977).

Thus, it can be seen that the negative attitude towards the left permeates our very language. This is brought out even clearer if one considers the various uses of the word "left" in phrases that are used presently. Therefore, a "left handed friend" is considered

an enemy, while a "left handed compliment" is not a compliment at all but a veiled insult (Blau, 1946). "Bar sinister" in heraldry popularly connoted illegitimacy. The word "sinister" incidentally comes from the Latin word for left and means bad omen, evil, awkward, wrong, perverse and so on. The British slang word for left handed, "cack handed", lowers the view of the left to what is almost the bottom of the barrel in that "cack" is the British colloquial term for feces. Australians call the left-male a "molly dooker" which means "woman handed".

The identification as right as good and left as bad is present in almost all languages (Thass-Thieneman, 1955). The French term "gauche" has been incorporated into the English language as a term meaning out of place (Barsley, 1976). On the other hand, the word for right in French is "droit" which stands for correct and law. In Italian, the term for left is "mancini" signifying crooked or even maimed ("mancus"). "Zurdo" is the term for left in Spanish. "Azurdas" which contained the root "zurda" means to go the wrong way. In addition, "no se zurdo" means to be clever, or in other words, not to be left handed.

This list could go on and on and the only language you would find that did not portray the left as bad would be Chinese. The question arises: Why do all

these languages have such derogatory meanings for the word left.

The Bible can certainly be considered one of the most important books in Western civilization. There are over 1 billion Christians in the world and the Bible is the basis for their faith (Wallechinsky & Wallace, 1975). The same authors report that between 1800 and 1955, one and a half billion copies of the Bible have been sold, making it the all time best seller. In total, the Bible contains 80 references to the right hand (Wile, 1934) and all of them give it an honored and powerful position. Hardyck and Petrinovich (1977) give us some examples, all from the Book of Psalms. For example: "the Lord's right hand is full of righteousness" (48:10); and "...(this) right hand shall hold me" (139:10). As these authors point out, there are no references to the Lord's left hand in the Old Testament. However, in the New Testament the Book of Matthew gives a clear indication of the fate of those persons who are at the Lord's left hand. This passage speaks of the second coming of Christ. For those on the left, the consequences are not that palpitable, i.e., "the curse is upon you; go from my sight to the eternal fire that is ready for the devil and his angels" (Matthew, 25). Considering this statement, it is little wonder that the left was considered dangerous and evil.

If the Christian view of the left hand is one that

is connected with eternal damnation, views held by other cultures throughout the ages are not more favorable. One would say that the Hellenic culture and the philosophy that ensued from it is one of the main foundation of Western thought (Dampier, 1971). Thus, it would be of interest to see what the Greeks and their leading thinkers felt about the left hand. As Lloyd (1973) points out for the Greeks the right was the lucky side and the left the unlucky one. The terms, right and left, appear quite frequently in Greek philosophical writings and were often paired with other dichotomies, such as light and dark, or male and female. All these appear in the Pythagorean Table of Opposites in which right, male and light appear on the side of good, and left, female and darkness, appear on the side of bad. Lloyd (1973) contends that these pairings stem from very early Greek beliefs and that these early beliefs have affected a great portion of Greek philosophy. Thus, if we look at medical beliefs, we see that Parmenides believed that the sex of the child could be determined by its position in the womb. Male children came from the right side and female children from the left. The father of medicine, Hippocrates, wrote that if the sperm came from the right testicle, a male child would result and if it came from the left testicle, a female child would be born. Thus, since women were seen as the inferior sex, they would naturally come from the

inferior side.

If we look at Aristotle's writings, we see that, while adopting a more rational philosophy concerning the left and the right, nevertheless, he still tends to view the left in a more perjorative way (Lloyd, 1973). Aristotle, thus, rejects the medical hypotheses of his predecessors. He is able to do this because he has followed the scientific approach and sees for himself via dissection that these speculations are not true. In his philosophy, however, Aristotle's theory favors the right. For example, he believed that all locomotion proceeded from the right. He associated the right side with the dimensions of "up" and "front" because they all represent the "starting principle". Furthermore, because they are seen as such, they are naturally superior to their corresponding points, "left", "down" and "behind". In fact, Aristotle's belief in the superiority of the right was so strong that it leads him to make blatant errors in logic. Confronted with the fact that the heart, an organ he considers very important, is placed towards the left side, he chooses to invoke an arbitrary argument rather than reconsider his theory. The heart, he believes, gives off heat, and it is placed towards the left to counteract the natural chilliness of that side. For a person of such obvious intelligence to make such an unsupportable argument appears to speak

for the tenacity of the belief in the superiority of the right and the inferiority of the left. Lastly, since one of the foundations of Western thought holds the left in less esteem than the right, it is not surprising that latter cultures also do so.

If we were to travel around the entire world, the same attitude towards the left and the right would be found. There are a few exceptions, however. The Chinese culture slightly favors the left, but basically believes that both directions are equal (Granet, 1973). This is because left and right are seen as complementary, related to the concept of Yin and Yang where both are seen as different but equal. The Zuni Indians saw the left and right as two gods who were brothers with the left as the wise one and the right as the impetuous one (Hertz, 1973). Finally, some tribes in the northeast of Africa, namely the Ehor of the Cameroon, the A Kamba and the Wagera as well as the Kavirondo and the Danakil consider the right as the unlucky side (Wieschhoff, 1973). The rest of Africa sees the left as the unlucky side.

In many countries today, the left is seen as the unlucky hand and only it can be used for toilet functions (Barsley, 1976). To eat with it would be in the least, a gross display of bad manners. In some cultures, however, the punishment may be quite severe. For example, it states in the Talmud that the use of this

hand can lead to blindness, deafness and polypus (Barsley, 1976).

Perhaps the most definitive paper on cultural and societal views towards the left was written by the sociologist, Robert Hertz (1973), a student of Durkeim. In studying the Maori of the South Pacific, he found that their attitude towards the left was one of fear and denigration. The left was considered profane while the right was considered sacred. Everything connected with the left was condemned. He traces this attitude and the similar attitudes of other cultures as an attempt in man to have the sacred dominate the profane. Thus, the dichotomy stems from the basic religious duality of good and evil which he believes is part of the makeup of all mankind.

Up to now, we have for the most part, discussed cultures that are far removed from this one. One could argue that the belief of some primitive tribe in the South Pacific has little to do with present day society. As we have seen, however, the denigration of the left is embedded in our language and is part of the basis of our philosophy. Moreover, there are other indications that this attitude is very much alive in the twentieth century.

A study was performed using the Semantic Differential to test the attitudes of college students of the

right and the left (Domhoff, 1969). Eighty students rated the concepts of "right" while seventy-eight rated the concept of "left." The left was characterized as bad, dark, homosexual, profane, unclean, curved, female and weak among other perjorative attributions. The right was seen as good, light, heterosexual, sacred, clean, straight, male and strong. It should be noted that these dichotomies were taken from historical and antropological data on this subject and correspond to primitive views on this subject. Furthermore, Domhoff tested school children and found that they also saw the left in a negative light, although the rating did not become highly negative until the sixth grade. Domhoff also reports the observation of Janet Brown (1962) of three year old children in a play situation. She found that these children tend to use their right hands for socially acceptable activities and their left for aggressive ones as well as contact with their own bodies if they were right handed.

In addition, Domhoff cites examples from psychoanalytic case studies in which negative attitudes towards the left were expressed quite clearly. One patient reported in a dream that a person was on her left side because the left was wrong (Fodor, 1945). Another patient named Rose, had a mental picture of herself as two people, a right and left Rose. The left one represented the bad or wicked self. A patient of my own, in a

description of the period before his first psychotic break, expressed views of the left and the right that are similar. He states that when he was in church, listening to the sermon, he would at times stamp his right foot and, at times stamp his left. If he stamped his right foot that meant that the person speaking would go to heaven. Alternately, if he stamped his left foot that would mean that the speaker was destined to go to hell.

Another point that suggests that the left is still seen in a negative light can be deduced from the attitudes of modern investigators. Blau, writing in 1946, produced a monograph called, "The Master Hand." In it he investigates quite thoroughly the attitudes concerning the right and the left and the relation of handedness to personality. He finds that left handedness can result from three different etiologies: (1) an inherent deficiency, physical or mental; (2) faulty education; or (3) emotional negativism. Note that none of these factors are natural. Left handedness is always due to some deficit. However, the third category, emotional negativism, is the most perjorative because it equates left handedness to an "infantile psychoneurosis characterized by a reaction of contrariness which is a type of defiance against a restrictive parent or due to other frustrations" (p. 121). In addition, negativism and arbitrariness

become part of the left hander's personality structure. Furthermore, he believes that the psychoneurotic basis for left handedness is the most common and that most left handed children have frustrating mothers.

The twentieth century's scientific establishment's negative view of left handedness is not restricted to Dr. Blau. In this century, left handedness has been implicated in the etiology of such disorders as reading disabilities (Orton & Skygaard, 1934); poor academic achievement (Gilbert, 1973); personality disorders (Orme, 1970); perceptual deficits (Flick, 1966); and mental deficiencies in children (Burt, 1937).

Hardyck and Petronovich (1977), in reviewing the results of this data, state that no substantive data has been found confirming these claims. They also point out that the samples these studies have used are not from the general population in that they have come from clinics to which children have been referred for academic, language or other types of problems. Thus, it would not be appropriate to generalize the results of these studies so broadly and claim that these results describe all left handers. In addition, Hardyck, Petronovich and Goldman (1976) performed a study on 1688 left and right handed school children, comparing their performance on intellectual and performance tests. No relationship of any kind was found between handedness

and test performance.

Finally, Haefner (1929) tested over 1100 children in grades 4 through 7 on a number of measures, such as intelligence, school acheivement and general emotionality. In terms of intelligence, school achievement and interests, there was no difference between right and left handers. Left handers appeared slightly better adjusted to the school situation. There was no difference in emotionality. Thus, it would appear that there is no clear evidence relating left handedness to cognitive deficits yet as Hardyck et al. (1977) state the "willingness to perceive an association between the two persists" (p. 266). It can be strongly suggested that this again is a manifestation of society's negative attitude toward the left. Indeed, all the evidence in this section convincingly supports the contention that people do have differential attitudes toward their left and right sides.

Fisher's work on body image is of particular relevance in that it demonstrates that attitudes towards the two sides of the body can affect perception. This is an important consideration in that one could accept that one could accept that persons have differential attitudes towards the left and right sides of their bodies and not accept that this could affect LEMs.

Fisher (1970; 1972) has hypothesized that there is a relationship between perceptual awareness of certain areas of the body and central cognitive processes. He asserts (1970) that the delineation of various body areas in a person's awareness serves the role of a cue that, in turn, plays a part in the regulation of certain responses. He gives the analogy of a child who is reminded to buy an article because his mother has tied a string to his finger in order to remind him (p. 355). Thus, a person, through the process of socialization may develop a variety of "attached strings" or perceptually highlighted body areas that serve as signals that modify judgments and responses. A body area may become more prominent in a person's awareness because of its utility, its significance, or its activity in reaching a goal. Body areas or landmarks as Fisher calls them supply feedback to the person that certain things are important while others are not (p. 356). For example, if the stomach muscles contract, this is interpreted many times as a signal that one needs food.

In earlier reports (1960; 1965), the author had demonstrated that increased attention of males to their right or left sides was was correlated with measures of sexual adjustment and sexual identity. Contrary to what one would expect, difficulties in heterosexual activities

were related to increased awareness of the right side of the body for men, as measured by a body focus questionnaire. One would have expected the opposite finding given cultural and societal beliefs which have associated the right side with maleness and the left side with femaleness. However, Fisher (1965) has found that the more a male or a female identified the right side of his or her body with their own sex, the more likely it would be that they would see their own sex as superior to the other in power relationships. This view is more consonant with cultural attitudes in that it identifies the right side as the powerful one.

