Order Number 9521298

The cross-situational consistency of lateral eye movement and its relationship to trait affect

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City University of New York, 1995

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THE CROSS-SITUATIONAL CONSISTENCY OF LATERAL EYE MOVEMENT AND ITS RELATIONSHIP TO TRAIT AFFECT

by

DENISE McEVADDY-CANTALUPO

A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

1995

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Approval Page

This manuscript has been read and accepted for the Graduate Faculty in Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

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ABSTRACT

The Cross-Situational Consistency of
Lateral Eye Movement and its Relationship
to Trait Affect

by

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The primary intent of this study was to reduce the methodological and theoretical inconsistencies in the lateral eye movement (LEM) literature by assessing whether LEMs could be accurately described as a cross-situational trait variable. It was further examined whether those individuals described as consistent left and consistent right movers would differ on other measures of hemisphericity and on measures of trait affect.

The lateral eye movements of 120 dextral college students were measured during three different experimental situations. Individual were classified as left movers, right movers or bidirectional within each situation and their relationships with trait affect and two performance measures of hemisphericity (Chimeric Faces Test and Image Location Task) were assessed. Data was then aggregated across situations and individuals were reclassified as consistent left movers, right movers, bidirectional or untraited. The performance of these consistent groups on the affect and performance measures was then reassessed.

Female bidirectional and right mover groups performed

differently on the Tense-Relaxed dimension of the Scales of Emotional State then left movers . The LEM groups did not differ on the Chimeric Faces Task and the Image Location for Positive Images Task within each situation. Their was a significant difference in the scores on the Image Location Task for Negative Images Task between individuals classified as left movers and bidirectionals during the first situation.

The results indicated that subjects were inconsistent in their eye movement direction across the experimental situations. When data was aggregated over the situations, few subjects could be classified as consistent right movers, left movers, bidirectional or untraited. The performance of the consistent groups on measures of trait affect and hemisphericity also did not differ.

Conjunctive lateral eye movement is frequently used in psychological research as an indicator of lateralized hemispheric activation. LEMs are used in this manner despite pervasive inconsistencies in the results of this and other studies that use this variable. The present results question what LEMs assessed in a single experimental situation indicate.

ACKNOWLEDGEMENTS

I owe gratitude to many as they helped me in all different capacities as I progressed through this study. First, I offer many thanks to Dr. Howard Ehrlichman as he guided me through each stage of the experiment and written report. His suggestions about theory and methodology and his succinct editing style were insightful and on-target. I would like to thank Dr. Edward Katkin for making a laboratory available and his suggestions about the later drafts. I also would like to thank Dr. Joan Borod, Dr. Herbert Saltzstein and Dr. Harvey Baker for serving as committee members and offering their suggestions.

I would next like to extend my appreciation to my family members who provided emotional and technical support. My mother and father, Mr. and Mrs. Thomas McEvaddy were the first to kindle my fundamental belief that with education and endurance anything can be accomplished. Although my father could not be present, I know he is happy I finally completed these requirements and am the first to attain a doctorate in his family. Other family members provided unyielding emotional support and on-the-spot babysitting when needed. These included: Doreen McEvaddy, Louis and Thomas Parziale, Catherine and Peter Castranova, Dr. and Mrs. Cantalupo, and of course Mrs. Katherine (Nanny) Huss. I particularly have to thank Jean Parziale for answering those many late night phone calls. I also have to thank Kevin, Thomas, and Lisa McEvaddy for their technical help in producing the experimental stimuli and for serving as "guinea pigs" in the pilot trials. I am very grateful to Dr. Janetta Astone and Dr. Tomi Berney for encouraging me to complete my degree, sharing their dissertation experiences and warning me about the inevitable pitfalls.

The one person I could never thank enough is my husband, Joseph Cantalupo, for his love and humor. I do not know anyone (besides me) who would stay up nights scoring and coding lateral eye movements and listening to my unending complaints. I also thank and apologize to my children Joey and Shannon who endured a part-time mother while I completed the study.

Finally, but foremost, I thank God and the Blessed Mother for permitting me and providing the strength to continue working through very difficult times.

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INTRODUCTION

The lateral eye movement response refers to an individual's shift in eye gaze to the left or right in response to a reflective question (Day, 1967). A number of investigators have posited that the directionality of LEMs is consistent within an individual and is associated with a number of physiological and psychological variables (Day, 1964, 1967, 1968; Duke, 1968; Ehrlichman & Weinberger, 1978; Ehrlichman, 1984). Further, these eye movements have been of interest to researchers because they may provide external indices of differential hemispheric activation (Bakan, 1969; Kinsbourne, 1970; Davidson, 1990). To date the literature on lateral eye movements (LEMs) is equivocal, plagued with both theoretical and methodological inconsistencies (Ehrlichman, 1984). This investigation attempted to eliminate some of these inconsistencies by (1) providing empirical evidence that LEMs constitute a reliable individual difference variable (2) demonstrating a relationship between LEMs and individuals' trait affect and (3) assessing the relationship of LEMs and performance measures of cerebral activation to establish convergent validity.

Early Contributions to Lateral Eye Movement Research

The notion that lateral eye movements constitute a stable individual difference variable related to other psychological and physiological variables was first proposed by Day (1964, 1967, 1968). Day (1964) claimed that LEMs are related to active/passive and internalized/externalized components of attention. The characteristic direction of the individual's lateral eye movement reflects a shift of attention from a passive to an active mode (Day, 1964).

For Day, the connection between attention and LEMs derives from their common basis in frontal lobe function. Evidence of the linkage is that LEMs are physiologically related to the frontal lobe centers, Brodman Area 8. Ontogenically, individuals also develop the ability to shift between active and passive modes of attention. Day claimed that LEMs are only observed in children over age three or four and are not observed in retarded individuals.

In addition to being related to attention, LEMs were also hypothesized to be related to anxiety (Day, 1964). Individuals who were characterized by predominately left LEMs reported experiencing anxiety as a tension state with an internal focus associated with upper visceral activity. Individuals characterized by predominately right LEMs reported experiencing anxiety as an immobilizing panic state with an external focus (Day, 1968).

Anxiety, attention and LEMs are interwoven components in Day's theory. LEMs are motoric indexes of attentional shift (Day, 1967). Individuals unable to shift their attention between active and passive modes would experience anxiety. "Mature interpersonal relations require attentional shift without anxiety between passive-internal, passive-external, active-internal and active-external modes of attention. Anxiety may be seen as restricting one's attentional and perceptual modes" (Day, 1964, p. 445-446).

Although Day was the first to report on the consistency of LEM direction in individuals and to hypothesize about specific correlates, he did not elaborate on the underlying mechanisms responsible for the directionality of the motoric response. The theoretical conceptions of Bakan and Kinsbourne attempted to explain the connection between presumed process and direction of gaze.

Bakan (1969) was the first to posit a hemispheric asymmetry model to account for the direction of eye gaze. For Bakan, the tendency to look in one direction when asked a question requiring reflection indicated that the hemisphere contralateral to the direction of gaze had been activated. Further, individual consistency in left and right movements was asserted to reflect individual differences in brain organization: "For Ss who tend to make left eye movements the right hemisphere is relatively more important and for Ss who make right eye movements the left hemisphere is relatively more important in total psychological functioning" (Bakan & Strayer, 1973, p .429). Bakan further suggested that eye movement to the right or the left is indicative of easier 'triggering' of activities in the contralateral hemisphere. This ease of triggering of either hemisphere may be related to other physiological, cognitive, and psychological variables.

Kinsbourne (1970) proposed an attentional model to account for the relationship between cerebral function and perceptual and motoric lateral asymmetries. In lower order species, the right and left hemispheres act symmetrically but differ with respect to which direction they select information from and subsequently respond to. The right and left hemisphere serve the contralateral space. Kinsbourne suggested that orientation to one direction was associated with preparatory activation of the contralateral hemisphere. In humans this arrangement is more complex because of the introduction of the asymmetrical representation of cognitive functions. For example, a left hemispheric activity such as language "though in respect of a symbolic function unrelated to spatial location will nevertheless generate detectable orientation to the right, even though such orientation has lost its original adaptive value" (Kinsbourne, 1970, p.196).

Kinsbourne (1972) suggested that cognitive activity can determine head and eye orientation and the direction of eye gaze. Hence, when either the left or right hemisphere is activated, eye gaze would shift to the contralateral side. In addition, when both are activated equally, the individual should gaze centrally (Kinsbourne, 1972). Two major tenets of his theory are: "(1) If cognitive set proper to one hemisphere is adopted, attention is demonstrably biased to the opposite side; (2) If attention is constrained to one side, cognitive processes proper to the opposite hemisphere are favored" (Kinsbourne, 1970, p. 197).

Bakan's and Kinsbourne's theories initiated two branches of research on LEMs. The first examined lateral eye movement as an individual difference variable and attempted to identify related psychological and physiological variables. The second included studies in which the effects of specific types of questions or tasks on lateral eye movement were evaluated.

Empirical Issues

Ehrlichman and Weinberger (1978) and Ehrlichman (1984) cited a number of problems with research on the hemispheric asymmetry model of LEMs. 1) The cross-situational reliability of LEMs has not been adequately tested. 2) Studies of the relationship of lateral eye movement and other personality, stylistic, cognitive and affective variables have frequently been unreplicable. In addition, variables purportedly related to LEMs are often weakly related to differential hemispheric activation. 3) Other simultaneous measures of hemispheric activation are necessary in order to more fully document the relationship of LEMs to cerebral activity and obtain convergent validation.

1) The Reliability of Lateral Eye Movement

Ehrlichman (1984) argued that the usefulness of LEMs as a valid indicator of stable individual differences in hemispheric activation was unproven. He suggested that applying personality research methodology (Bem & Allen, 1974; Epstein, 1979) to this field of inquiry could be beneficial. Following these suggestions, the literature on the reliability of LEMs will be reviewed and it will be proposed that the cross-situational consistency of LEMs must be more systematically investigated. It will be suggested that more accurate measurement of LEMs may be obtained by employing a technique similar to Epstein's (1979) aggregation method by 'averaging data over the situation'. Following Bem and Allen (1974) it will also be noted that lateral eye movement may not be a trait that is applicable to everyone.

Single-Session Consistency

Duke (1968) attempted to find empirical support for Day's hypotheses that LEMs were a consistent trait of the person. His data indicated that most subjects do consistently make LEMs in one direction as opposed to the other. Specifically, he reported that on the average 86% of his subjects' lateral eye movements were in the same direction. Etaugh and Rose (1973) also examined the reliability of lateral eye movements within a single session. These authors reported a reliability coefficient of .92 indicating that LEMs are highly consistent within a single session.

Ehrlichman and Weinberger (1978) examined the percent-right scores for 214 subjects from a number of different experiments. The derived distribution indicated that for this group an average of 76% of their lateral eye movements were in the same direction. Hence, within a single session many subjects were consistent in their LEM direction. However, the authors questioned whether this consistency in LEM direction may be affected by conditions in the measurement situation which must be considered.

More recent studies have also found that many individuals are fairly consistent in their direction of eye movement. Using a criterion of 70% consistency, Domangue (1984) reported that 77% of her subjects could be classified as left or right movers. Parrot (1984) also used a criterion of 70% consistency to classify two separate groups of students as right movers and left movers. His results indicated that 59% of a group of psychology students could be classified as left or right movers and 44% of a group of engineering students could be classified as left or right movers.

Test-Retest Reliability

Templer et al. assessed the test-retest reliability of lateral eye movement. Although, the experimenters were in agreement for 14 of the 19 subjects over the two sessions, lateral eye movement was not stable within individuals across sessions. Lateral eye movement was judged to be consistent for only 5 of the 14 subjects on whom the two raters agreed over both sessions. According to the authors this lack of test-retest reliability raises doubt in the observations of previous studies. As a result they recommended that more standardized techniques be employed and caution be used in judging correlations between LEMs and other personality characteristics.

Bakan and Strayer (1973) found a .78 test-retest correlation for 34 subjects' LEMs after a time period of one to seven days (M=3). (Bakan and Strayer state that they used the same procedure for both sessions but do not specify whether or not they used the same experimenter and setting.) They posited that the correlation was high enough to indicate that the direction of LEMs was a stable individual difference characteristic. Bakan and Strayer suggested that Templer et al.'s (1972) results were confounded due to the experimental situation. Templer et al. employed two experimenters to assess LEMs (one sat directly across from the subject and one sat next to the first experimenter) thus creating an asymmetrical setting for the subject. Bakan and Strayer suggested that if subjects turned their eyes one way they would not see the second experimenter but if they turned the other way they would. Further, they reported that right and left movers will not look right and left respectively if the experimenter is sitting in their preferred visual field. They believed that gazing away from E probably is one of the functions of the lateral eye movement. "The eye movement away from E probably is related to a switch from external to internal processing as S begins to think of an answer to the question asked by E" (Bakan & Strayer, 1973, p. 430).

Etaugh and Rose (1973) examined the test-retest reliability of children over two sessions in identical settings. The direction of the children's eye movements was obtained with a set of five questions. Identical questions were used in both testing sessions which took place within one month of each other (81% of subjects were tested within the same week). The correlation coefficient obtained was .38. The authors suggested that LEMs may not be a highly stable characteristic of children and that five questions were not adequate to assess reliability.

In a second, comparable study Etaugh and Rose (1973) examined the test-retest reliability of adults with a 20 question instrument used for both sessions. Testing sessions occurred in an identical setting two days apart. The test-retest reliability coefficient for all twenty questions was .55. The reliability coefficient computed on the first five questions was .38. As was the case with the children's data, the shorter instrument produced the lower coefficient. Comparable reliability coefficients for the children and adults on the first five questions indicated that lateral eye movement stability does not vary substantially between childhood and adulthood.

Equivalent-Form Reliability

Etaugh and Rose (1973) also examined the reliability of adults tested on two occasions with equivalent but different questions designed to elicit LEMs. The testing sessions were separated by two days and took place in identical settings. The reliability coefficient computed on the entire set of twenty questions was .77; the coefficient computed on the first five questions was .65. As before, the longer instrument resulted in a higher reliability coefficient. The authors concluded that "the various reliability estimates indicate that eye movements as currently measured, are highly stable at a given point in time, and moderately stable over brief time intervals" (Etaugh & Rose, 1973, p. 215).

Reliability Over Different Situations (Tasks, Settings)

The consistency of LEMs across different situations has received minimal attention in the literature. Hatta (1984) investigated the individual consistency of LEM direction as subjects participated in different experimental tasks which included verbal and spatial questions, a word detection task and an emotion detection task. The verbal and spatial questions were presented orally by a tape-recorded female voice. The latter two tasks consisted of a set of artificial language passages incorporating one to four target CVC syllables recorded by an actress in four different emotional tones. The instructions were varied for each task; the subjects were either instructed to count word syllables disregarding the emotional nature of the task or to identify the speaker's emotion disregarding the context of the passage. For all tasks lateral eye movement was assessed by employing the identical EOG procedure. However, the author did not specify whether the same setting and/or same experimenter were used. Hatta calculated the percentages of LEM direction for each subject in each experimental condition. He then computed the mean of these percentages for each subject over the experimental conditions. The analysis of variance indicated that although the task factor was not significant the subject factor was significant $\underline{F}(16,80) = 3.218$, $\underline{p}<.001$. Hatta concluded that LEM direction was a consistent behavioral trait of individuals.

In an unpublished study by Waldman (1987), measurements of subject's lateral eye movements were obtained in two different situations. The first situation was a formal setting in which the experimenter asked each subject a series of affective questions. The subjects were asked to look at the experimenter the entire time the question was being asked so the experimenter could ascertain whether the subject was paying attention. The experimenter held a clipboard on his lap with a sheet of paper bisected into two halves. The direction of lateral eye movement was scored by making a mark on the right or left half of the paper. Deviations from central gaze after each question were scored by the experimenter and included in a LEM index. In a second, more 'natural' situation the experimenter engaged the subject in an informal conversation. The subjects were not instructed to look at the experimenter. Lateral eye movements were scored each time the subject made and broke eye contact. The two lateral eye movement assessments were taken consecutively. Both conditions employed the same experimenter, experimental setting and scoring procedure. The Pearson product-moment correlation computed between the LEM assessments from the two situations was .90.

Ehrlichman, Weiner, and Baker (1974) examined subjects' lateral eye movement response to verbal and spatial questions in a series of experiments. In the third of this series, they assessed LEM response by using two different procedures. In the first procedure LEMs were recorded with a video camera. The experimenter observed the subject from another room and all communication was maintained through the use of a microphone and speaker. Questions were prerecorded by male and female experimenters. Subjects were instructed to look into the camera when they were ready for a question and during the length of the question. During the second procedure, a male experimenter remained in the room and directly asked the questions. Gaze instructions were not given to the subjects. Different questions were asked in the two conditions. Although the measurement procedure and questions varied in the two conditions, both occurred in the same experimental setting. The authors reported a correlation of .77 between the two conditions.

Summary of the Reliability Studies

The results of the reliability studies are inconclusive. In the single session studies, a fairly high amount of consistency is noted. However, single situation/session studies are affected by a number of contextual variables rendering it difficult to ascertain whether results are due to experimental or situational variables (Epstein, 1980). According to Epstein, single assessments of any personality variable are problematic and the investigation of many variables has been weakened by this error. Specifically, Epstein (1979) suggested that single observations are prone to errors in measurement and low temporal reliability: "single items of behavior have a high component of error of measurement, thereby limiting the possibility of replication, and a high component of situational uniqueness, thereby limiting the possibility of generalization" (p. 1102).

Situational variables that have been found to affect experimental manipulations include the experimenter's personality, sex, status, vested interest in the outcome, and the atmosphere created by the experimental setting including the use of apparatus. The time in which the experiment is conducted can affect subjects' motivation, subject selection, and subjects' knowledge and attitude about the experiment (Epstein 1980). Ehrlichman and Weinberger (1978) have suggested that the measurement of LEMs in a single situation can also be affected by particular situational characteristics which include the positioning of the experimenter in front or behind the subject, the homogeneity of the surroundings in front of subject, the distance between the subject and the experimenter as well as the distance from walls or windows (Ehrlichman and Weinberger, 1978; Gur, Gur and Harris, 1975; Jamieson and Sellick, 1985; Templer et al., 1972).

The results of the test-retest studies and the experiments which sampled over task and situation are inconsistent as both high and low reliability coefficients were obtained. Contextual variables may have affected both the studies which reported high coefficients as well as those which reported low coefficients.

In Templer et al.'s (1972) study and Etaugh and Rose's (1973) investigation of children, lateral eye movement was not consistent over the two sessions. The adult study conducted by Etaugh and Rose, which entailed using the same questions, yielded moderately higher correlations. The low reliability coefficients could be due to incidental factors associated with specific testing sessions masking any consistency on the variable of interest. Epstein (1980) suggested that certain situational/contextual variables change incidently over occasions.

> This follows from the consideration that the same situation will vary psychologically over occasions, even though the objective situation remains constant. Consider, for example, the experimenter who conducts the same experiment on different occasions. The experimenter's mood will vary, and he or she will be influenced by intervening experiences. Thus, the "same" experimenter will actually be a somewhat different experimenter. (Epstein, 1980, p. 800)

Etaugh and Rose's (1973) test-retest studies of children and adults provide evidence that a "similar" experimental situation can change between sessions. They suggested that the low reliability estimates obtained may be due to the use of identical questions in the two sessions which resulted in carry-over effects. The coefficients obtained in the equivalent forms condition were higher then those reported for the test-retest condition using the identical questions. Reflective questions designed to elicit eye movements in one session may not warrant the same amount of reflection needed to elicit LEMs in a second session.