Using the finding that men who demonstrated increased awareness of their right side tended to experience more difficulties in heterosexual relationships as a basis, Fisher (1972) attempted to demonstrate that increased awareness of the right side would influence perception and thus, central cognitive processes. A vibrator was attached to the right arm of twenty-one male college students in order to increase awareness of these two sides. The vibrator was turned on one minute prior to the task and was left on for the duration of it. These two groups were compared to a control group of fifteen male students. All three groups viewed tachistoscopically a group of pictures depicting heterosexual, homosexual, narcissistic and neutral themes. The pictures

were viewed at five successively decreasing speeds. Fisher did not specify whether identification of the heterosexual pictures would stem from left or right sided stimulation. This is because the method used in this study has been shown to either facilitate or inhibit perception of the target stimulus.

The results indicate that the right vibrator group had a significantly lower threshold for the heterosexual as compared to the left vibrator group and the controls, who did not differ from each other. Thus, it was demonstrated that increased bodily awareness does affect perception. In another study reported on in the same paper, men who had suffered wounds to the right and left sides were tested via the same procedure. The results obtained demonstrated that heightened awareness, caused by the wound, was related to perception of heterosexual stimuli.

These studies demonstrate that meanings do appear to be attached to the sides of the body. Furthermore, when the right side of the male body is highlighted, perceptual changes occur and these are related to the particular meaning that is attached to that part of the body. Thus, one could certainly hypothesize that other meanings could be attached to the right and left sides of the body. In addition, one could theorize that if perception is affected, LEM behavior could be also.

Evidence supporting this contention has been reported.

Fisher and Greenberg (1979) have hypothesized that the more a person displays a biased directionality in his perception, the higher the probability that he has converted a psychological attitude into a spatial metaphor. They tested their theory by attempting to correlate measures of right-left perceptual asymmetry to a measure of bodily symptoms. Visual asymmetries were evaluated using two tests. First, they asked subjects to judge when a luminous rod in a dark room had been moved into a vertical position when the left vs. right starting points were used. Error scores were determined for both starting points based on eight left-right trials. Second, subjects were given the Thurstone Movement Directionality Test. For this test, subjects are seated 15 feet from a screen upon which colored spots are projected. On the screen is a clock face. The spots move across the face in a straight line and the subjects are asked to judge after a $1\frac{1}{2}$ second presentation what direction the spots have moved. The score is the total number of movements to the left and the total number to the right. The two separate scores were compared individually to a Body Symptom questionnaire. The subjects for this study were 131 college students, who had been divided into three samples. The first sample was composed of 51 males. The two other samples were both composed of

women: 51 in one and 29 in the other.

The results indicated that for both sexes, symptoms involving bodily openings were significantly related to a left perceptual bias. This correlation was stronger for the women. In discussing their results, the authors hypothesized that the left vs. right dichotomy is linked psychologically to a self vs. other orientation. Those with a left sided perceptual bias, they hypothesized, would display an orientation towards the self rather than others. Bakan (1971), using LEM methodology, came basically to the same conclusion. He found that left movers tended to direct their attention inward as opposed to right movers who tended to direct their attention outwardly. Thus, in demonstrating a link between bodily symptoms and left/right perceptual biases, a strong basis for hypothesizing that feelings towards the left and right sides of the body can affect LEM behavior is established.

Summary and Recapitulation

In this chapter, several groups of studies have been reviewed bearing on the question of a possible relationship between LEM behavior and differential attitudes towards the left and right sides of the body. In the first section, studies were reviewed concerning LEMs and their relationship to asymmetrical hemispheric activation as it relates to the verbal/spatial hypothesis. It was concluded that there was very little rationale for

accepting this hypothesis. Studies reviewed were inconsistent in their results, some supporting the hypothesis while others did not, and these differences could not be attributed to differences in methodology. Furthermore, other alternative explanations were found that could explain the LEM pheneomenon equally well.

The research on emotional asymmetry and the hemispheres was then reviewed. The purpose was to ascertain if all emotions were lateralized to one hemisphere, or if different groups of emotions were lateralized tc the left or right hemisphere. Five groups of studies were reviewed: (1) the sodium amytal studies; (2) lesion studies; (3) dichotic listening studies; (4) facial asymmetry studies; and (5) EEG studies.

The review of the amytal studies suggested that emotions did appear to be connected with hemispheric functioning but no evidence could be found concerning the specific lateralization of emotion.

The review of the lesion studies, while contradictory, tended to support the contention that the hemispheres were emotionally lateralized. Furthermore, the fact that persons with right hemispherectomies experiences laughing outbursts tends to suggest that positive affect is lateralized to the left hemisphere (Sackeim et al., 1980). This data although based on a small sample, at least is unambiguous in that it is clear that

the emotional reaction is coming from the left hemisphere. As previously stated, one of the problems in this type of research is that it is difficult to determine if the locus of effect of the lesion is contralateral or ipsilateral. In addition, at times it is not clear if the emotional outbursts observed are just an emotional display as opposed to a true emotional reaction with all the concomitant feelings typically felt. Lastly, as Gainotti (1972) contends, psychological reactions to insult cannot be ignored as a possible cause of the emotional outburst.

The result of the dichotic listening studies reviewed, except for one, demonstrates a right hemisphere specialization for emotion. These results, however; are difficult to interpret because they may have been due to task effects rather than laterality effects. One study (Beaton, 1979), using a dichotic paradigm, found that the right hemisphere appears to subserve positive affect.

The facial asymmetry studies also appear to point to right hemisphere involvement in emotion but full acceptance of this hypothesis is clouded by a lack of knowledge involving facial nerves and their connection to the brain.

The results of the EEG studies give some evidence suggesting that the hemispheres are differentially lateralized for emotion, with the left hemisphere subserving positive affect and the right, negative affect.

As in the other studies reviewed, there are contradictions in the data. As a whole, however, the EEG studies point to a more complex relationship between emotion and the hemispheres.

If all five groups of studies concerning emotional asymmetry and the hemispheres are taken into consideration, the following conclusions can be drawn. First, there appears to be a relationship between emotionality and the hemispheres but it is not totally clear which hemisphere subserves which emotion. The most consistent support is for the view that the right hemisphere subserves emotion in some capacity. Second, there are several indications in the literature that task demands (Safer & Leventhal, 1977) or style of information processing (Cacioppo et al., 1977) may be responsible for the results obtained in these studies. These issues need to be investigated further in order that research in this area may proceed on a sound basis.

The studies on LEMs and hemispheric emotional involvement on the whole appear at least somewhat questionable. Three studies have found a relationship between emotional questions and left eye-movement, theoretically supporting a model of right hemispheric involvement in emotion. One study, however, has received contradictory results. Furthermore, the one study published attempting to demonstrate a relationship between LEMs and

questions eliciting positive and negative affect is contradictory in its results.

The literature on meanings attributed to the left and right was then reviewed. It was found that societies past and present, hold the left in low esteem and that this attitude is pervasive enough to be tapped experimentally. Fisher's research (1960; 1965; 1970; 1972) was reviewed and it was determined that meanings attached to body areas can affect perception and also can affect directional perceptual biases (Fisher et al., 1979). A strong rationale for the pursuit of this study was thus established.

II. HYPOTHESES INVESTIGATED IN THE PRESENT RESEARCH

The purpose of the present study is to ascertain if there is a relationship between lateral eye-movements and attitudes towards the left and right sides of the body. If there is a relationship, this would be seen as a further refutation of the hemispheric asymmetry hypothesis as it related to LEMs. Specifically, it would call into question the hypothesis offered to explain the results of LEM studies purporting a relationship between the left hemisphere and positive emotion and the right hemisphere and negative emotion. In addition, it would question the hypothesis of those LEM studies whose results support a theory of right hemisphere dominance for emotion.

In addition the data obtained on the attitudes towards the left and right sides of the body will be of interest. Do left-handers hold the same attitudes towards the left as right-handers do? Furthermore, are attitudes towards the two sides of the body related to lateral superiorities, or are they strictly determined by cultural beliefs?

Objectives

First, LEM behavior in response to questions eliciting positive and negative affect will be assessed. Second, attitudes towards the left and right sides of the body, using four separate measures, will be assessed. Third, these measures will be compared to see if there is

a relationship.

In connection with the first objective, this study offers the following hypotheses:

1. For right-handed subjects, a relationship will be found between questions eliciting positive affect and right eye-movement;

2. For right-handed subjects, a relationship will be found between questions eliciting negative affect and left eye-movement;

3. For left-handed subjects, the relationship between direction of eye-movement and emotional valence of question will correspond to the description in the third objective following shortly.

In connection with the second objective, this study offers the following hypotheses:

1. Differential attitudes towards the left and right sides of the body will be obtained and these will correspond to societal attitudes which view the left as negative and the right as positive.

2. This relationship will be most strong among right-handed subjects and weaker or non-existant among left-handed subjects if hand preference is related to manual dominance;

3. Data analysis will also focus upon an assessment of the possible relationship between degree of manual dominance and degree of difference of attitudes

towards the right and left sides of the body;

4. There may be a difference between conscious and preconscious attitudes towards the left and right sides of the body, e.g., left-handed subjects may consciously rate the left as positive but see it as negative preconsciously. This will be assessed.

In connection with the third objective, this study offers the following hypotheses:

1. In response to questions eliciting positive affect, the direction of the LEMs will correspond to the side of the body the subject feels most positive about either consciously or preconsciously;

2. In response to questions eliciting negative affect, the direction of the LEMs will correspond to the side of the body the subject feels most negative about either consciously or preconsciously.

III. METHODS AND PROCEDURES

This experiment was designed in order to see if the subjects' attitudes towards the left and right sides were predictive of their LEMs in response to questions eliciting positive and negative affect. The tasks will be described in the order in which they were presented to the subject.

Subjects

The subjects in this study were 40 Brooklyn College Introductory Psychology students, 20 males and 20 females, half of each group being left-handed and half right-handed. Handedness was assessed by Annett's Handedness Scale. Their average age was 23.4.

Tasks

Handedness Questionnaire

Annett's Handedness Questionnaire (1971) was used to determine the degree of left or right handedness of the subjects.

Lateral Eye-Movement Task

For this section of the experiment, subjects were seated in a room facing a background that was made as homogeneous as possible. The experimenter sat directly in front of the subject at a distance of 1.5 meters.

The subjects were told that, for this part of the experiment, what is of interest was their style of answering questions. They were requested to pay close

attention to the question, give some thought, and then answer. The LEMs were scored in the following manner. If the subject's gaze was not centered upon completion of the question, the direction the subject was looking towards at that moment was scored. If it was centered upon completion of the question, the first LEM that occured was scored. A LEM was considered lateral from half-way between the 1 and 2 o'clock positions. All of the other LEMs were considered vertical.

The subjects were requested to attend to the question in an attempt to keep their gaze on the experimenter as much as possible. It has been determined that when one is paying attention to what someone is saying, the person usually looks at the person who is speaking (Kendon, 1967). The experimenter focused his gaze on the bridge of the subject's nose in order to avoid any discomfort that the subject might feel about being stared at directly (Richerdson, 1978).

The LEM questions used by Schwartz et al. (1975) were used to elicit the eye-movement. They total forty-eight in all and are divided into six different types comprising eight questions each. They are: (1) Verbal Non-Emotional; (2) Spatial Non-Emotional; (3) Verbal Positive Emotional; (4) Verbal Negative Emotional; (5) Spatial Positive Emotional; and (6) Spatial Negative Emotional.

Puppet Task

Fisher (1960; 1965) developed a semi-projective technique in order to tap differential attitudes about the right and left sides of the body. He asked his subjects to place identical lengths of paper tubing over the middle finger of each hand and to imagine they were puppets. The subjects were then asked to name each puppet and then make up a story involving the characters. Three more stories were requested but for these, themes were suggested. The score computed was the number of masculine vs. feminine names given the left and right sides.