Bakan and Strayer (1973) achieved a high test-retest reliability coefficient. Additionally, Waldman (1987) and Ehrlichman et al., (1974) reported high reliability coefficients over two situations. Hatta (1984) also reported that LEMs were individually consistent over tasks. These authors suggested that based on these findings LEMs appear to be consistent and reliable aspects of an individual. However, the results could be viewed from two other perspectives. Since the situation was similar for the different sessions in the above studies, incidental contextual variables may have accounted for the high reliability coefficients. Second, even if the situation changed over the two sessions, it is possible that the change in the situation interacted with lateral eye movement rendering it difficult to determine whether reported consistency is due to contextual variables or lateral eye movement.

Aggregation- A Technique to Minimize Situational Variance

The reliability studies on lateral eye movement are inconclusive. Although, the single session and some of the test-retest studies yield moderate to high reliability coefficients, it remains unclear how much of the consistency obtained is due to the experimental situation. A stringent test of the cross-situational consistency of LEMs appears warranted in order to clarify its status as an individual difference variable.

Consistency across situations is a familiar problem to many trait researchers. Mischel (1968) stated that the cross-situational correlation coefficient of .30 for most traits is accurate and not due to methodological error. However, others argue that it is possible to measure stable aspects of the person if methodological approaches were modified.

Epstein (1979) suggested that the .30 barrier referred to by Mischel (1968) can be surpassed if the investigator reduced error of measurement. Epstein (1979, 1980) proposed the use of aggregation to reduce error of measurement and increase temporal and concurrent reliability. According to Epstein (1980) there are four different uses for aggregation in research. 1) Aggregation over subjects is frequently used in psychological research to cancel the effect of the uniqueness of individual subjects. 2) Aggregation over methodology requires the investigator to use several methods to assess the experimental variable in order to cancel out the variance contributed by individual techniques. This multi-method approach has received support from Campbell and Fiske (1978). 3) Aggregation over stimuli and/or situations requires the researcher to collect data in response to more than one stimulus and/or situation to cancel out the unique effects contributed by any one stimulus and/or situation. 4) Aggregation over trials and/or occasions requires the investigator to assess behavioral responses on more than one trial and/or occasion to cancel the incidental effects of specific trials within sessions and/or the unique effects of specific sessions.

Epstein (1979) used aggregation to increase the temporal reliability coefficients of self-report data, data derived from ratings by others and measurements of objective behavior. His use of this technique required correlating aggregated data collected on a number of different days. Experimentally, he demonstrated that higher reliability coefficients between variable scores could be obtained when the number of days of measurement were increased. In one of a series of experiments, Epstein examined the temporal reliability of several types of data obtained from psychology students over 12 different time samples. Specifically, he collected the following data at the beginning of each class period: subjects' reporting of their current emotional state and of the frequency with which a number of events occurred in their lives since the last meeting (social telephone calls made and received, entertainment events attended and number of headaches and stomach aches). In class, the subjects took and recorded three 30 second samples of their pulse rate. The instructor also kept records of a number of behavioral variables related to carelessness and lack of organization: minutes late to class, borrowing of pencils etc.

Epstein (1979) reported stability coefficients for a 1 day and a 12 day sample for each variable. His results indicated that for all variables reliability coefficients increased from a 1 day to a 12 day sample.

> The increase in reliability that occurs when data are averaged over events and arranged in order of increasing objectivity results in the following: For the 10 unpleasant inner states, the respective mean coefficients for a 1 day and a 12-day sample are .37 and .77, respectively. For self-recorded behavior that is externally observable, the corresponding figures are .40 and .96. For self-recorded physiological reaction, the corresponding figures are .27 and .94. For examiner-recorded variables, the corresponding figures are .44 and .84 (Epstein, 1979, p. 1115).

The author notes that the three externally observable event categories resulted in higher reliability coefficients than the inner state category.

Epstein (1979) proposed that reducing error of measurement and increasing temporal reliability by averaging over situations demonstrates cross-situational stability. In the study discussed above as well as in three other studies, Epstein assessed various response tendencies to everyday situations. He argued that since his data indicated consistent response tendencies to a variety of daily situations, cross-situational stability was demonstrated.

Others such as Mischel (1982) argued that Epstein's use of aggregation only served to produce higher temporal reliability coefficients, but evidence of increased cross-situational stability had not been adequately demonstrated.

Despite objections to Epstein's use of aggregation to obtain cross-situational stability, this method can serve to reduce the effect of incidental contextual variables by averaging data across experimentally varied situations. According to Epstein, aggregation can be employed with laboratory data as well as data derived in a more natural setting (Epstein, 1980). Aggregation may be effectively used for data derived from self reports, ratings by others or objective behavior. Since aggregation is useful in reducing situational variance it could be applied to the measurement of lateral eye movement taken in a number of different settings and in response to a number of different stimuli. By minimizing situational variance the consistent LEM response of the individual would be more apparent.

It is important to acknowledge that the idea of averaging lateral eye movements over situations is not entirely new. Investigators have averaged LEM scores over different types of questions to construct a cumulative index. Other investigators such as Hatta (1984) have examined the mean percentages of LEMs over tasks but the situations were not systematically varied in an attempt to minimize common situational variance and obtain a more valid assessment of lateral eye movement.

The Applicability of LEMS to Individuals

A number of investigators have suggested that all traits may not apply equally to all people. "...Allports' idiographic view emphasized that individuals differ not only in the ways in which traits are related to one another in each person but that they differ also in terms of which traits are even relevant" (Bem and Allen, 1974, p. 509). Bem and Allen (1974) followed Allport's suggestion that traits are not applicable to everyone; they argued that the best any investigator can hope to do is predict "some of the people some of the time..." (p. 506). Similar assumptions are discussed by Baumeister & Tice (1988). These authors described the 'metatrait hypothesis' "which entails that a given trait dimension will not apply equally well to all individuals ...The metatrait refers to the presence versus the absence of the associated trait dimension in a person's personality" (Baumeister & Tice, 1988, p. 572-573). Traited individuals are those who possess the trait in their personality and untraited individuals are those who do not. In the terminology of these authors individuals may be traited or untraited on the LEM dimension. Consistent right and left movers may be considered 'traited' on the unilateral eye movement dimension.

However, a third group of subjects must also be addressed. In 1978 Ehrlichman and Weinberger examined the percent-right scores of 214 subjects whose lateral eye movements had been assessed in a number of different experiments. The scores ranged from extreme right to extreme left with mixtures in-between. The classification of individuals into groups of left and right movers is dependent upon imposed criteria. The most frequent criteria employed have been 65% to 80% consistency; this leaves a large group, 22% to 60%, of bidirectionals (Ehrlichman and Weinberger 1978). Others have also commented on the large group of individuals who are not consistent left or right movers. For example Parrot (1984) reported that 41 percent of the psychology students and 56 percent of the engineering students in his study were classified as bidirectionals using a consistency criterion of 70 percent. Ehrlichman and Weinberger (1978) suggested that if lateral eye movement is considered a continuous variable, the group of bidirectionals must be examined. However, in the terminology proposed by Baumeister and Tice (1988) it may be prudent to suggest that the trait of unilateral consistency in eye movement is not relevant to these individuals. Hence, bidirectionals could be viewed as 'untraited' on this dimension.

In agreement with Allport, Bem and Allen (1974) proposed that one reason most cross-situational coefficients reach a ceiling of .30 is due to fundamental errors associated with most traditional nomothetic research where researchers assume that their conception of a specific trait variable is applicable to all subjects under investigation. One solution would be to study only those individuals for whom the trait is relevant or who are cross-situationally consistent on the trait dimension. They conclude:

> only the behavior of consistent individuals can be meaningfully characterized by the investigator's construct; only their behaviors can be partitioned into the equivalence class under investigation. Perhaps a statistical metaphor will make this proposal seem less illegitimate: Unless an individual's variance on a particular trait dimension is small, it makes no sense to attach psychological significance to his mean on that dimension. (Bem and Allen, 1974, p. 512)

Baumeister and Tice (1988) suggested a comparative research strategy where individuals who are consistent on a particular trait dimension are compared to those who are not. It may be fruitful to compare those individuals who are unilaterally consistent in eye movement direction to those who are not so 'traited' as well as compare the correlates of the bidirectional group to groups of right movers and left movers. Theoretically, if right and left eye movement reflects differential cerebral activation, it would be interesting to consider what bidirectional movement indicates.

2) The Relationships Between Lateral Eye Movement and Other Variables

The Correlation of Lateral Eye Movement and Trait Affect

Ehrlichman (1984) suggested that the personality variables frequently studied as potential correlates of lateral eye movement are only tangentially if at all related to hemisphericity (e.g., hypnotizability; imagery). Further, variables examined that were plausibly related to hemisphericity were usually cognitive (Davidson & Fox, 1988; Ehrlichman and Weinberger, 1978; Ehrlichman 1987). However, more recent work has begun to consider affectivity as a plausible correlate of LEM direction. The literature on emotion and cerebral laterality has made significant progress in the last two decades (Ehrlichman, 1987). Further, the relationship between lateral eye movement, as a putative indicator of hemisphericity, and affect as a trait dimension has also been investigated (Ehrlichman, 1987).

The possibility of a relationship between emotion, especially anxiety, and lateral eye movement was raised in the early literature by Day (1968). More recently, the empirical work linking LEMs to emotion has been encompassed within larger investigations of emotion and asymmetry. A critical debate in the affect literature is between the body of research emphasizing the superiority of the right hemisphere in all affective functioning and the work which stresses the hemispheric specialization of positive and negative affect (Ehrlichman, 1987; Leventhal and Tomarken, 1986). The empirical work on LEMs and emotion has followed these two directions.

A number of studies found a relationship between overall emotion and left eye movement, supporting the assumption that emotion is a function associated with the right hemisphere.