A modification of this technique was used in this study. Based on Domhoff's (1969) study on attitudes towards the right and the left, three dichotomies were selected: (1) Good vs. Bad; (2) Graceful vs. Awkward; and (3) Strong vs. Weak. In this study, each of these dichotomies was symbolized by a well-known, popular character and his opposite. Batman and his arch enemy, the Joker, and God and the Devil represented the dichotomy of Good vs. Bad. The Graceful vs. Awkward dichotomy was symbolized by John Travolta and a clumsy man he is teaching to dance. Hercules and an ordinary man symbolized the Strong vs. Weak dichotomy. An open story and one involving the President and Vice-President were also requested in order to disguise the true

nature of this task.

The subjects were asked to make up a short story concerning the individuals named. They were told that the story should have a beginning (what led up to the main action), a middle (the main action) and an end (the result of the main action). Although these stories were not the main interest, they were taped to make the subjects believe that they were. This was done in order to disguise the task. The data of interest was the name attributed to each puppet. In addition, the subjects were asked to act out the story using the two puppets. Via this method, it was rarely necessary to ask them to name the puppets. The names could be reliably ascertained from their actions. In the pilot study, the names were scored from the subjects' actions and by asking them after the experiment was over, it was determined that scoring in this manner was 100% valid. During this phase of the experiment if there was any doubt, the subjects were asked in a casual manner which name they had given to one of the puppets.

Pegboard Task

The pegboard task was used to ascertain reliable differences in manual dexterity between the two hands (Annett, 1971). The pegboard was a 16 inch square, $1\frac{1}{4}$ inches thick. In it were drilled 20 holes, one inch deep, divided into two rows of ten, eight inches apart.

Ten pegs, 3/8 inch in diameter and two inches long, were placed in the top row. The subjects stood in front of the board. Their task was to move the pegs as fast as they could from the top row to the bottom row while being timed. They did this with their dominant hand first and then with the non-dominant hand. Five alternating dominant/non-dominant trials were completed.

Manual Performance Tasks

In an attempt to gain a direct assessment of the subjects' attitudes towards the two sides of their bodies it was felt that the subjects' emotional reaction to the tasks performed with either the right or left hand would be valuable. This was felt to be true because affects expressed towards the two sides of the body could be intimately related to how frustrating or not a task performed with a certain hand was. The presumption was that the tasks would be least frustrating when performed with the dominant hand and more frustrating when performed with the non-dominant hand. Thus, three tasks were designed, a screwdriver task, a design copy task and a writing task, to tap performance levels of the right and left hands. An emotion rating scale was then administered in order at assess the emotions elicited during the three tasks. For all the following manual tasks, the subjects performed one trial per hand. Hand order was counterbalanced for each handedness group.

Screwdriver task. For this task, the subjects were expected to screw down completely as many screws as they could in one minute using only one hand. Throughout all the manual tasks, including the completion of the emotion scale, the subjects were asked to sit on the hand they were not using. This was done to insure that their emotional reactions were stemming only from the activity of the hand that they were using to perform the task. For this task, a 4x6 metal plate was used in which three threaded holes were placed, one inch apart, going down the middle of the plate in a straight line. Threaded into the holes were three 3/4 inch, #4 screws. This assembly was then placed in a bracket which held it at an angle of 35^{o} from the surface it rested on. This had proven to be a comfortable angle for subjects. The bracket and the plate were then attached securely to the table by two miniature clamps. A $3\frac{1}{2}$ inch screwdriver was provided to the subjects. The head easily fitted into the slot on the head of the srew. The measure of performance was the total number of millimeters displaced within one minute.

Design copy task. This task required the subjects to copy two designs as accurately as possible. The designs were #3 and #7 from the Bender-Gestalt Test. The subjects copied the designs on unruled paper that was secured on to a board with rubber feet attached to

the back of it to prevent it from slipping. This assembly was placed in front of the subjects at an angle that they considered comfortable. The measure of performance was the total time it took the subjects to complete the two designs.

Writing tasks. The subjects for these tasks were asked to write out neatly two different segments. The first was the alphabet. The second segment was the first sentence of the instructions of the Emotion Rating Scale. The subjects wrote on ruled paper that was secured to a board and placed at an angle that was comfortable for them. The sentence they were to copy was placed directly above the paper that they were writing on. The measure of performance again was the total time it took the subjects to complete the two segments.

Emotion Rating Scale

Izard (1969; 1972) has developed the Differential Emotion Scale which is based on the theory that separate and distinct emotions exist and that they are measurable. The scale consists of 67 items constructed to measure nine fundamental emotions. These are rated on a five-point scale. The fundamental emotions are: (1) Interest-Excitement; (2) Enjoyment-Joy; (3) Surprise-Startle; (4) Distress-Anguish; (5) Disgust-Revulsion; (6) Anger-Rage; (7) Shame-Humiliation (which is broken down into two sub-factors: Shame-Guilt and Shame-Shyness); (8) Fear-

terror; and (9) Contempt-Scorn. For this study, the entire scale was not used. It was felt that subjects engrossed in filling out a long scale would have lost touch of the emotional reaction that they were rating. Thus, the scale was shortened to 32 items. All of the fundamental emotions were included. Each was represented by three adjectives (except for Contempt-Scorn which was only represented by two adjectives). The adjectives chosen for this scale consituted for the most part those that had the highest primary loadings from the Promax factor rotation of the entire 67 item scale. The emotion scale was given twice: once to rate the emotional reaction for the right hand and once to rate the emotional reaction for the left hand.

Semantic Differential

The Semantic Differential (SD) is a method of measuring the psychological meaning of concepts (Osgood, Suci & Tannenbaum, 1957). The SD is composed of several bi-polar 7 point scales. Two adjectives are at the ends of the scale. Osgood and his associates have determined that when analyzed statistically, the adjective pairs tend to fall into a number of clusters or factors. The most important of these factors are: the Evaluative factor; the Potency factor; and the Activity factor. The entire instrument is usually composed of a number of adjective pairs representing each of the above factors

at least three times.

For this study, Domhoff (1969) was used as a guide in selecting the adjective pairs from the Osgood et al. (1957) validation studies of the SD. Four adjective pairs were selected to represent the Evaluative factor; four to represent the Potency factor; and three to represent the Activity factor. The concepts that the subjects were asked to judge were: (1) left; (2) right; (3) down; and (4) up. Down and up were added in an attempt to disguise as much as possible the true nature of the experiment. The subjects used their preferred hand to fill out this scale.

Procedure

The subjects were told that the purpose of the experiment was to investigate a person's style of answering questions and its relation to manual dexterity. All subjects were examined individually.

The experiment began with the Handedness Questionnaire. Following this, the LEM procedure was administered. The eye-movement section was given prior to the manual tasks in order to insure that the examiner had no prior knowledge of the subjects' attitudes towards their left and right sides of the body that could bias the eye-movement results.

The next task which was administered was the Puppet Task, followed afterwards by the Pegboard Task.

Following this, the subjects were read all the instructions for the Emotion scale, as they read along silently. If there were no questions, the subjects were asked to place their hand which they were not using under their leg and begin the manual tasks. The order of the three manual tasks was completely randomized for both right and left handed groups. Furthermore, for each handedness group, hand usage for the manual tasks was counterbalanced, with half of each group starting with the left hand, the other half starting with the right. Immediately following the completion of all manual tasks for the hand selected, the Emotion scale was administered. The meaning of the demarcation of the five point scale was in open view of the subjects to insure that they knew what each one meant. The subjects were also reminded at the beginning of each manual task to keep a tab on their reactions to the tasks.

Following the completion of the Emotion scale, the subjects were read the instructions for the Semantic Diff Differential, again with the subject reading along silently. If there were no questions, the subjects were told to proceed with the task to its completion. The manual tasks and the Emotion scale were then administered again for the opposite hand. The opposite order used in the previous trial was used for this one.

Index Scores

For purposes of statistical analysis, all measures, except for the Puppet task and the Handedness Scale, were reduced to asymmetry index scores.

Pegboard Index

The Pegboard asymmetry index is represented by the formula:

$$\left[\frac{L-R}{L+R}\right] \times 100$$

Thus, the mean time performance of five trials for the right hand was subtracted from the mean of the trials for the left. This was divided by the sum of the two and the result was multiplied by one hundred.

LEM Data

Three separate indexes were created, a LEM Positive Affect Question Index, a LEM Negative Affect Question Index, and an overall asymmetry index, the LEM Positive-Negative Affect Question Index.

LEM Positive Affect Question Index was derived by the following formula:

$$\frac{\left[\frac{VPR - VPL}{VPR + VPL}\right] \times 100 + \left[\frac{SPR - SPL}{SPR + SPL}\right] \times 100}{2}$$

Thus, total left eye-movement in response to verbal positive questions was subtracted from total right eye-movement in response to the same questions. This was divided by the sum of the two and the result was

multiplied by one hundred. This was then added to the result of the same formula, but this time for the spatial questions. The obtained result was divided by two. A positive number signifies right eye-movement, while a negative number signifies left eye-movement.

LEM Negative Affect Question Index was derived using the same formula but in this instance the negative affect questions were used. Again, a positive number represents right eye-movement, while a negative one represents left eye-movement.

The formula for the asymmetry index, LEM Positive-Negative Affect Question Index is:

LEM Positive Affect Question Index -
LEM Negative Affect Question Index

This formula, which represents a relationship between the difference scores, LEM Positive Affect Question Index and LEM Negative Affect Question Index, can be interpreted as follows. The closer the the number is to zero the lesser the asymmetry between right and left eye-movements for positive and negative questions. A positive number represents relatively higher right eye-movement for the positive questions in comparison to the negative questions. The higher the number, the greater the difference. A negative number represents relatively higher right eye-movement for the negative questions in relation to the positive questions. Again, the higher the number, the

greater the difference.

Performance Index

Performance Index is a compilation of all three performance tasks into a single asymmetry index. The formula is:

$$\frac{\text{Screwindex} + \text{Designsindex} + \text{Writeindex}}{3}$$

$$\text{Screwindex} = \left[\frac{R - L}{R + L}\right] \times 100$$

$$\text{Designsindex \& Writeindex} = \left[\frac{L - R}{L + R}\right] \times 100$$

The Screwindex is the total number of millimeters displaced with the right hand minus millimeters displaced by the left hand divided by the sum of the two and then multiplied by one hundred.

The Designsindex and Writeindex are the mean total time of two trials for each task. The raw time trials were transformed ($\log_{10}$) to minimize any possible differences between the medians and the means of the data. Finally, the right/left terms were reversed for the Screwindex as compared to the other two because for the former, the higher the number the better the performance while for the latter two, the smaller the number the better the performance.

Affect Scale Index

The Affect Scale Index was derived from two Varimax Factor Analyses of the entire affect scale for: (1) Domi-

nant hand across left and right handed subjects; and (2) Non-Dominant Hand across left and right handers. This was done in order to reduce to a minimum the number of variables that had to be entered into the multiple regression. A general factor was also anticipated. This was because previous research had shown that positive-negative attitudes are quite common in response to the concepts of left and right and the Affect Scale was designed to tap this. The thirteen adjectives that represented the highest factor loadings on both scales were extracted for use in the index. The criteria for a particular item was a loading of 0.50 on both factor analyses. However, many of the loadings were 0.65 or above. The resulting factor represented a clear positive-negative dimension. The Eigenvalue and corresponding portion of the variance for the Dominant Factor Analysis was: Eigenvalue = 10.53; portion = 0.32, while the same statistics for the Non-Dominant Factor Analysis was: Eigenvalue = 8.85; portion = 0.26. Thus, in terms of the Dominant Hand Factor, 32% of the variance was accounted for by the Positive-Negative factor that emerged, while in the case of the Non-Dominant Hand Factor, 26% of the variance was accounted for.

Using the Dominant Hand analysis, scores were created for both handedness groups that reflected their attitudes concerning their dominant hand. Thus, for the right

handed group, the mean score rating of the thirteen selected adjectives rating Concept Right were used to create an Emotion Rating Right Score. Similarly, for the left handed group, the mean score rating of the thirteen selected adjectives rating Concept Left were used to create an Emotion Rating Left Score. Using the Non-Dominant Hand Analysis, scores were created that reflected attitudes towards Concept Left for the right handers (Emotion Rating Left) and for the left handers (Emotion Rating Right). Thus, an Emotion Right mean and Emotion Left mean were created for each subject. This pair of scores for each subject was then used to create a laterality index which is represented by the formula:

$$\left[\frac{\text{Emot R} - \text{Emot L}}{\text{Emot R} + \text{Emot L}}\right] \times 100$$

Semantic Differential Data (Semindex)

Four Varimax factor analyses were done on the equalized means for the Semantic Differential. They were: (1) Right handers, Concept Right; (2) Right handers, Concept Left; (3) Left handers, Concept Left; (4) Left handers, Concept Right. The means had to be equalized prior to the analysis because while the Evaluative and Potency factors were represented by four scales, Activity was represented by three. Again, the factor analyses were performed in order to reduce the number of variables. A general factor was expected. This is because

in rating the Concepts Left and Right, the Potency and Activity factors are naturally related to the Evaluative one. For example, in rating one's limb, stating that it is strong and fast or weak and slow is just as much an evaluation of it as saying that it is good. The Eigenvalues and their corresponding portion of the variance are reported in Table 1.

Since all four factor analyses loaded very highly into one positive-negative factor, it was decided that the entire scale could be seen as representing one factor.

Table 1

Eigenvalues and the Corresponding Portion of the Variance for 4 Varimax Factor Analyses of Semantic Data

Category	Eigenvalues	Portion
Right Handers, Concept Right	1.56	.52
Right Handers, Concept Left	2.43	.81
Left Handers, Concept Left	2.53	.84
Left Handers, Concept Right	2.60	.87

In order to compute the Semindex, a semantic mean was first computed for each subject using the following formula:

$$\frac{M\ Eval + M\ Pot + M\ Act}{3}$$

That is, the mean of Evaluation was added to the means of Potency and Activity and the result was divided by three. This was done for Concept Right (M Sem R) and for Concept Left (M Sem L) from each subject's raw data regardless of handedness. These two terms were used to compute the Semindex for each subject through the use of this formula:

$$\left[\frac{\text{M Sem R} - \text{M Sem L}}{\text{M Sem R} + \text{M Sem R}}\right] \times 100$$

Thus, the mean Semantic Left was subtracted from the mean Semantic Right. The difference was divided by the sum of the two and the result was multiplied by one hundred.

Puppet Index (Good Right)

All four indices (Batman-Joker; God-Devil; Travolta-Clumsy; and Hercules-Man) were collapsed into essentially a good-bad dimension. Goodrht represented the number of times the positive character was selected from each of the above four groups and attributed to the right hand. The minimum number of times was 0 while the maximum was 4

Handedness Scale

Handedness was treated as a dichotomous variable. The responses to the scale were not varied enough to differentiate different groups within handedness. The scores are presented in the Appendix.

IV. RESULTS

LEM Data[1]

It should be noted before the results are presented that one subject, a right-handed male, was excluded from the analysis of the LEM data because for one question category, Spatial Positive, all his eye-movements were vertical. Thus, the LEM analysis was done on an N of 39. However, this subject's data was included in all analyses of the attitudinal and performance data.

Presented in Table 2 are the means and standard deviations of the R-L asymmetry index for LEMs by handedness and sex for each of the four question categories, namely: Verbal-Positive (VP Index); Spatial-Positive (SP Index); Verbal-Negative (VN Index); and Spatial-Negative (SN Index).

[1]The results presented will deal with the data concerning only the Positive-Negative sets of questions, thus dropping the Neutral set. The neutral questions were included in the study: (1) because they had been included in previous LEM emotion studies; and (2) the data for the Verbal/Spatial neutral questions were of intrinsic interest considering the discrepant results concerning them, as have been described in previous sections of this dissertation. However, since the primary interest of this study was the pattern of eye-movements in response to questions eliciting positive and negative affect, it was felt that an analysis performed on these questions would be clearer and more understandable. The analysis, including the neutral questions, can be found in the Appendix.

Table 2

Asymmetry Index Scores (R-L) and Standard Deviations for Male and Female, Right and Left Handers for Each Question Category

Question Category	Subject Group Rt. Males	Rt. Females	Lt. Males	Lt. Females
Positive				
Verbal	41.27 (48.11)	4.40 (45.01)	-6.11 (41.15)	5.90 (62.42)
Spatial	25.71 (60.20)	-15.71 (76.92)	42.71 (47.41)	22.04 (70.54)
Negative				
Verbal	1.48 (7.20)	-20.76 (66.70)	19.35 (70.72)	12.92 (59.79)
Spatial	-20.29 (45.87)	-46.64 (41.14)	13.02 (59.27)	50.42 (47.41)

\+ = overall right eye-movement tendency
\- = overall left eye-movement tendency

If one compares overall right hander scores with those of the left handers, one sees that the right handers as a whole responded in a much more differential manner than did the left handers who predominantly moved their eyes to the right. For the right handed group, Positive questions generally elicited right eye-movement except for the female group for Spatial Positive. There was a strong tendency for right handers to respond to Negative questions with left eye-movement except for the

right handed males who responded with a basically equal right and left eye-movement to the Verbal Negative questions.

An analysis of variance with hand and sex as between groups and cognitive mode nested within the Positive/ Negative questions as repeated measures was performed. No between group main effects were significant but two interactions were significant. They were: Cognitive Mode by Hand (F (1, 35) = 15.09; $p.$ = .0004); and Emotion by Hand (F (1, 35) = 8.66; $p.$ = .005).

Presented in Table 3 are the means and standard deviations of the Cognitive Mode by Hand interaction.

Table 3

Means and Standard Deviations (in parentheses) of Left-Right Asymmetry Scores for LEMs for Interaction of Cognitive Mode by Hand

Handedness	Cognitive Mode	
	Verbal	Spatial
Right	6.60	-14.20
	(57.95)	(56.00)
Left	8.00	17.15
	(56.12)	(55.35)

Thus, the verbal/spatial aspects of the questions when embedded in the positive/negative questions appear to be affecting the direction of eye-movements. For the right handed group, the difference is in the predicted direction, that is, in response to verbal questions the response was right eye-movement while in response to spatial questions the response was left eye-movement. The means for the left handers when compared to the right handers are in the opposite direction when the spatial questions are considered. The right handed group moved their eyes to the left in response to the spatial questions while the left handers moved their eyes to the right. Thus, the two groups differed in the direction of their eye-movements in response to the cognitive mode aspects of the questions.

The Emotion by Hand interaction indicates that the emotional valence of the question did affect the direction of LEMs in a different manner for each handedness group. As will be shown in Table 4 and Figure 1 for the right handed group, positive emotions were related to right eye-movement while negative emotion questions were related to left eye-movement. The left-handed group, however, while showing a predominance of right eye-movement to both positive and negative questions, showed a trend towards less right eye-movement for positive questions as compared to the negative questions.

The Neuman-Keuls Multiple Comparison test for Unequal Ns revealed that for the right handed group the difference between the positive and negative question means was significant ($p = .05$) while the same comparison for the left handed group was not.

Presented in Table 4 are the means and standard deviations for the Emotion by Hand interaction. The same data are shown graphically in Figure 1 which will follow immediately afterwards.

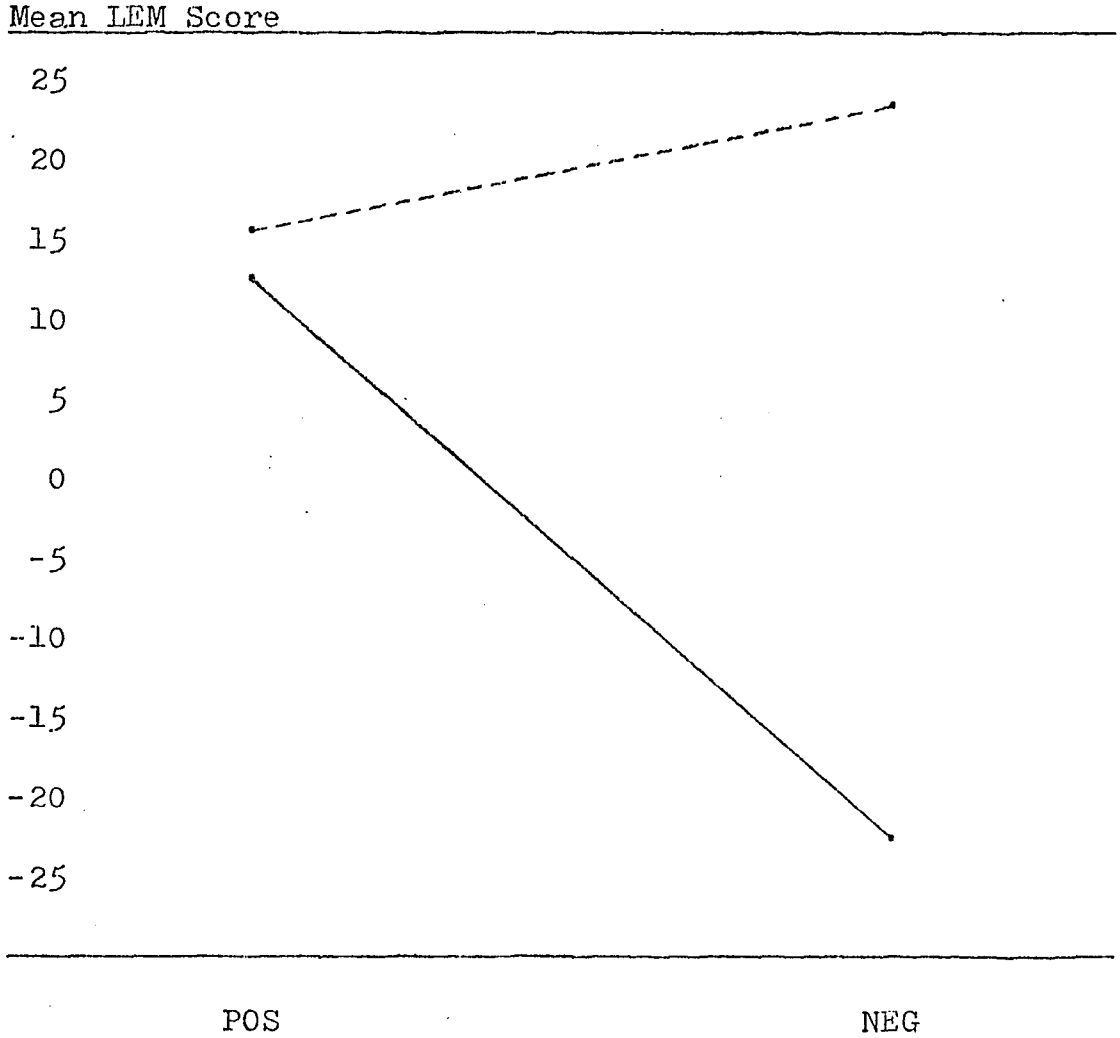
Table 4

Means and Standard Deviations (in parentheses) of the Right-Left Asymmetry Scores of the Emotion by Hand Interaction

Handedness	Emotion	
	Positive	Negative
Right	12.89	-22.19
	(57.56)	(56.43)
Left	16.14	23.94
	(52.63)	(59.30)

Figure 1

Emotion by Hand Interaction



In order to more fully evaluate the interaction, the LEM Positive-Negative Affect Questions Indexes for all subjects were rank ordered from positive to negative retaining handedness classification (see Table 5).