Schwartz, Davidson, and Maer (1975) examined subjects' eye movement response to questions that were designed to vary along verbal-spatial and emotional-nonemotional dimensions. The results tended to support the association between the right hemisphere and emotion and provided information about the relationship between emotion and cognition. The interaction between LEMs and verbal-spatial questions was significant ($p<.001$). In response to verbal questions, subjects exhibited a greater number of right LEMs than to spatial questions indicating greater left hemispheric involvement. The interaction between LEMs and emotional-nonemotional questions was also significant ($p<.005$). The authors reported fewer right LEMs in response to the emotional questions than in response to non-emotional questions ($p<.01$) and conversely there were more left LEMs in response to the emotional than in response to the non-emotional questions ($p<.001$). Hence the association between the right hemisphere and emotionality was supported. The overall pattern of results clearly illustrates this association as well as the interrelationships among cognition, emotion and hemispheric differences. Specifically spatial-emotional questions elicited the most left movement and the least right movement while verbal-nonemotional questions elicited the greatest right movement and the least left movement. The other two mixed question categories elicited LEMs which were between these two extremes. The authors caution that individual consistency in LEM response may have affected these results. Specifically, the authors noted that overall for the four question types there was more left movement than right movement. Further analysis revealed that 25% of the sample were left movers whereas none were right movers. This could have contributed to the number of left LEMs obtained overall.

Tucker, Roth, and Arenson (1977) replicated the Schwartz et al.'s (1975) findings and found additional support for the model. These authors examined LEMs in response to the emotional tone of questions as well as to a stress manipulation. The four question categories designed by Schwartz et al. (1975) were again used. Within each category one half of the questions were given under stressful conditions and one half were given under non-stressful or neutral conditions. Relevant results are reported here. 1) The subjects responded with more left eye movements to emotional questions as opposed to non-emotional questions $\underline{F}(1,40) = 11.41$. $\underline{p}<.002$. 2) There was a significant increase in left eye movements during the stress condition $\underline{F}(1,40) = 7.13$. $\underline{p}<.02$. This was primarily due to a decrease in non-lateral trials during the stress manipulation. 3) The pattern of results obtained to the combined affective manipulations was strikingly similar to those reported in the Schwartz et al. (1975) study. Specifically, the mean number of left LEMs to the two affective manipulations were as follows: 2.53 for the emotional questions during the stressful condition; 2.03 for the non-emotional questions during the stressful condition; 1.98 for the emotional questions during the neutral condition; and 1.76 for the non-emotional questions during the neutral condition.

Tucker et al. (1977) also assessed the lateral eye movement response of individuals during the stressful condition who were previously categorized as left movers, right movers and bidirectional during the neutral condition. Interestingly, left movers and right movers showed significant increases in left movement during the stressful condition. The bidirectionals showed smaller non-significant increases in left movement.

Jamieson and Selleck (1985) examined the relationship between anxiety and lateral eye movement. The investigation incorporated two anxiety manipulations. The distance between the subject and experimenter was varied; closer distances were believed to be correlated with heightened anxiety. In a stressful instructions condition, subjects were told that they had to answer questions correctly compared to a non-stressful condition where the subjects were informed that accuracy did not matter. Following the research of Tucker et al. (1977), the authors hypothesized that under conditions of heightened anxiety, the subjects would demonstrate more leftward LEMs, which would support the right hemispheric model of emotion. Further, they hypothesized as did Ehrlichman and Weinberger (1978) that under conditions of low anxiety the subjects' eye movement would be determined by the content of the questions (spatial/verbal).

The results produced moderate support for these predictions. Although the main effect for instructions did not conform to the hypothesis, the distance manipulation and the interaction of distance by instructions did partially conform. At closer distances, subjects in the stressful instruction condition exhibited more left LEMs; subjects in the stressful instruction condition at further distances exhibited more right LEMS. In the non-stressful instruction condition, there were no differences in LEM direction. The second hypothesis concerning question content was not supported. However, since the groups did not differ in either heart rate or in their performance on a state anxiety inventory, the authors questioned the anxiety manipulations.

In an investigation primarily designed to develop a procedure for eliciting LEMs in response to emotional stimuli, Borod, Vingiano, and Cytryn (1988) compared subjects' LEM response to emotional and nonemotional instructions. Their results indicated that subjects responded with more left lateral eye movements to emotional instructions as compared to non-emotional instructions. Borod, Vingiano, and Cytryn (1989) also investigated the correlation between subjects' performance on a chimeric faces task and other neurophysiological tasks which included an emotional lateral eye movement task and a nonemotional lateral eye movement task. The subjects were biased to the left for the emotional LEMs task.

The association between LEMs and right hemispheric activity received additional support in and investigation of the relationship between LEMs and Alexithmia. Alexithmia is a clinical disorder characterized by a deficit in emotional processing manifested by difficulties in identifying and verbalizing feelings, an impoverished fantasy life, and a preoccupation with the details of external events rather than inner experience (Parker, et al., 1992 pg. 94). These authors hypothesized that alexithmia was associated with a dysfunction in right hemispheric functioning since this hemisphere is involved in emotional functioning. Further those individuals high on the dimension of alexithmia would be characterized by heightened right lateral eye movement indicative of left hemispheric activity. The authors found support for their hypothesis in a group of college students.

Recent studies have reported a robust correlation between lateral eye movement and visceral perception. Acknowledging that the empirical studies are few, Ehrlichman (1984) suggested that there is fairly strong evidence that individuals characterized as left movers are better heartbeat detectors than are right movers. Hantas, Katkin, and Reed (1984) examined the relationship between lateral eye movement and visceral perception. Based on their notion that the right hemisphere is associated with visceral perception, the authors believed there would be a relationship between this variable and LEM as an index of differential hemispheric activation. Specifically, the authors predicted that those individuals who were characterized as left movers as opposed to right movers would perform more accurately on a heartbeat detection task and they also would demonstrate learning of the task with 'knowledge of results' feedback. As predicted, the baseline performance of left movers was superior to that of right movers. The 'knowledge of results' feedback enabled both groups to increase their perceptual ability; the left movers did not benefit more than the right movers from the training but across all the trials they did perform better.

The concept of visceral perception has interesting implications for emotion. Many theories of emotion incorporate the perception of visceral functioning; frequently these theories suggest that emotion is a result of the perception of physiological activity (Katkin & Blascovich 1981). Hantas, Katkin, and Blascovich (1982) examined the relationship between visceral perception and affective experience. The authors hypothesized that individuals who were differentially classified, on the basis of a heartbeat detection task, as good and poor heartbeat perceivers would also differ in their affective response to a series of slides designed to be noxious. The results indicated that those individuals classified as good visceral perceivers rated their response to the noxious stimuli as more upsetting than those individuals who were poor visceral perceivers. The heart rates of the poor and good perceivers did not differ in response to the stimuli.

Montgomery and Jones (1984) examined the relationship between hemispheric laterality, emotionality and heartbeat perception. The authors believed than an individual's ability to perceive visceral activity was related to activation of the right hemisphere. Since affect is purportedly associated with the right hemisphere the authors also believed that individuals who were good visceral perceivers would score higher on certain emotional inventories. The following specific hypothesis were formulated: 1) Those individuals who were better at perceiving their heartbeat would exhibit more left LEMs than those individuals who were poor heartbeat perceivers. 2) Those individuals who were good heartbeat perceivers would also score higher on the emotionality indexes. 3) Those individuals who scored higher on the emotionality indexes would also exhibit more left LEMs than would low scorers.

The first hypothesis received support as those individuals classified as good heartbeat perceivers exhibited significantly more left LEMs than those individuals classified as poor heartbeat perceivers. Furthermore, when individuals were classified as 'left' and 'right' movers in lateral eye movement, the left movers achieved a significantly better perceptual discrimination index than the right movers. Although these findings are supportive, the authors caution that the group classified as 'good heartbeat perceivers' was composed of bidirectionals since these individuals exhibited nearly the same number of left and right eye movements. Specifically, the group of good heart beat perceivers did exhibit significantly more left LEMs than the group of poor heart beat perceivers, however they could not be characterized as left movers.

> This finding suggests that while right hemisphere involvement need not be greater than left hemisphere involvement for the accurate perception of visceral activity, it seems clear that the right hemisphere is significantly involved in such perception. It also

is clear that predominantly left hemisphere involvement will result in poor performance on tasks in visceral perception. (Montgomery & Jones, 1984, p. 463)

Emotionality as assessed by the Speilberger State Trait Anxiety Inventory (STAI) and the Neuroticism scale of the Eysneck Personality Inventory (EPI) was not related to the heartbeat discrimination scores. However, the authors reported a relationship between emotionality and left LEMs which provided support for the right hemispheric model of emotion. Specifically, those individuals classified as left and right movers did not differ on the Speilberger 'state' anxiety questionnaire. However, the two groups did differ (almost significantly, p.<.08) on the Speilberger 'trait' anxiety scale and the neuroticism scale of the EPI. Left movers obtained higher scores on these two latter inventories. Individuals were then separated into high and low scorers on each of the emotional inventories. The LEM scores (Percent-right index) of subjects with high and low scores on the state anxiety measure did not differ significantly. However, subjects who scored high on the 'trait' anxiety inventory and on the neuroticism scale had lower percent-right LEM scores than subjects scoring low on these measures.

Other investigators have failed to provide evidence for a relationship between left LEMs and emotion. MacDonald and Hiscock (1984) attempted to replicate and clarify Schwartz et al.'s (1975) results. MacDonald and Hiscock posited that although Schwartz et al.'s results supported the relationship between affect and right hemispheric activation as indicated by left LEMs, it was not clear whether the anxiety arousing questions used in the study altered subject's affective state. Hence, they compared subject's LEM response to anxiety producing questions and to a direct anxiety manipulation. Their results contradicted those of Schwartz et al. (1975). Specifically, anxiety arousing questions did not differ from neutral questions in eliciting leftward LEM responses. Furthermore, the anxiety manipulation elicited an increase in ocular motility but not in the proportion of left LEMs.