It can be seen that if left handers showed absolutely no effect for question type their scores would have been distributed among and between those of the right handers, but this was not the pattern found. Indeed, it appears that the left handed group did exhibit a pattern of scores that does reflect differential eye-movement in response to questions eliciting positive and negative affect. If you inspect the left handers' scores, most of them do reflect right eye-movement for the Negative questions. Inspection of Table 5 also shows that the distribution is not normal given the gap between the positive score of 120 and the rest of the scores. In addition, the large string of zeros further complicate the interpretation of the left handers' scores. Due to these considerations, a non-parametric method, the Sign test, was carried out to see if the left handers did show an effect for question type. The results were marginally significant ($p = .10$). This finding tends to suggest that the left handers' LEMs did move differentially as per question type. Furthermore, if that extreme subject's score is deleted, and a t test is performed, the difference in direction of LEM in response to positive/negative questions just misses signi-

ficance (p = .06). Thus, this tends to suggest in a stronger manner that there was a tendency for the left handers to show an effect for question type.

Table 5

LEM Positive-Negative Affect Question Index Scores
Rank Ordered Retaining Handedness Group Classification

Right Handers	Left Handers
125	
120	120
100	
83.33	
50	
50	
42.86	
40	
37.	
33.33	
28.57	
25	25
25	25
	20
16.66	
14.28	
0	0
	0
	0
	0
	0
	0
	-12.50
	-12.50
	-14.29
-25	
-25	
	-28.57
	-28.57
	-33.33
	-33.33
	-40
	-42.86
-75	
	-100

Thus, it would appear that both the Hemispheric model and the Lateral Attitudes model received support from the data. Support, for the Hemispheric model, comes from the fact that the right handers moved their eyes to the right for positive questions and moved their eyes to the left for negative questions and that the difference in direction of LEMs was significant. Support for the Lateral Attitudes model, while not as conclusive, strongly tends to suggest that the model is a viable one. The reasons are as follows. First, the data for the right handed group can be explained just as easily by the Lateral Attitudes model if right handers do, indeed, prefer their right side as opposed to their left. (This data will be presented in the next section) Second, the Sign and $\underline{t}$ tests performed which approached significance demonstrated a definite trend for a difference in direction of eye-movement in response to the Positive and Negative Emotion questions for the left handed group. Third, as shown in Figure 1 there was a definite trend for the right and left handed groups to show an opposite pattern of eye-movements which is consistent with the Lateral Attitudes Model, if the two groups showed opposite lateral attitude preferences, which they did. In addition, as shown in Table 4, the degree of left eye-movement by the right handed group in response to the negative questions was

equal in degree to the degree of right eye-movement by the left handed group in response to the same questions which again suggested a difference in pattern of eye-movements between the two groups. Admittedly, for the Positive Emotion questions, there was more right eye-movement by the left handed group than there was by the right handed group. However, there is a possible reason for this finding that will be presented later in the discussion section.

It can be stated that only the results for the right handed group were significant. Thus, in terms of the strictest interpretation of data, the Hemispheric model was supported. However, the right handed data can also be explained by the Lateral Attitudes model. In addition, the pattern of scores for the left handed group tend to support the Lateral Attitudes Model. Thus, this model should not be ignored as a viable alternative to the Hemispheric model.

In order to interpret the LEM data as having a relationship with attitudes towards the left and right sides of the body, we now turn to the analysis of this data.

ANOVAS to Assess Differential Performance Levels and Attitudes Towards the Left and Right Hand Pegboard Data

A repeated measures ANOVA was performed on the Pegboard data. This analysis yielded a significant inter-

action for Performance time by Hand (F (1, 36) = 79.58; p = .0001). Presented in Table 6 are the means and standard deviations for the Performance Time by Hand interaction.

If we compare the means within each handedness group for Performance Time Right vs. Performance Time Left via Duncan's Multiple Range test, we find that there is a significant difference (p = .05) in the Right vs. Left performance times. Therefore, the pegboard task was able to differentiate performance times for right and left hands for both groups. Interestingly, the left handers were significantly faster (p = .05) with both their dominant and non-dominant hand when compared to the right handers.

Table 6

Means and Standard Deviations (in Parentheses) of the Performance Times in Seconds for the Pegboard Task for both Handedness Groups Across Sex

	Performance Times	
Handedness	Right Hand	Left Hand
Right	9.40	10.33
	(.71)	(.84)
Left	9.29	8.68
	(1.86)	(1.69)

Performance Data

The same results were found for these performance measures. The repeated Measures ANOVA on the means for right hand performance time (across three tasks) vs. those for the left, across handedness and sex, yielded a significant interaction between Performance Times and Hand ($F(1, 36) = 86.15$; $p = .0001$).

Presented in Table 7 are the means and standard deviations for Performance Time by Hand across Sex.

Table 7

Means and Standard Deviations (in Parentheses) of Performance Times in Seconds on the Performance Tasks by Hand Across Sex

Handedness	Performance Time Right	Performance Time Left
Right	21.10 (5.23)	33.42 (9.56)
Left	36.35 (9.10)	23.97 (5.12)

Of specific interest was the contrast of the means for dominant vs. non-dominant hand within handedness groups. Thus, for right handers, the difference between Performance Time Right and Performance Time Left was significant using Duncan's Multiple Range test and this difference was significant at the .05 level.

Similarly, for the left handers, dominant and non-dominant performance time differed significantly using the Duncan test. Therefore, it can be stated that for both handedness groups, the Performance items were able to differentiate between the dominant and non-dominant hand.

Puppet Data

An ANOVA on the Puppet data (Goodrht) yielded a significant difference between handedness groups. Right handers attributed the positive name to the right hand puppet 2.85 times, while left handers attributed the positive name to the right hand puppet o.90 times. The difference between the two is highly significant ($F(1, 36) = 19.81$; $p = .0001$). Thus, right handed subjects and left handed subjects differed significantly in terms of what hand was seen as positive. In addition to the ANOVA, a Chi Square analysis was done for dominant and non-dominant hand across handedness groups. The difference was highly significant ($X^2 = 34.22$, $df = 1$; $p < .001$). Thus, within both groups, the dominant hand was seen as positive significantly more times than the non-dominant hand.

Affect Scale[2]

Presented in Table 8 are the means and standard deviations for the Emotion Rating Right and Emotion

[2]The lower the mean, the less negatively that particular concept was rated.

Rating Left scores for right and left handers.

Table 8

Means and Standard Deviations (in Parentheses) for Emotion Rating Right and Emotion Rating Left Scores for Both Handedness Groups Across Sex

Handedness	Emotion Right	Emotion Left
Right	1.50	1.88
	(.54)	(.80)
Left	1.93	1.75
	(.78)	(1.02)
		(1 - 5 scale)

If one examines the means they are in the predicted direction, that is, the right handed group felt more positive about Emotion Rating Right as opposed to Emotion Rating Left and vice versa for the left handed group, but these differences did not reach statistical significance on the repeated measures ANOVA performed on the data.

Semantic Differential Data

The ANOVA with repeated measures by Hand and Handedness by Sex for this data yielded a significant interaction of Mean Semantic by Handedness ($F(1, 36) = 52.70$; $p = .001$). Presented in Table 9 is the interaction of Mean Semantic by Hand.

Thus, it would appear that Concept Right (Mean

Semantic Right) and Concept Left (Mean Semantic Left) were judged differently on the Semantic Differential across both groups. When specific contrasts were done for right handers for Mean Semantic Right vs. Mean Semantic Left and for left handers on the same measures both within handedness group differences were significant using Duncan's Multiple Range test. Mean Semantic Right and Mean Semantic Left were significantly different for both handedness groups.

Moreover, a comparison of Mean Semantic Right scores obtained by right handers as opposed to left handers revealed significant differences as did a comparison of Mean Semantic Left scores as obtained by right handers as opposed to left handers using the Duncan test.

It should be noted that, however, the means on the diagonals were not significantly different from each other when the Duncan test was done. Thus, both handedness groups were essentially equal in the positiveness of their ratings of their dominant side concept and in the negativeness of their ratings of their non-dominant side concept.

Taken in total these data demonstrate that for the most part (Affect scale excluded), the attitude scales were able to differentiate different levels of affect between handedness groups for the right and left sides. In addition, the Performance tasks were able to differentiate

differences in performance levels for right and left hands for both handedness groups. Before turning to the multiple regression, the intercorrelations for all index measures will be considered in order to lay the groundwork for the presentation of the regression analysis.

Table 9

Means and Standard Deviations (in Parentheses) of Mean Semantic Right and Mean Semantic Left Scores for Left Handers and Right Handers Across Sex

Handedness	Mean Sem R	Mean Sem L
Right	5.76	3.13
	(.645)	(.804)
Left	3.93	5.43
	(1.204)	(1.211)

Intercorrelations Among Index Scores

Presented in Table 10 are all the correlation coefficients for all the asymmetry index scores as noted for all subjects while presented in Tables 13 through 18 are the means and standard deviations of the asymmetry index scores for the LEM data, the Pegboard data, the Performance data, the Puppet data (Goodrht), the Affect scale data and the Semantic Differential data. The individual

asymmetry index scores for all these measures are presented in the Appendix.

Table 10

Intercorrelations Among All Index Scores For All Subjects

	LEM	AFF	SEM	PEG	PER	PUP	HAND
LEM	1.00	-.07	.40**	.38*	.25	.17	-.44**
AFF		1.00	-.22	-.25	-.18	-.24	.35*
SEM			1.00	.58***	.58***	.60***	-.73***
PEG				1.00	.68***	.46**	-.84***
PER					1.00	.50**	-.80***
PUP						1.00	-.58***
HAND							1.00

* $p < .05$

** $p < .01$

*** $p = .0001$

As can be noted in Table 10, a number of asymmetry index variables are correlated at significant levels. However, the most striking pattern of correlations occurs when the variable, Hand, is considered. It must be noted

that the high number of negative correlations of Hand with the other variables was due to the way Hand was coded. The right hand was coded "0", while the left hand was coded "1". Examining Table 10, it is seen that Hand is correlated with all six asymmetry index variables. Thus, one must consider that the correlations found among the asymmetry index variables may be due to the high correlation of these variables with Hand. If one removes Hand as a factor by computing the correlation of all variables by handedness groups, this premise finds support. These data are presented in Table 11 for the right handed subjects and in Table 12 for the left handed subjects.

Table 11

Intercorrelations of All Index Scores for Right Handed Ss

	LEM	AFF	SEM	PEG	PER	PUP
LEM	1.00	.04	.01	.11	-.31	-.12
AFF		1.00	-.36	.49*	.22	-.36
SEM			1.00	-.23	-.46*	.11
PEG				1.00	.19	-.05
PER					1.00	-.31
PUP						1.00

* $p < .05$

Table 12

Intercorrelations of All Index Scores for Left Handed Ss

	LEM	AFF	SEM	PEG	PER	PUP
LEM	1.00	.18	.22	-.04	-.06	-.10
AFF		1.00	.19	-.15	.18	.13
SEM			1.00	.01	.26	.44*
PEG				1.00	-.15	-.07
PER					1.00	.46*
PUP						1.00

* $p < .05$

The number of significant correlations within the right handed group was two, while the number of significant correlations for the left handed group was also two. Thus, it would appear that measures were not able to differentiate differences within handedness groups among individuals but were only able to differentiate between group differences as evidenced by the index variables' correlations with Hand.

Table 13

Means and Standard Deviations of LEM Pos-Neg Affect Question Index for Both Handedness Groups Across Sex

Handedness	Mean LEM Pos-Neg Index	SD
Right	35.08	49.42
Left	-7.80	41.45

Table 14

Means and Standard Deviations of Pegboard Index Scores For Both Handedness Groups Across Sex

Handedness	Mean Pegboard Index	SD
Right	4.74	2.75
Left	-3.30	2.68

Table 15

Means and Standard Deviations of Performance Index Scores for Both Handedness Groups Across Sex

Handedness	Mean Performance Index Score	SD
Right	14.79	8.96
Left	-8.01	8.05

Table 16

Means and Standard Deviations of Puppet Scores (Goodrht) For Both Handedness Groups Across Sex

Handedness	Mean Puppet Score	SD
Right	2.85	1.39
Left	.90	1.37

Table 17

Means and Standard Deviations of Affect Index Scores For Both Handedness Groups Across Sex

Handedness	Mean Affect Index Score	SD
Right	-9.73	16.36
Left	7.29	28.64

Table 18

Means and Standard Deviations of Semantic Index Scores For Both Handedness Groups Across Sex

Handedness	Mean Semantic Index Score	SD
Right	29.99	15.57
Left	-16.63	27.59

Predictions of LEMs from Differential Attitudes Towards the Left and Right Sides of the Body

A multiple regression was performed with LEM Positive-Negative Affect Question Index, that is the difference in direction of LEMs between the positive and negative questions, as the dependant variable and the Performance Index, Pegboard Index, Affect Index, Semantic Index, Goodrht and Hand, as predictors. If the Lateral Attitudes Model has any validity, it was expected that at least some of these variables would be predictive of LEM. The R^2 for the entire model was .26 which was not significant ($F(1, 38) = 1.97$; $p = .09$). Semantic index was predictive of LEM Positive-Negative Affect Question Index ($F(1, 38) = 6.97$; $p = .01$), but as one notes in Table 10, this probably is due to Semantic Index's high correlation with Hand.

Given the Emotion by Hand interaction, it was expected that Hand would be predictive of the LEM Positive-Negative Affect Question Index. Due to the high correlation of the index variables with Hand (see Table 10), it was decided to run the multiple regression again without Pegboard Index because of its extremely high correlation with Hand ($r = .83$). It appeared plausible that Pegboard Index was redundant and was diminishing the predictive effect of Hand. Thus, with Pegboard index removed, the R^2 (.27) becomes significant ($F(1, 38) = 2.42$; $p = .05$), and Hand becomes a significant predictor of LEM Positive-

Negative Affect Question Index (F (1, 38) = 4.51; p = .05). This result conincides with the ANOVA performed on the LEM data. Handedness group was predictive of pattern of LEM scores elicited by questions which elicited positive and negative affect.

To further illustrate that attitudes and performance measures were not predictive of eye-movements and again to demonstrate that Semantic Index's correlation with LEM Positive-Negative Affect Question Index was due to the high correlation of Semantic Index with Hand, one can take out the Hand factor by computing the regression within handedness groups. Thus, for the right handed group, the entire model was non-significant and none of the predictors were significant. Similarly, for the left handed group, the entire model, again, was non-significant, and none of the predictors were significant. Therefore, it would appear that only Hand was a significant predictor of LEM.

V. DISCUSSION

It would appear that the relationship between the direction of LEM and questions eliciting positive and negative affect is a robust one. This effect has now, to my knowledge, been obtained on three separate occasions. As already reported, the Ahern and Schwartz (1980) experiment achieved results that while somewhat inconsistent, nevertheless were in the hypothesized pattern. Schwartz, Ahern, Davidson and Pusar, in an unpublished manuscript, obtained the hypothesized results using the same questions used in this study. Lastly, this study strongly replicated the results of the Schwartz et al. (1980) study. Up until now these results were seen as solely explainable by the Hemispheric Model. However, the results of this experiment tend to suggest that the Lateral Attitudes Model could be seen as an alternative explanation of these results. Both models can explain the results of the right handed group. It is the pattern of results, admittedly non-significant, of the left handed group, that while readily explainable by the Lateral Attitudes Model, is not by the Hemispheric Model. In illustration, it would be difficult for the Hemispheric Model to explain the opposite response pattern of LEMS between handedness groups on those questions eliciting negative affect. The Lateral Attitudes Model states that eye-movements, to negative

questions, will correspond to the direction the person feels most negative about. Since, indeed, the left handed group felt more negative about their right side, this part of the hypothesis was supported. Proponents of the Hemispheric Model might state that the left handed sample was atypical in that they could all be right hemisphere dominant. Perhaps, but this appears unlikely given that the majority of left handers are left hemisphere dominant (Milner, 1974).

Given the possibility that the Lateral Attitudes Model is the best explanation of these results concerning LEMs in response to questions eliciting positive and negative affect, it would be worthwhile to explore the implications this theory has for this area of research. The first implication of this model for LEM research is that the locus of control is no longer seen as due to information processing aspects of the hemispheres but rather to attitudes connected with the direction of right and left as they pertain to one's body. Thus the model presupposes a psychological process where emotions connected to ideas concerning body image are the pre-eminent factor rather than activation of anatomical structures (the hemispheres) which in turn activate other anatomical structures (the eye-movement control centers) which activate the eye-movement. Specifically, the mechanism postulated for the Lateral Atti-

tudes Model is one in which in the course of time, schemas or cognitive affective structures, concerning body image develop where the right and left sides of the body come to symbolize positiveness and negativeness. Thus in the mind's eye, or the personal consciousness of a right handers for example, the left comes to symbolize negativity, while the right positivity. As the negative/positive body image evoles, naturally occuring body responses are also taking place which, at first, become a response to the body image representation and later become part and parcel of it. Thus when an affect is elicited in a person, the response that occurs is one in which the lateral body image associated with that particular affect is activated simultaneously with the bodily responses associated with it, be they particular muscle response patterns or LEMs.

How does this mechanism develop? First, it is hypothesized that the differential affectively lateralized body image evoles as the child manipulates the environment and finds that one hand is becomming increasingly effective while the other is becomming less so. Thus in this manner the effective side comes to symbolize positiveness, while the less effective side comes to symbolize negativeness. Second, presumably as the child is using one or the other hand, he is orienting his attention to the hand or side that is performing the primary action, perhaps in the process of learning eye-hand coordination.

This orienting of attention becomes the basis for the LEMs. It should be made clear that the residue of muscle tension felt when a task is not being performed well by the child with his non-dominant hand, or residues of muscle fluidity when the task was being performed well by the dominant hand, may be activated simultaneously with the lateralized body image thus eliciting an added pull to the orientation of the eyes to one side or the other. The difference in the two theories now become quite clear. While the Hemispheric Model presupposes an almost automatic physiological response, the Lateral Attitudes Model presupposes an acquired psychological response.

The implication of the Lateral Attitudes Model for the results of how laterality studies in general are interpreted are potentially far-reaching. Thus, one can ask: Can one ignore the fact that these lateral attitudes may be affecting a subject's response in laterality experiments not dealing with LEMs. Levy (1976), in a study on aesthetics, had subjects view asymmetrically composed pictures in which either the right or left side were given more pictorical weight. The results indicated that the picture in which the right side had the greater pictorial weight was the one preferred. The interpretation of these results, as per the Hemispheric model, was that the right side was preferred as a way of producing pictorial balance in the right visual field, to the dominant impression in

the left visual field which is viewed by the more spatially oriented right hemisphere. Perhaps this is true, but then again these subjects, who were right handers, may have preferred the picture with the greater weight on the right side because for them, the right was viewed in a more positive light. Indeed, in any laterality study where right and left in someway are made explcit, the effects of the subjects' attitudes could be a factor. It may not even be necessary that the right and left be made explicit in that these attitudes, in the present study, were elicited from the subjects via the puppet task with absolutely no mention of right or left. Thus, the attitudes appear so basic that a person does not even have to consciously aware of them in order for their effect to be operative.

This brings us to another point. Hardych et al. (1977), in their study on the relationship of left handedness to cognitive deficits state that the "willingness to believe in an association between left handedness and cognitive deficit continues to persist despite of a good deal of evidence to the contrary" (p. 266). The belief in dualities which left and right are just one example, is quite a pervasive entity in the conscious and unconscious minds of mankind. Man, in effect, exists in a veritable sea of dualities, some natural, some self-conceived. Male-Female; Light and Dark; Good and Bad;

Primary Process and Secondary Process; Heterosexual and Homosexual; God and the Devil, are only a few examples. If the duality, Male-Female, is taken as an example, it is simple to demonstrate the powerful effect this duality can have on behavior. For thousands of years, the female has been looked on as inferior to the male. At this point in time, women are struggling to gain equality with men. It would appear that, at least in part, the repression in the past, and the struggle in the present is due to this perceived duality in which man is superior and woman is inferior. In reality, however, men and women are simply different. Furthermore, the two can, in many respects, be seen as complementary.

This concept of complementariness is important because it forms the basis of my argument that most, if not all, dualities are composed of complementary parts and it is the perception of these dualities as differences or to a greater extreme, positives and negatives, that blind people, scientific researchers included, to miss or ignore relationships and concepts that, in reality, could be the best answers to the problems being dealt with.

Nature has been viewed in two lights. One as a struggle or survival of the fittest if you may, where the strong overpower the weak, and the big, prey on the small. However, it can also be viewed as a system in balance. What perhaps occurs is that what is focused on by man is

the struggle and not the symmetry. What we may tend to forget, however, is that the struggle is part of the system of balance. For example, when birds act as predators of insects that feed on the leaves of trees, this is viewed as the strong overpowering the weak. But in reality, this is part of the system of balance. The leaves are needed to maintain the balance of oxygen in the environment; however, the leaves are a food supply for the birds. Each component is part of a duality: The predator and the prey, but they complement each other also to form a balance. Perhaps man's perception of dualities stems from an overemphasis on the struggle aspects and not on the balance aspects. This may be so because as Hertz (1973) has claimed, the root of all dualities is the one of Good and Evil or as he states it, the sacred and the profane.

This digression has been made in order to illustrate the opinion that it is not far-fetched to assume the pull to look upon dualities as opposites and, ultimately as superior vs. inferior, is a pervasive aspect of man's psyche. As mentioned before, Hardych et al. (1977) implied this in their discussion of left vs. right handedness. Thus, this attitude could be operative in hemispheric research also. In the nineteenth century, the right hemisphere was viewed as unimportant (Hertz, 1974). More contemporary research has modified this view to where the two hemispheres are no longer seen as superior

or inferior to each other but as different, i.e., negative affect is associated with the right hemisphere while positive affect is associated with the left hemisphere (Davidson et al., 1978). Granted, the necessities of research design for the most part lead one to interpretations that stress differences. But to reiterate a point made earlier, this emphasis on differences could lead to the overlooking of important issues. The literature review presented earlier can be seen as a case in point. The conclusion drawn was that the differences in affective balances between the hemispheres was not as clear as one would assume. Some researchers indicated that in terms of emotion, the two hemispheres may indeed complement each other (Monakhov et al., 1980). The conclusion that can be drawn from this discussion is that an attempt should be made to view the hemispheres as complementary and to develop research strategies that could demonstrate this. The duality that we assume may be an expression of our propensity to see nature as such, in fact, may not represent the truth.

It is unfortunate that the results for the left handed group were not definitive enough to support the Lateral Attitudes Model in a more significant manner. The results for the left handed group in terms of the Emotion by Hand interaction, while in the correct direction, were not significant. Thus, right eye-movement was the response to both the positive and negative questions with a lesser

degree of right eye-movement for the positive emotion questions. One possible explanation for this pattern is that the left handed group was more anxious about the experiment than the right handed group. An indication of this was that the left handers were much more aware of themselves as being researched upon than the right handers. A good number of them were curious about why the experiment was being performed on left handers, while the right handed group never identified themselves as right handed subjects, nor were they interested in why the experiment required right handers. This salience of handedness group in the self-concept of left handers has been reported in the literature, (Mc Guire & Mc Guire, 1980). In an open-ended siutation where right handers and left handers were asked to tell something about themselves, the left handed group was more likely to mention their handedness than were the right handers. It is feasible to hypothesize that because the left handers saw themselves as a distinct group being investigated they felt that they had to prove themselves thus casuing them to acutally feel more anxious in the experimental situation than the right handers.