Hatta (1984) investigated the role of emotion and LEMs in a series of studies designed to empirically test the hemispheric asymmetry model of LEMs. He predicted that subjects would exhibit left LEMs in response to an emotional task and right LEMs in response to a word detection task. His results did not support his hypotheses.

A number of theorists have argued that positive and negative affect are lateralized differently within the cerebral cortex. Specifically, Davidson and his colleagues (Davidson et al., 1979; Davidson and Fox, 1982; Fox and Davidson 1986; Davidson et al., 1987; Fox and Davidson, 1987b; Tomarken and Davidson 1988; Davidson and Fox 1988; Fox and Davidson 1987a, Tomarken et al., 1992) have hypothesized that positive affect is associated with left hemispheric functioning and negative affect is associated with right hemispheric functioning. Davidson and Fox (1988) suggested that the lateralization of affect according to valance is related to the lateralization of withdrawal and approach tendencies, where withdrawal is lateralized in the right hemisphere and approach tendencies in the left.

In a recent experiment, Tomarken et al., (1992) examined the relationship between individual differences in resting anterior EEG asymmetry and trait dimensions of emotion as measured by the Positive and Negative Affect Schedule (PANAS-GEN) and the Affect Intensity Measure (AIM). The authors hypothesized that individuals characterized by a stable pattern of increased left anterior activation as opposed to increased right anterior activation would report that, in general, they experience greater PA and lesser NA. As an indication of discriminant validity, the authors also hypothesized that individual differences in resting anterior EEG activity would not be related to individual scores on the AIM which is used to assess individual differences in generalized reactivity. The sample consisted of 90 undergraduate right-handed females who were further subdivided into groups based on the stability of their EEG readings assessed over two experimental sessions. Specifically, six groups were included in the design. Subjects classified as belonging to the left mid-frontal and left anterior temporal groups demonstrated stable greater relative left hemispheric activation over two experimental sessions. These subjects scored within the top 25th percentile on asymmetry scores in the two hemispheric regions. Subjects assigned to the right mid-frontal and right anterior temporal groups demonstrated greater relative right hemispheric activation across the sessions. These subjects scored below the bottom 25th percentile on asymmetry scores in the two hemispheric regions. The last two groups were the middle mid-frontal and the middle anterior temporal groups who consisted of subjects whose stable asymmetry scores were in the middle (i.e., between the 25th and the 75th percentile).

Overall, the data confirmed the authors' hypotheses. The left mid-frontal group reported increased PA and decreased NA compared to the right mid-frontal group. The groups did not differ on NA. The middle mid-frontal group had higher PA scores than the right mid-frontal group but did not differ from the left mid-frontal group. The data of the anterior-temporal groups were similar to the above. Specifically, the left anterior temporal group reported higher levels of positive affect than the right anterior temporal group. Again there were no significant differences between these groups on NA.

The authors predictions concerning the AIM were upheld. None of the groups differed from each other on this measure.

Ehrlichman (1987) proposed that individuals' basic experiential representations of what is good and bad for them may be lateralized. He further suggested that these general experiential representations are operative regardless of whether the experience is self-referenced or involves an external stimulus.

Ehrlichman (1987) found partial support for the relationship between affect and lateralized hemispheric function. In one study, he examined the relationship between positive and negative odors and lateral eye movement. Subjects rated the odors as more negative when they elicited left as compared to right eye movements. In a second experiment, Ehrlichman investigated the relationship between trait affect and lateral eye movement. He reported a significant correlation between negative affect and left lateral eye movement. Hence, the results of the both experiments led the author to conclude that although negative affect may be more lateralized in that it appears correlated with right hemispheric functioning, positive affect does not appear to be associated with one or the other hemisphere.

On the basis of Ehrlichman's findings, Waldman (1987) predicted that negative trait affect would be related to left LEMs but positive affect would not be related to right LEMs. However, he found that both positive and negative affect were associated with left LEMs. He suggested that the association of total affect with left LEMs may be due to the 'intensity' of the emotion experienced and that perhaps the right hemisphere may be associated with this intensity factor.

Ahern and Schwartz (1979) investigated the relationship between lateral eye movement, as an index of differential hemispheric activity, and affective tone. Specifically, the authors examined lateral eye movement in response to a series of verbal/spatial questions which incorporated both positive (happiness/excitement) and negative (sadness/fear) affective tones. While the authors did not find the visual/spatial effect, they found moderate support for the differential lateralization of positive and negative emotion. The subjects demonstrated more right looks to excitement and happiness questions than to the fear questions, and fewer left looks to the excitement questions than to the fear questions. The subjects' eye movement response to 'sad' questions was contrary to prediction. There were more right movement to these questions than left movement. These findings were the same for both the verbal and spatial questions.

Ahern and Schwartz (1979) concluded that the relationship between positive and negative affect and LEMs must be stronger than the relationship between LEMs and verbal/spatial processing. Further they suggested, as have others (Davidson & Fox, 1988), that the differential cerebral lateralization of positive and negative affect may be related to a more general approach/avoidance dimension.

A number of investigations have not found evidence to support the relationship between LEM direction and emotional valence. Hatta (1984) investigated the relationship between positive and negative emotion and differential cerebral activation. He hypothesized that a positive affective task would elicit right LEMs and a negative affective task would elicit left LEMs. His results did not support his hypotheses. Hatta suggested that the conflicting results of his study and that of Ahern and Schwartz (1979) could be due to cross-cultural differences (his study was conducted in Japan) and/or stimulus differences. Similarly, Borod et al. (1988, 1989) could not find support for a differential LEM response to positive and negative components of an image generation task.

Davidson and Fox (1988) suggested that different aspects of emotion may be associated with differential hemispheric activation as well as differential intrahemispheric activation. The perception of emotion is linked to the posterior or parietal region of the right hemisphere, while the anterior regions of the brain are activated during tasks involving emotional expression. In a number of experiments, Davidson and others (Davidson et al., 1979; Davidson and Fox, 1982; Fox and Davidson 1986; Davidson et al., 1987; Fox and Davidson, 1987b; Tomarken and

Davidson 1988; Davidson and Fox 1988; Fox and Davidson 1987a) consistently demonstrated that differences in right and left frontal cerebral activity was related to individuals expression of positive and negative affect. Specifically, right frontal hemispheric activation was related to negative affective responses and left frontal hemispheric activity was related to positive affective responses. In two separate studies Tomarken and Davidson (1988) and Davidson and Fox (1988) demonstrated that resting left and right frontal asymmetries related to future expression of positive and negative affect in children and adults. In addition, Davidson and Fox (1988) reported the results of a number of investigations where differential activation of the right and left anterior regions of the brain was associated with negative and positive affect respectively, often with an absence of differential activation in the posterior region.

Heller (1993) reviewed evidence to support a theory that individual differences in affect are determined by two distinct neural systems: the frontal lobes and the right parietotemporal region. Specifically, the right parietotemporal region is not only specialized for the processing of emotion but is involved in the modulation of autonomic arousal and therefore plays a fundamental role in the experience of affect. The frontal lobes are involved in the modulation of emotional valence. The interaction of these two neural systems is responsible for the entire experience of emotion. Heller further suggests that the two-dimensional structure of affect established by Russell and others can be explained in terms of these two neural substrates.

> The interaction of these two systems leads to specific predictions regarding the patterns of regional brain activity that would be expected in a variety of emotional states. For example, happiness, which involves pleasant valence and high arousal, would entail (a) relatively high left frontal activation and (b) relatively high right parietotemporal activity. In contrast, depression, which involves unpleasant valence and low arousal, would entail (a) relatively high right frontal activation and (b) relatively low right parietotemporal activity (Heller, 1993, pg. 477-478.)

Heller's (1993) model differs from other models of brain activity and emotion in a number of significant ways. Her model expands on that of Davidson and others cited above by postulating that the right hemisphere plays a more critical role in modulating emotional states than is described by its role in evaluating and interpreting emotional information. Heller's model does not attribute specific emotional qualities to particular areas of the brain. The left frontal region and the right frontal region are not seen as specialized for positive and negative emotion respectively. With respect to the experience of valence, her model calls for more dynamic interplay between neural substrates. "Rather, certain emotional states are associated with relative activation of these brain regions with reference to each other. Any factor that influences the relative activation of these brain regions..... could therefore indirectly influence the occurrence of a particular emotional state (Heller, 1993, pg. 479).

Heller's model also diverges from that of Levy, Heller, Banich, and Burton (1983a) who proposed that the right hemisphere is responsible for all emotional experience, in particularly the processing of emotional information. According to Heller (1993), while the processing of emotion is dependent on hard-wired specialized processes with the right posterior hemisphere, the experience of emotion is a dynamic phenomenon associated with changeable patterns of regional brain activity.

An Alternate Method to Assess the Relationships Between Lateral Eye Movement and Other Variables

The review on the relationship between affect and lateral eye movement is inconclusive. Partial support is found for a relationship between left lateral eye movement and total affect and partial support is found for differential model where positive and negative affect are associated with right and left LEMs respectively. The relationship between affect and LEM appears to exemplify the association of LEM with many variables.

In 1984, Ehrlichman reviewed 39 correlational studies of lateral eye movement. The hypothesized relationships of lateral eye movement and other personality, stylistic, cognitive and affective variables were found in 23 experiments but not found in the remaining 18. The pattern of relationships were vague and failed to replicate.

> Unfortunately, there does not appear to be a clear pattern in these results: It is not so much that one set of correlates has been consistently found and another hasn't but that the results have failed to replicate. For example, one study reported a correlation of .64 between left moving and hypnotic susceptibility, two found no relationship and a fourth found a non-significant tendency for right movers to be more susceptible. Similar contradictions are reported for verbal versus visuospatial ability measures, choice of college major, creativity, nonverbal sensitivity and defensive style (Ehrlichman, 1984, p. 4).