If indeed the left handed group felt more anxious, this could have affected the pattern of their eye-movements in that the anxiety felt may have elicited a pull to the right (given the hypothesis that according to the Lateral Attitudes Model the eye-shift will be towards the right

when negative affect is experienced) that the positive affect questions could not counteract enough to reduce the degree of right eye-movement to a point where they would be significantly different from the degree of eye-movement elicited by the negative affect questions. One aspect of the data supports this contention. If the performance time scores on the Pegboard task are examined, it is found that the left handed group have faster performance times than the right handers, and that this difference was significant. Perhaps this is so because the left handed group did feel that they had something to prove and thus were anxious to perform the best they could. When confronted with the LEM questions, which is more typical of a regular test situation, the anxiety may have increased to a point where the pattern of eye-movements were affected in the manner just described. The method of testing this hypothesis will be offered in the recommendations for future research.

A discussion of the sensitivity of the attitude scales should be undertaken in order to ascertain if any shortcomings inherent in them contributed to the lack of a clear-cut demonstration of the major hypothesis. Of course the possibility exists that the hypothesis was not supported because it was not valid.

Nevertheless, a consideration of the scales is in order. It has already been noted that the scales were able to differentiate positive and negative attitudes bet-

ween the left and right handed groups as well as between the left and right hands within individuals. However, as evidenced by the lack of correlation among the individual measures, it appears that they were not able to differentiate reliable individual differences in attitudes towards the sides of the body within handedness groups. If there was perhaps a greater correspondence between these attitudes and the direction of eye-movements would have been found. Specifically what the lack of correlations of the measures meant was that some or all of the measures were not reliable enough to differentiate individual differences in the hypothesized attitudinal variable. There are two possible reasons for this. One is that the scales were too coarse to determine fine distinctions in the variable of interest. As long as the variance was great enough such as in the case of the between group differences or the attitudinal differences between the hands, the scales were effective. However, considering the reduction in variance when dealing with individual differences within handedness groups, the measures possibly were not sensitive enough to define fine gradations. The second possible reason is that the variable itself, that is the lateral attitudes, is not a stable one and fluctuates. Attitudes are processes that can change depending on the methods of measurement used and the stimuli in the environment at the time. These points should be considered in any future research

in this area.

Before continuing to an interpretation of the scaled data, it is important to discuss an aspect of the methodology used to rate the eye-movements in this study. Most LEM studies have used the criteria of the first eye-movement made by the subject upon completion of the question. For this study, the criteria used was the direction the subject was looking in upon completion of the question, if his gaze was lateralized. Of course, if the subject was looking straight ahead, the first LEM was scored. It is possible that this variation in technique was responsible for the robust effects obtained. One of the problems in LEM research has been when to score the eye-movement (Ehrlichman et al., 1978). The technique used in this study removed the ambiguity of scoring a subject's LEM when his gagaze was not centered upon completion of the question. In addition, because it is difficult to assess at what point in the question the desired impact is achieved, this technique is better because it is more likely to be sensitive to different points of impact. For example, if impact of the question occurs close to the completion of it but not at the very end, the direction of the eyes upon completion would tend to take this into account.

Another point that should be discussed is that it appears that positive vs. negative attitudes towards the two sides of the body are determined by the subject's

perception of the dominance of one hand over the other and not by cultural attributions. This is clearly demonstrated by the results of the Semantic Differential. Both left and right handers rated their dominant hand equally in terms of positiveness. Conversely, both groups rated their non-dominant hand equally in terms of negativeness. If cultural factors had played a role, in the determination of attitudes towards the two sides, the left handed group would ahve rated Concept Right at least equal to Concept Left in positiveness. This, however, was not the case since the two means are significantly different from each other. In addition, the same pattern of scores was found in the Puppet data. Therefore, on a preconscious level, lateral attitudes continue to be determined by what side is the more effective.

This is somewhat surprising in reference to the left handers, considering the negativity that has been expressed towards the left. Viewed from another prespective, however, the results are not that surpirsing. After all, it would appear likely that the reinforcement one would get from continually completing a manual task successfully with a well-functioning limb would be more important in determining how one feels about a limb than what opinions are expressed about it in the surrounding environment. Attitudes concerning handedness may act as moderating variables especially if the person has experienced a great deal of

negativeness concerning his handedness, but in the final analysis what appears most important is the utility of the limb and its place in the body image.

Recommendations For Future Research

In an attempt to further clarify and extend the hypotheses put forth in this dissertation, a number of strategies are suggested. First, further research should be performed to develop more support for the Hemispheric Model now that the possibility exists that the results it predicts can be possibly explained by the Lateral Attitudes Model. In this light, it would be interesting to see if the Hemispheric Model can explain LEM behavior of left handers when they are not treated as a homogenious group. Milner (1974) has reported that 64% of the left handers are left hemisphere dominant while 20% are right dominant. Observing the writing position of the subject's hand could be used as an indicator of cerebral dominance. For those left handers who were left hemisphere dominant, one would expect if the Hemispheric Model was correct, that their LEM behavior would approximate that of the right handers. One would expect the opposite pattern of LEMs from those left handers who were right hemisphere dominant. The effects possibly would not correspond in magnitude to those of the right handers because of the heightened probability of mixed dominance in left handers, but strong trends in the hypothesized direction would be encouraging.

In terms of devloping further support for the Lateral Attitudes Model, these strategies could be employed. It would be interesting to see if indeed, left handers felt more anxious in situations where they felt that their handedness was being evaluated. Thus, anxiety scales could be used for this purpose or perhaps structured interviews. The hypothesis would state that the less anxious a subject was, the larger the discrepancy would be between LEMs elicited by positive questions as opposed to those elicited by negative questions. Another important consideration would be to refine the methods of assessing differential attitudes towards the two sides of the body.

APPENDIX

Handedness Questionnaire

Name_____Age_____Sex_____

Were you one of twins, triplets at birth, or were you single born?

Please indicate which hand you habitually use for each of the following activities by writing R (for right), L (for left), E (for either).

Which hand do you use:

1. To write a letter legibly?.....
2. To throw a ball to hit a target?.....
3. To hold a racket in tennis, squash or badminton?.....
4. To hold a match whilst striking it?.....
5. To cut with scissors?.....
6. To guide a thread through the eye of a needle (or guide needle on to thread)?.....
7. At the top of a broom while sweeping?.....
8. At the top of a shovel when moving sand?.....
9. To deal playing cards?.....
10. To hammer a nail into wood?.....
11. To hold a toothbrush while cleaning your teeth?.....
12. To unscrew the lid of a jar?.....

If you use the RIGHT HAND FOR ALL OF THESE ACTIONS, are there any one-handed actions for which you use the LEFT HAND? Please record them here.....

.....

Instructions For LEM Task

For this section of the experiment what I am interested in is your style of answering questions. This is not an intellegence test nor does it measure any ability whatsoever. Some of the questions may be somewhat personal. If you choose not to answer them that is your privilege but I trust you will be able to answer all of them because they are not really that personal.

What I would like you to do is pay close attention to me while I am reading the question. When I am finished it is important that you give it some thought, then answer it. Two or three sentences are all that are necessary but you may answer at lenght if you wish. Do you have any questions.

Lateral Eye-Movement Questionnaire

What is the primary distinction between pleasure and ecstacy? V (+E)

Try to picture a situation in which you experienced extreme dislike. S (-E)

What is the primary distinction between recognition and recall? V (OE)

Visualize the Statue of Liberty and the towers of the Verrazano-Narrows bridge and tell me which one is taller. S (OE)

Make up a sentence with the word "sadness" in it that really portrays what the word "sadness" means. V (-E)

Try to picture and describe a situation in which you felt truly happy. S (+E)

Imagine that you are a veterinarian and you must make a long and deep incision upon a dog. You must cut a a straight line from the dog's left eye to his right, front shoulder. Visualize making the incision and tell me what parts of his face you would cut through. S (-E)

Try and picture a circle being drawn on top of a square. What is the maximum number of points at which the two figures can intersect? S (OE)

Imagine that you are relaxing in hot sulphur baths looking westward over the Pacific Ocean in California on a clear, sunny day. Your friend is peacefully resting with his back toward you right side. Approximately what direction is your firend looking out over? S (+E)

Tell me your primary experience when you are thinking. V (OE)

Tell me how you feel when you are relaxed and contented. V (+E)

What is the primary distinction between anger and hate? V (-E)

Picture and describe the last situation in which you felt extreme sorrow. S (-E)

What is the primary difference between the meanings of the words "mischief" and "malice"? V (-E)

What is the primary distinction between logical and rational? V (OE)

Briefly tell me about the last time someone did something charitable and compassionate for you. V (+E)

Picture and describe the inside of a watch. S (OE)

Make up a sentence using the words "code" and "mathematics". V (OE)

Tell me how you feel when you experience achievement. V (+E)

Picture your favorite store. You are on your way to but something you have wanted for a long time. Describe to me the route you would take to get there. S (+E)

Make up a sentence using the words "miserable" and "depression". V (-E)

Picture and describe what the roots of a big tree look like. S (OE)

Picture and describe the most disgusting scene from the most distressing movie you have ever seen. S (-E)

Visualize your face. What part of your face is the most expressive of negative emotions, such as hate and sadness? S (-E)

What is the primary difference between the meanings of the words "flexible" and "reasonable"? V (OE)

Make up a sentence using the words "shock" and "grief". V (-E)

Visualize your face. What part of your face is most expressive of positive emotions, such as love and happiness? S (+E)

What is the fundamental meaning of the word "joy"? V (+E)

Imagine a rectangle. Draw a line from the upper left hand corner to the lower right hand corner. What two figures do you now have? S (OE)

Visualize and describe the most awe-inspiring picture of the Grand Canyon that you have ever seen. S (+E)

Picture the Statue of Liberty and tell me in which hand is she holding the torch. S (OE)

Visualize and describe the most upsetting photograph of the Vietnam War that you have seen. S (+E)

Make up a sentence with the words "surprise" and "cheerful". V (+E)

What is the definition of the word "mathematics"? V (OE)

Tell me how you feel when you are frustrated. V (-E)

Make up a sentence using the words "time" and "space". V (OE)

Picture and describe the nicest scene from the most beautiful movie you have ever seen. S (-E)

Picture and describe the most anxious situation that you have recently been in. S (-E)

Visualize your face. What part of your face is most expressive of thinking? S (OE)

Make up a sentence using the words "happy" and "elation". V (+E)

Tell me how you feel when you are anxious. V (-E)

Picture and describe the last situation in which you laughed. S (+E)

What is the primary distinction between being "in love" and "loving somebody"? V (+E)

What is the primary distinction between guilt and shame? V (-E)

Picture the last funeral you went to. From which side of the room did you enter? S (-E)

Briefly tell me about an article that you read that was of some interest to you. V (OE)

Picture and describe the most joyous situation that you have recently been in. S (+E)

Picture a circular telephone dial. As you face the dial, which number appears furthest to the left? S (OE)

Instructions For Semantic Differential

The purpose of this section of the study is to measure the meanings certain words have for people by having them judged against a series of descriptive scales. In taking this test, please make your judgements on the basis of what the words mean to you, taking into account the context that will be provided you. On each page you will find a different word to be judged and beneath it a set of scales. You are to rate the word on each of these scales in order. The words at the two ends of the scale will not always make logical sense when applied to the words you are rating. You are to make your ratings on the basis of what you feel is the best fitting rating rather than what is logical. Rate on the basis of your first impressions.

Here is how to use the scales.

If you feel that the word at the top of the page is quite closely related to one end of the scale, you should place your check mark as follows:

GOOD x / / / / / / BAD

OR

GOOD / / / / / / x BAD

If you feel that the word is closely related to one end of the scale (but not extremely) you should place your check as follows:

GOOD____/ x /____/____/____/____/____BAD

OR

GOOD____/____/____/____/____/ x /____BAD

If the word seems only slightly related to one side as opposed to the other side (but is not really neutral), then you should check as follows:

GOOD____/____/ x /____/____/____/____BAD

OR

GOOD____/____/____/____/ x /____/____BAD

The direction toward which you check, of course, depends upon which of the two ends of the scale seems most characteristic of the word you are judging.