Ehrlichman (1984) suggested that more stringent methodology be employed to clarify these relationships. Aggregation of data may again be relevant here.

Epstein (1979, 1980) suggested that increasing reliability by averaging over situations in the manner described earlier is a prerequisite for providing evidence of relationships with other variables. In reference to his own investigations, Epstein (1980) stated "Once adequate stability, or temporal reliability coefficients were obtained, evidence for validity emerged in the form of statistically significant relationships among variables" (p. 793). Further analysis of the experimental data reported in the section on aggregation (pg. 17-21) supports this assertion. For the 12 day sample, Epstein (1979) correlated objective events with one another and with negative emotions. All correlations were significant and formed coherent patterns. For example, carelessness and lack of organization variables correlated with emotional states of tension, powerlessness, and confusion. Additionally, variables indicating heightened physiological arousal and psychosomatic reactivity such as mean heart rate and heart rate range as well as reported headaches and stomach aches correlated with emotional factors of unhappiness, confusion and anger-in.

Aggregating lateral eye movement across situations may result in reducing situational variance and a more accurate classification of individuals on this trait dimension. Further, this reduction in situational variance may result in higher correlations between LEM and other trait dimensions such as affect.

<u>3) The Convergent Validation of Lateral Eye Movement</u>

A fundamental assumption underlying this research area is the relationship of lateral eye movement to cerebral asymmetry. Ehrlichman (1984) suggested that convergent validation must be demonstrated to support this assumption. Convergent validation may be obtained by simultaneously assessing other indices of hemispheric activation.

Studies have been conducted which attempt to link lateral eye movement to differential physiological arousal in the cerebral hemispheres. In an attempt to find empirical support for the hemispheric asymmetry model of LEMs, Shevrin, Smokler, and Kooi (1980) examined the relationship between a disposition to look to the left or the right when answering a reflective question and an overall disposition to respond to an external stimulus with greater event-related potential (ERP) on the contralateral side. (It is important to note that these authors did not examine the relationship between LEMs and simultaneous event-related potentials). The results of their experiment did indicate that there was a significant relationship between LEMs and occipital ERP. The authors concluded that despite the indirect procedures employed their data suggested "that individuals may be characterized by a certain disposition such that lateralization of brain response is correlated with a preferred direction of looking. It might be parsimonious to assume further that during eye movements the contralateral hemisphere is activated" (Shevrin et al. 1980, p. 6). The authors are careful to note that although a relationship between preferred direction of LEMs and lateralized brain response may exist, the exact nature of this relationship cannot be specified.

Gur and Reivich (1980) examined individual differences in hemispheric activation as measured by LEMs and variation in differential hemispheric blood flow. The authors tested the hypothesis that consistent directionality of eye movements is reflective of individual differences in characteristic hemispheric activation as assessed by cerebral blood flow. Using a noninvasive procedure, the authors assessed the lateralized hemispheric blood flow in a group of eleven left movers and ten right movers. The results indicated that left movers had significantly more flow to the right hemisphere than to the left hemisphere; right movers demonstrated a non-significant trend in the reverse direction. Nine of the eleven left movers demonstrated more blood flow to the right relative to the left hemisphere whereas only half of the right movers had more blood flow to the left relative to the right hemisphere. The authors suggested that these results are consistent with other reports that in a non-selected sample of subjects there was greater right hemispheric blood flow as compared to left hemispheric flow. Therefore, the results of this study indicate that characteristic right hemispheric activation strengthen this trend while characteristic left hemispheric activation moderates but does not significantly reverse its direction significantly. The authors stressed that these findings support the premise that individual differences in hemispheric activation exists and influences cognition and cognitive performance.

Another strategy for assessing convergent validity is to compare LEMs to performance measures that allegedly reflect differential hemispheric activation. Neilsen and Sorensen (1976) examined the relationship between subjects' eye movement direction and right or left ear superiority in a dichotic listening task. Specifically, the authors hypothesized that an individuals' response to a dichotic listening procedure emphasizing verbal material depends on both hemispheric speech localization and hemispheric activity distribution. They predicted that left movers would demonstrate a significantly reduced right-ear advantage as compared to right movers. The data supported this prediction. The right mover group demonstrated a more pronounced right ear superiority than the left mover group, ($p<.01$).

Two other performance measures which have previously been incorporated in studies of lateral eye movement are the chimeric faces task and the image location task.

The chimeric faces task is used to assess perceptual bias (Levy et al. 1983b). The task involves the viewing of a chimera which is a face constructed of two half faces.

The two half faces can be of the same or different posers, and/or can display the same, different or no emotional valence. The chimeric face can be presented by slides, a tachistoscope or on sheets of paper. Different instructions have been employed to measure perceptual bias toward the left or right side of the face; for example, the subject may be told to identify the happier chimera out of two faces, each of which is composed of a half smiling and half neutral face.

Levy, Heller, Banich, and Burton (1983a, 1983b) reviewed evidence showing that dextrals frequently demonstrate a left visual field bias when viewing chimeric faces. When viewing these same faces, sinistrals exhibit either a weakened left visual field bias or no bias. Levy et al.'s (1983b) interpretation of this phenomenon is based on Kinsbourne's notion that left visual field bias "...may reflect an attentional bias toward the left induced by selective activation of the right side of the brain" (p. 404), which occurs when dextrals view faces. Further, they reviewed evidence which indicated that the right hemisphere is associated with facial processing and the interpretation of emotional facial expressions for dextrals (Levy et al. 1983b). According to these authors, since hemispheric specialization is more diverse in sinistrals, they should exhibit a reduced left visual field bias. Although as a group dextrals exhibit a left-visual field bias, Levy et al.

(1983a, 1983b) note that there is a great deal of inter-individual variation. These variations in both magnitude and direction are attributed to the individual's characteristic pattern of asymmetric arousal. To summarize:

> Laterality tasks are simultaneously sensitive to hemispheric specialization itself, reflected in the average asymmetry for a group of right-handed individuals, and to individual differences in characteristic patterns of asymmetric hemispheric arousal, reflected in diversities among subjects in the magnitude, and even the direction, of perceptual asymmetries (Levy et al., 1983a, p. 333).

In a early experiment, Levy et al. (1983b) examined the performance of both dextrals and sinistrals on a chimeric faces task which permitted free viewing as opposed to earlier tachistoscopic studies. Levy et al. argued that tachistoscopically presented stimuli introduced noise into the experimental setting as a result of subject fatigue, lengthy test sessions, learning effects, and performance level confounding. Since the free viewing task permits the subjects to have unlimited time to view the stimuli, these factors would be virtually eliminated.

The study addressed two specific issues. Right-handed subjects were evaluated to determine if under free-viewing conditions they would demonstrate the usual left-visual field bias. Additionally, left-handers were examined to see if their responses would differ and if so to what extent. Secondly, the authors looked within handedness groups to observe individual patterns of asymmetry. The stability of these differences was also examined, as Levy et al. (1983b) believed that "if the free-vision task is sensitive to individual differences in asymmetric functioning of the two hemispheres, a subject's degree of perceptual asymmetry should remain highly stable" (p. 407).

The results indicated that the performance of dextrals and sinistrals conformed with expectations. Both dextrals and sinistrals exhibited a leftward bias but the bias for dextrals was greater.

The magnitude of asymmetry was also investigated. Three classification groups were formed to determine the extent to which scores deviated significantly from zero. Classification I incorporated the subjects' observed asymmetry scores. Classification II utilized the statistical criterion of $p=.10$, 1-tailed to reject the null hypotheses. Finally, Classification III employed the statistical criterion of $p=.05$, 1-tailed in order to reject the null hypothesis. On the bases of these classifications, subjects were categorized three ways into left-biased, no-biased and right-biased groups. For each classification group, the authors computed fourfold point correlations between right-handed/left-handed and left-biased/right biased subjects (no-bias subjects were omitted). The results yielded significant differences between left- and right-handers. In addition, when subjects were classified by the first method, the magnitude of asymmetry for right-biased dextrals was significantly less than for left-biased dextrals. This relationship between magnitude and direction was either weak or absent for sinistrals. Based on these findings the authors concluded that the free-viewing of chimeric faces task is sensitive to the hemispheric specialization of face processing.

The authors also noted stability in the subjects' asymmetry scores. For dextrals and sinistrals, the split-half reliabilities of asymmetry scores were both .925. The authors noted that such scores reflect true individual differences. Retest scores were available for 26 right-handed subjects; the test-retest reliability for this group was .87. "The split-half reliabilities show that subjects are consistent in their asymmetries for different stimulus items, and the test-retest reliability shows that they are stable over time in their asymmetry scores for the same items" (Levy et al., 1983b, p. 413).

Wirsen, af Klinteberg, Levander & Schalling (1990) investigated the reliability of the chimeric faces free-vision task and its relationship to reaction time. The authors reviewed evidence from prior investigations of a relationship between the right hemisphere and reaction time. During session one, the subjects completed Levy et al.'s

(1983b) free-vision chimeric faces task, a reaction time test and two handedness instruments. Two months later, a subsample of subjects completed a parallel chimeric faces instrument. Two years later a small subsample completed the original Levy et al. (1983b) instrument.

Within testing sessions, the split-half reliability coefficients were high; for both Levy et al's (1983b) instrument and the parallel form the coefficients were .88. For the original Levy et al. (1983b) instrument, the retest correlation after two years was .63; this was also significant ($p < .001$). Additionally, the two forms of the chimeric faces task were significantly correlated ($p < .001$). The subjects demonstrated a significant left visual field bias for both Levy et al.'s task ($p < .001$) and the parallel form ($p < .01$). The results pertaining to the magnitude of asymmetry scores are similar to those obtained by Levy et al. (1983b). When subjects were divided on the bases of asymmetry scores on Levy et al's (1983b) instrument, the magnitude of bias is larger for the left visual field bias group as compared to the right visual field bias group ($p < .05$). Finally, as predicted, the right visual field bias group demonstrated longer reaction times than the left visual field bias group and the no bias group. The authors concluded that the chimeric faces task "might be a useful method of exploring individual differences in hemispheric activation patterns" (Wirsen, af

Klinteberg, Levander & Schalling, 1990, p. 238).