If you consider the word to be neutral on the scale, both sides of the scale equally associated with the word, then you should place your check mark in the middle space:

GOOD____/____/____/ x /____/____/____BAD

Semantic Differential Scale

To evaluate the concepts, RIGHT, LEFT, UP, AND DOWN, the following scale was used.

GOOD / / / / / / BAD

WEAK / / / / / / STRONG

FAST / / / / / / SLOW

PROHIBITED / / / / / / PERMITTED

ACTIVE / / / / / / PASSIVE

DOMINEERING / / / / / / LAX

GRACEFUL / / / / / / AWKWARD

UNINTENTIONAL / / / / / / INTENTIONAL

IMPORTANT / / / / / / UNIMPORTANT

DIFFUSE / / / / / / CONCISE

NEGATIVE / / / / / / POSITIVE

Instructions For Affect Scale

This scale consists of a number of words that describe different emotions or feelings. Please indicate the extent to which each word describes the way you felt during the three tasks you have just completed.

Record your answers by circling the appropriate number on the five point scale following each word. Presented below is the scale for indicating the degree to which each word describes the way you felt.

1	2	3	4	5
very slightly or not at all	slightly	moderately	considerably	very strongly

In deciding on your answer for a given item or word, consider the feeling connoted or defined by that word. Then if during the task you felt that way "very slightly" or "not at all" you would circle the number 1 on the scale; if you felt that way to a "moderate" degree, you would circle 3; if you felt that way "very strongly" you would circle 5; and so on.

Remember, you are requested to make your responses on the basis of the way you felt at the time you were performing the three tasks. Work at a good pace. It is not necessary to ponder; the first answer you decide on for a given word is probably the most valid. You should be able to finish in about 5 minutes.

Affect Scale

CONCENTRATING	1	2	3	4	5
ENTHUSIASTIC	1	2	3	4	5
SURPRISED	1	2	3	4	5
DISCOURAGED	1	2	3	4	5
CONTEMPTUOUS	1	2	3	4	5
IRRITATED	1	2	3	4	5
ASHAMED	1	2	3	4	5
SHEEPISH	1	2	3	4	5
JITTERY	1	2	3	4	5
SARCASTIC	1	2	3	4	5
SLUGGISH	1	2	3	4	5
SCORNFUL	1	2	3	4	5
SICKENED	1	2	3	4	5
EMOTIONAL	1	2	3	4	5
STARTLED	1	2	3	4	5
ENERGETIC	1	2	3	4	5
ALERT	1	2	3	4	5
FEELING OF DISTASTE	1	2	3	4	5
FATIGUED	1	2	3	4	5
MOCKING	1	2	3	4	5
SHAKY	1	2	3	4	5
SHY	1	2	3	4	5
BLAMEWORTHY	1	2	3	4	5
ANGRY	1	2	3	4	5

QUARRELSOME	1	2	3	4	5
UPSET	1	2	3	4	5
SHOCKED	1	2	3	4	5
EXCITED	1	2	3	4	5
INTERESTED	1	2	3	4	5
AWAKE	1	2	3	4	5
ANXIOUS	1	2	3	4	5
BASHFUL	1	2	3	4	5
GUILTY	1	2	3	4	5

TABLE 19

All Index Scores for Right-Handed Subjects with Lem Positive - Negative Affect Question Index Rank Ordered from the Highest to the Lowest Score with Sex of each Subject Designated

Sex	Pos	- Neg	= Lem	Sem	Pup	Per	Peg	Aff
M	50	-75	125	24	3	15	4	-13
M	80	-40	120	15	1	18	6	-18
M	100	0	100	50	3	5	4	-21
F	50	-33	83	50	4	15	7	-4
M	0	-50	50	26	1	13	5	3
F	0	-50	50	8	0	27	7	23
F	43	0	43	32	4	8	9	-7
F	-40	-80	40	64	4	-4	4	-22
M	75	37	38	19	3	14	7	-18
F	-50	-83	33	11	4	21	8	0
M	71	42	29	18	4	15	1	-39
M	-50	-75	25	42	3	11	2	-25
F	-63	-87	25	40	4	9	-2	-32
F	17	0	17	30	2	32	4	0
F	71	57	14	10	4	7	5	0
F	-60	60	0	53	0	15	5	-8
F	0	-25	-25	27	3	28	2	-2
M	0	-25	-25	28	2	9	2	-2
M	-25	50	-75	29	4	29	8	-30

Table 20

All Index Scores for Left-Handed Subjects with Lem Positve - Negative Affect Question Index Rank Ordered from the Highest to the Lowest Score with Sex of each Subject Designated

Sex	Pos	-	Neg	=	LEM	Sem	Pup	Per	Peg	Aff
M	40		-80		120	19	0	-8	-3	43
M	-63		-88		25	-30	0	-22	-8	7
F	75		50		25	-26	0	-12	1	24
F	60		40		20	-4	1	-11	-1	28
M	50		50		0	-34	0	-6	-4	6
M	83		83		0	6	0	-13	-3	21
M	14		14		0	-51	0	2	-5	-44
F	0		0		0	-29	0	-11	-3	3
M	0		0		0	20	4	-3	-5	10
F	25		25		0	17	0	-14	-2	-58
M	-25		-12		-13	-18	3	-14	-2	-29
F	75		88		-13	17	4	2	4	24
F	14		28		-14	38	1	2	-7	59
F	57		85		-28	-1	2	8	1	0
M	0		29		29	-32	0	-16	0	-18
F	-100		-67		-33	-39	1	4	-8	5
F	33		66		-33	-30	2	-12	-3	-15
M	40		80		-40	-35	2	-5	-3	45
M	43		86		-43	-64	0	-15	-6	10
F	-100		0		-100	-53	0	-13	-1	9

Table 21

Handedness Scale Scores for Right and Left Handed Subjects by Sex

Handedness	Handedness Score									
Right										
Males										
# Right	10	11	9	12	11	9	7	12	12	12
# Left	0	1	3	0	1	0	0	0	0	0
# Either	2	0	0	0	0	3	5	0	0	0
Females										
# Right	12	12	12	11	12	12	12	12	11	11
# Left	0	0	0	0	0	0	0	0	1	1
# Either	0	0	0	1	0	0	0	0	0	0
Left										
Males										
# Right	3	0	2	0	2	0	1	2	0	0
# Left	9	12	7	11	7	11	9	10	11	12
# Either	0	0	3	1	3	1	2	0	1	0
Females										
# Right	6	0	0	0	4	1	4	0	0	0
# Left	6	12	12	12	8	11	8	12	12	8
# Either	0	0	0	0	0	0	0	0	0	4

LEM Data with Neutral Questions

Presented in Table 22 are the means and Standard deviations of the asymmetry index scores for LEMs by handedness and sex for each of the six question categories, namely: Verbal/Positive (VP Index); Spatial/Positive (SP Index); Verbal/Negative (VN Index); Spatial/Negative (SN Index); Verbal Index (V Index); and Spatial Index (S Index).

Table 22

Asymmetry Index Scores for LEMS (R-L) and Standard Deviations (in parentheses) for Male and Female, Right and Left Handers for each Question Type

Question Type	Subject Group R. Males	R. Females	L. Males	L. Females
VP Index	41.27 (48.11)	4.40 (45.01)	-6.11 (41.15)	5.90 (62.42)
SP Index	25.71 (60.20)	-15.71 (76.92)	42.71 (47.41)	22.04 (70.54)
VN Index	1.48 (70.20)	-20.76 (66.70)	19.35 (70.72)	12.92 (59.79)
SN Index	-20.29 (45.87)	-46.64 (41.14)	13.02 (59.27)	50 42 (47.41)
V Index	-8.86 (66.81)	-7.28 (61.95)	14.33 (71.59)	9.23 (69.46)
S Index	29.89 (45.75)	5.78 (56.20)	-4.21 (63.43)	3.92 (55.42)

\+ = overall right eye-movement tendency

\- = overall left eye-movement tendency

If one compares overall right handers' scores with those of the left handers, one sees that the right handers

as a whole responded in a much more differential manner than did the left handers who predominently moved their eyes to the right. In terms of the neutral questions, right handed males and females responded with left eye-movement to the verbal questions and right eye-movement to the spatial questions. This curiously, is the opposite of the predicted direction.

An analysis of variance by Hand & Sex with the six question categories as repeated measures was performed. No between group differences were significant but three group interactions were significant. They were: Emotion by Hand (F (2, 70) = 7.27; $p.$=.001); Cognitive Mode by Hand (F (1, 35) = 3.94; $p.$=.05); and Emotion by Cognitive Mode by Hand (F (2, 70) = 6.06; $p.$=.004).

Presented in Table 23 are the means and standard deviations for the Emotion by Hand interaction.

Table 23

Means and Standard Deviations (in parentheses) of Asymmetry Index Scores (R-L) for Lems for the Interaction Emotion by Hand Across Sex

Handedness	Emotion		
	Positive	Negative	Neutral
Right	12.89 (57.56)	-22.19 (56.43)	4.59 (57.68)
Left	16.14 (52.63)	23.94 (59.30)	1.20 (64.97)

The significance of the Emotion by Hand interaction indicated that the emotional valence of the question did affect the direction of LEM. As shown in Table 23, for right handers, positive emotion questions were related to right eye-movement while negative emotion questions were related to left eye-movement. The mean for the neutral questions fell in between those of the positive and negative questions. On the other hand, as already suggested in Table 21, left handers tended to look right regardless of question type.

Presented in Table 24 are the means and standard deviations of the significant interaction of Cognitive Mode by Hand.

Table 24

Means and Standard Deviations (in Parentheses) of LEM Asymmetry Scores (R-L) for the Interaction of Cognitive Mode by Hand

Handedness	Question: Verbal	Question: Spatial
Right	1.20 (60.11)	-4.35 (54.35)
Left	6.20 (62.43)	21.32 (57.24)

Thus, the verbal/spatial aspects of the questions appear to be affecting the direction of eye-movement.

However, if one examines the mean for left handers for spatial questions, it would appear that most of the variance may be explained by the difference of this mean from the other two.

Presented in Table 25 are the means and standard deviations of the significant interaction of Emotion by Question by Hand.

Table 25

Means and Standard Deviations (in Parentheses) of the LEM Asymmetry Index Scores (R-L) for the Interaction of Emotion by Question by Hand

	Positive		Negative		Neutral	
Handedness	Verbal	Spatial	Verbal	Spatial	Verbal	Spatial
Right	21.87	3.91	-10.23	-34.16	-8.03	17.21
	(46.57)	(68.57)	(69.36)	(65.26)	(64.39)	(50.98)
Left	-.11	32.38	16.15	31.73	2.55	-.14
	(51.79)	(58.98)	(43.50)	(53.34)	(70.52)	(59.42)

If the means are inspected, one finds that for right handers, Verbal Positive and Spatial Positive questions elicited more right eye-movement with Verbal Positive questions eliciting a greater degree of right eye-movement than the Spatial Positive questions. This is in the predicted direction if one assumed that the spatial processing aspects of the right hemisphere would lead to a greater pull

towards the left, thus working against the pull towards the right for the positive emotion aspects of the questions.

For right handers, the Negative Emotion questions elicited greater left eye-movement with the Spatial question type eliciting a far greater degree of left eye-movement than the Verbal questions. In this case, also, the Verbal/Spatial difference is in the predicted direction, considering that the tendency towards left eye-movement of the spatial hemisphere would work with the left pull of the negative aspects of the questions.

In terms of the neutral questions, Vebral questions elicited greater left eye-movement while Spatial questions elicited greater right eye-movement. This is in the opposite direction that one would predict.

For the left handers, as has already been demonstrated, the overall tendency was for this group to look towards the right regardless of question type or emotional valence.

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