David (1989) examined subject's perception of schematic chimeric faces composed of happy-sad expressions. The experiment was designed to investigate whether subjects demonstrated a left hemiface perceptual bias to this task and to assess this effect in non-right handers. Additionally, David (1989) examined the effect of subjects' current mood on perceptual bias. The results are consistent with those reported by Levy et al. (1983b). Right-handed subjects demonstrated a consistent left hemifacial bias; females exhibited a greater bias than males. The non-right-hander group as a whole failed to exhibit a significant lateral bias. However, non-dextral males demonstrated a slight right hemifacial bias and non-dextral females showed a slight left hemifacial bias. Both the subjects' current resting mood and induced positive and negative mood failed to affect left hemifacial bias.

David (1989) also examined the reliability of this chimeric faces task. The split-half reliability of this test was .68. The test-retest reliability coefficient of ten subjects assessed one week after the original experiment was .85.

The chimeric faces task is reflective of both hemispheric specialization and individual differences in hemispheric arousal. Although it appears that this would complicate measurement, such is not the case (Levy et al.

1983b). According to Levy the 'functional competence of a hemisphere' results from its specialization for certain cognitive or emotional functions and its' arousal level. Hence, if the individual is working on a chimeric faces task (a right hemispheric task) but the characteristic arousal of his/her left hemisphere is greater, the left visual field bias will be weaker. This mode of functioning is characteristic of right-biased dextrals in their study (1983b), who exhibited weaker asymmetry than left-biased dextrals. Left handers' characteristic diversity of hemispheric specialization is demonstrated in the weak relationship between the magnitude and direction of perceptual asymmetries in the same study.

Another performance measure which has been used in conjunction with lateral eye movement assessments and the chimeric faces task is the image location task (Borod et al. 1988, 1989). The task requires the subject to generate an emotional image, experience the associated feelings and to locate the image by pointing to it in space (Borod et al. 1989). This task is the second part of an image generation task. LEMs are first recorded in response to the image generated. After LEMs are recorded, the subject is required to point to the image in space. Half of the images used in the Borod et al. (1988, 1989) inventory were positive and half were negative. Additionally, one third of the items were auditory images, one third were visual images and one third were tactile images.

Empirical support for the use of the image location task is derived from a study which investigated the relationship of a subject's performance on the chimeric faces task, tasks of ocular dominance, lateral eye movement in response to emotional and nonemotional tasks and the experience and location of emotional images (Borod et al., 1989). Both the emotional LEMs task and the image location task were components of the image generation task as discussed above. The authors hoped that by comparing such different measures, the mechanisms underlying perceptual bias would be clarified.

Subjects' laterality on each variable was initially determined. The authors conducted t-tests against the null hypotheses of laterality absence. The results indicated that on both the chimeric faces task and the emotional LEMs task, subjects exhibited a left-sided bias. Correlations were then computed between performance on the chimeric faces task and performance on the other measures. The only correlation which reached significance was between performance on the chimeric faces task and performance on the image location task. Further analysis was then conducted on the subscales of the nonemotional LEM task (spatial,verbal), the emotional LEM task (tactile, visual, auditory) and the image location task (tactile, visual, auditory). When scores for each subscale were evaluated for lateral asymmetry, significance was found only for auditory, visual and tactile emotional LEMs. Asymmetry was always left-sided for these three subscores. Correlations were again computed for scores on the chimeric faces task and scores on the subtasks. The only significant correlations were between performance on the chimeric faces task and performance on the tactile image location subtask and the tactile emotional LEMs subtask.

Performance on the chimeric faces task and the image location task appears to reflect differential hemispheric activity. Furthermore, the correlational data reported by Borod et al. (1989) indicated that these two tasks and lateral eye movement may reflect similar hemispheric processes. Hence, these two performance measures may prove adequate in providing convergent validation for lateral eye movement as a index of hemispheric activity.

SUMMARY

LEMs have been shown to have reasonably high split-half and test-retest reliability in the same situation. However, such demonstrations of reliability do not provide evidence for the validity of lateral eye movement as an individual difference variable. Prior research has not adequately shown that lateral eye movement is a valid individual difference variable. Additionally, much of the correlational research attempting to demonstrate systematic relationships between lateral eye movement and other variables has yielded inconsistent results.

The demonstration of cross-situational consistency for any individual difference variable is a prerequisite for its validation. Cross-situational consistency has not been adequately demonstrated for lateral eye movement. Perhaps those studies which reported moderate to high reliability coefficients for LEM reflect person by situation effects which are not error but are also not attributable to a cross-situational trait. Epstein (1979, 1980) and Bem and Allen (1974) proposed two theoretical and methodological approaches to demonstrate that individuals are cross-situational consistent on a number of trait dimensions. In the present study, these approaches were employed to evaluate the cross-situational stability of LEM.

In a variable centered approach, Epstein (1979, 1980) initially demonstrated that aggregation could be used to increase the temporal reliability of a variable. He argued that single assessments of any variable are affected by situational variance. In order to show the stability of any variable, one must reduce error of measurement by aggregating data over many occurrences. Epstein's use of this technique required correlating aggregated data collected on a number of different days. He demonstrated that higher reliability coefficients between scores could be obtained when the number of days of measurement were increased. In addition to being a useful tool for obtaining higher temporal reliability coefficients, Epstein argued that aggregation could be used to demonstrate increased cross-situational stability if measurement occurred over many different situations. He claimed that he had accomplished this in his studies since his measurements occurred in a variety of settings.

The primary intent of the present study was to provide evidence for the validity of LEMs by examining stable individual differences on this dimension as well as to examine its correlates. Epstein's particular use of aggregation over days is not applicable for studying individual differences in LEM direction. Epstein proposed that correlating aggregated data taken over days yielded higher temporal reliability coefficients and served to demonstrate increased cross-situational stability if measurement occurred over many different situations.

Mischel (1982) argued that Epstein's experiments merely increased temporal reliability coefficients and evidence for increased cross-situational stability had not been shown. Additionally, Epstein's approach is not sensitive enough to examine the bidirectional population. By computing reliability coefficients on aggregated data, one could not distinguish between the individual who is consistently bidirectional and the individual who elicits all right movement in one situation and left movement in another.

Although Epstein's specific method is not applicable, the technique of aggregating data could be used to demonstrate the cross-situational stability of LEM within groups of individuals who differ on the dimension. By aggregating subjects' LEM scores over experimentally varied situations, contextual variance would be minimized and trait differences and consistencies would be more apparent.

Many investigators have argued that certain traits are not applicable to everyone. Bem and Allen (1974) and Baumeister and Tice (1988) argued that including subjects who vary greatly on a trait dimension in an investigation will result in low cross-situational stability and inconsistent relationships with other variables. They proposed that investigators separate individuals who are highly consistent from those who do not demonstrate consistency on a trait dimension and examine them separately. With respect to lateral eye movement, it may be suggested that individuals who are traited on the lateral eye movement dimension will exhibit consistent left or right movements in a variety of situations. On the other hand, bidirectionals could be considered untraited on this dimension. Any attempt to examine these groups separately must first ascertain if individuals are consistent or inconsistent in their direction of lateral eye movement. Aggregation can be used in a more person-centered approach to identify and group individuals who are cross-situationally consistent in their 'direction' of lateral eye movement. This use of aggregation does not necessitate the computation of reliability coefficients across situations and/or days. Here aggregation would simply be used to accurately classify individuals as left movers, right movers and bidirectionals by minimizing the influence of situational factors. Additionally, the two distinct groups of bidirectional individuals could be identified. Once individuals are more accurately classified on this dimension by demonstrating cross-situational stability, the relationships between lateral eye movement and other variables should be more evident.

This study incorporated the methodological techniques proposed by Epstein (1979, 1980) and Bem and Allen (1974) in an attempt to provide evidence demonstrating that lateral eye movement is a valid individual difference variable indicative of cerebral asymmetry, at least in a subsample of the population. This evidence was gathered by using aggregated data and by identifying those individuals for whom the 'trait' of unidirectionality was relevant. Specifically, situational effects were minimized by aggregating data over three different situations and methodological variance was reduced by aggregating subjects scores on the two performance measures employed as other indices of hemispheric activation. Additionally, through aggregation, subjects who are consistently left movers and right movers were identified and differentiated from those who were inconsistent or bidirectional. It was hoped that by minimizing situational and methodological variance and more accurately classifying individuals, relationships with trait affect and the other indices of hemispheric activation would be strengthened.

The investigation was an attempt to validate lateral eye movement. The study attempted to demonstrate predictive validity by testing whether individuals' LEM scores could predict trait affect scores. It was an attempt to demonstrate convergent validation by testing whether subject's who differed in LEM direction would show similar asymmetries on other putative indices of hemispheric activation.

Hypotheses

1. Individuals classified as right movers, left movers and bidirectionals on the basis of their lateral eye movement scores will differ in trait affect. The relationship will be stronger when LEMs are aggregated over situations than when LEMs are not aggregated and when inconsistent and bidirectional subjects are removed from the analysis.

1.1 Left movers will score higher than right movers and bidirectionals on negative affect scales. No specific hypotheses are made for right movers or bidirectionals. No specific hypotheses are made about the relationship between lateral eye movement and positive affect.

2. Individuals classified as right movers, left movers and bidirectionals will exhibit different systematic responses on two performance measure tasks. The relationship will be stronger when LEMs are aggregated over situations than when LEMs are not aggregated and when inconsistent and bidirectional subjects are removed from the analysis.

2.1 Left movers will demonstrate a stronger leftward asymmetry to both the chimeric faces task and the image location task than right movers and bidirectionals.

2.2 The differences in the degree of perceptual asymmetry exhibited by left movers, right movers and bidirectionals will be more evident when individual scores on the chimeric faces task and the image location task are also aggregated into a single performance score.

METHOD

Subjects

One hundred and twenty-four subjects participated in the experiment. The data of two subjects were excluded from the analysis. One of these subjects reported that he was on medication for the treatment of depression and the other subject was excluded for not following procedures. Of the remaining 122 subjects, 101 were right-handed and 21 were left-handed. Only right-handed subjects were included in the analysis. Thirty-five subjects were male and sixty-six were female. The mean age of subjects was 21.6. Sixty-five were undergraduates and 20 were graduate students.

Overview

Subjects were recruited via posters and advertisements in the university newspapers and then contacted by telephone to schedule appointments. The experimenter told each respondent that the experiment was about the effectiveness of information presented in a number of ways on cognitive processing. Additionally, they were told that some of their responses would be videotaped. Upon arrival at the laboratory each subject signed a consent form. (A copy of the consent form is in the Appendix). Each subject then participated in three experimental situations and was debriefed at the conclusion of the third situation. Subjects were paid seven dollars for their participation.

Rational for the Three Experimental Situations:

In order to permit a stringent test for the cross-situational consistency of lateral eye movement, three situations were chosen that were as different as the practical constraints of the setting would allow. Therefore, the first situation was designed to be informal, interactive, social and less structured. The symmetry of the experimental setting was not controlled. During this situation, the subjects were not aware that the experiment had actually begun. The second and third situation were designed to be more formal and experimental. The setting for both these situations was less social, more structured and the subjects were aware the experiment was in progress. However, the second and third situation were designed to be different from the first situation and each other. During the second situation, LEMs were recorded while the subjects completed a visual word association task. The stimuli were presented in front of the subjects. LEMs were recorded while the subjects completed an auditory task during the third situation. The stimuli were presented behind the subjects.

Situation 1- This condition took place in an informal setting, in a classroom set apart from the materials used for the following two experimental situations. During this part of the study, the subjects sat across a desk (3'9" x 4'2" in.) from the experimenter and were asked questions requiring reflection as part of an informal conversation. The experimenter was a right-handed female for all subjects during this situation. The subjects were unaware that the experiment had begun. Lateral eye movement was scored surreptitiously by the experimenter each time the subject made and broke eye contact. The experimenter scored eye movement direction by squeezing electrical contacts held in each hand under the desk. The experimenter squeezed the contacts held in her left hand to indicate that a left eye movement had occurred; she squeezed the contacts with her right hand to indicate that a right eye movement occurred. The left and right contacts led to a stereo tape recorder in the drawer of the desk. The depression of the left and right leads resulted in different tones recorded on the tape recorder.

The experimenter then explained the nature of the tasks subjects would be asked to complete and each subject signed an informed consent form. The experimenter told the subjects that the experiment was now beginning and read the instructions of the chimeric faces task (eg. these instructions can be found on page 129) to each subject. Subjects were told to put their answer sheet in a coded envelope after completion. The experimenter walked to the other side of the room to insure the subjects' privacy.

Situation 2- This condition took place in a laboratory setting in the same room (18'10" x 21'9" ft.). Each subject watched a videotape of two male and two female presenters holding stimulus cards. The subject were asked to free associate aloud to each stimulus card. Each slide was presented for 1 second (long enough for the subject to read the stimulus word); subjects were given as long as needed to respond. The experimenter controlled the slide presentation with a remote control. Eye movement direction was recorded by a video camera positioned across the room facing the subject. The distance from both the screen and the video camera to the subject was 6'9". The video camera lens was positioned 2'2" from the floor.

Situation 3- This condition occurred in the experimental section of the room. The subjects were requested to remain sitting on the chair facing the video camera. Experimental questions designed to elicit eye movement were presented via audiotape. The tape recorder was positioned behind the subject and the stimulus tape was played through two speakers that were equidistant from the subjects' left and right ears. Subjects were requested to look into the camera while answering the questions aloud. Eye movement direction was recorded by the video camera positioned 6'9" across from the subject. After the eye movements were recorded, the subjects were requested to sit at the desk where the informal conversation had originally taken place. All subjects then completed the PANAS and scales of emotional state, and the handedness inventory. Subjects were debriefed at the end of this third situation.

Materials

Eye Movement Stimuli

Informal Conversation- It is well known that during conversation people make and break eye contact frequently. An informal conversation was initiated with each subject pertaining to school, where they live, why they agreed to be in the study, and what they would like to do in the future.

Free Association Stimuli- A series of 20 words adapted from Brown and Ure's (1969) word association stimuli were presented on a screen. The words were separated into two sets of stimuli. Subjects in Brown and Ure's study rated the words on various dimensions including: emotional intensity, pleasantness and goodness. Words rated as high in emotional intensity were used. These words were further separated into those that were highly pleasant and good and those which were highly unpleasant and bad. The first set of stimuli included words rated high in emotional intensity, pleasantness and goodness. Examples are: (a) happy and (b) love. The second set of stimuli included words rated high in emotional intensity, unpleasantness and badness. Examples are: (a) hate and (b) suicide. See the Appendix for the complete set of words used.

Experimental Questions- A series of 20 questions adapted from Schwartz et al. (1975, 1979) and Ehrlichman (1974) were used. Half the questions were presented by a male voice and half by a female voice. They were divided into positive affect and negative affect sets of 10 questions each. The positive affect set included questions designed to elicit positive emotion. Examples are: (a) What is the primary difference between PLEASURE and FUN?; (b) Picture and describe the last situation in which you LAUGHED. The negative affect set included questions designed to elicit negative emotion. Examples are: (a) Picture and describe a situation in which you experienced extreme DISLIKE; (b) Visualize your face. What part of your face is most expressive of SADNESS? See the Appendix for the complete set of questions used.

Laterality Measures

Chimeric Faces Task- the chimeric faces task used was the modified version presented in a booklet for free viewing (Levy, Heller, Banich and Burton, 1983b). The booklet contained 36 pairs of chimeric faces. The chimeric faces were constructed from 18 photographs taken of nine male posers photographed once while smiling and once with a neutral expression. The 18 photographs were bisected and recombined to construct four pairs of different chimeric faces for each poser. For each poser the smile and neutral half expressions were paired together; in one chimera the smile on the left of the poser's face was paired with the neutral expression on the right of the poser's face. In the second chimera this was reversed. These two chimeric faces were then paired with their respective mirror images. These pairs of chimeric faces were printed on separate pages of a booklet, once with the original chimeric face on top and its mirror image on the bottom and once with the mirror image on the top of the page and the original chimeric face on the bottom. This resulted in four pairs of chimeric faces for each poser. It is important to note that a given chimera and its mirror image were created from the same smiling half face and neutral half face of a given poser. Each of the nine posers appear once in succession in a set of nine pages. Subjects were instructed to decide which of the two chimeric faces in a pair looked happier. Right- and left-biased responses depended on the subject's choice of the chimera with the half smile to the viewer's right or left respectively. The subject was permitted to indicate that he/she could not decide which of the two chimeric faces looked happier. The laterality index was computed by subtracting the number of pairs in which a leftward bias was indicated from the number of pairs in which a rightward bias was indicated. This difference score was then divided by the total number of scores (N=36). Levy et al (1983b) reported split-half reliabilities of asymmetry scores of .925 for right-handers and left-handers separately. The test-retest reliability coefficient was .87. (See the Appendix for a copy of the instructions used and an example of a pair of chimeric faces.)

Image Location Task - The image location task developed by Borod, Vingiano and Cytryn (1988, 1989) has been shown to correlate significantly with the chimeric faces task. Both tasks may therefore reflect similar hemispheric processes (Borod et al., 1989). This task is a component of the Image Generation Task where subjects are provided with a sequence of emotional situations and required to generate the corresponding image. Subjects were requested to experience the image and the associated emotion as vividly as possible and then point to the image in space. A score of one was given if the individual pointed to the right side, a score of two was given if the individual pointed to the middle and a score of three was given if the individual pointed to the left side. The positive and negative emotional images developed by Borod et al. (1988,1989) were used. Examples are (a) Imagine seeing a brilliant red sunset over the ocean and (b) Imagine hearing the screeching siren of an approaching ambulance. Each subject was asked to indicate on a 7-point Likert scale how vividly they experienced each image and how pleasant or unpleasant the emotion experienced while conjuring up the image was to them. See the Appendix for a complete list of images used.

Trait Affect Measures

Scales of Emotional State- A scale based on Russell's (1989) circumplex model of emotion and modified from his Affect Grid and Scales of Emotional State was used. This likert-type instrument assesses both the valence and arousal components of affect with the following bipolar scales: (a) alert-sleep, (b) pleased-annoyed, (c) depressed-excited, and (d) tense-relaxed. These bipolar affect dimensions serve as endpoints on a continuum; subjects were required to indicate where they would generally characterize themselves on each affect scale. See the Appendix for the complete scale.

The Positive and Negative Affect Schedule (PANAS)- The PANAS (Watson, Clark and Tellegen, 1988) provided an independent assessment of positive and negative affect. The scale consists of 10 positive and 10 negative affect dimensions; subjects were required to indicate how each dimension describes them generally or on the average. Responses range from 1 (very slightly or not at all) to 5 (extremely). Test-retest reliability coefficients after an 8-week interval were .68 for the PANAS PA scale and .71 for the PANAS NA scale. Strong convergent and discriminant validation was obtained with the PANAS and other mood indexes. See the Appendix for the complete scale.

The Handedness Inventory

The handedness inventory included twelve items which required the subjects to indicate which hand they used when they did certain activities including writing and brushing teeth. A second section on the inventory asked the subject to indicated which hand family members write or wrote with. Two additional questions were included: 1. Which eye do you use to look through a telescope? and 2. When you clasp your hands together, which thumb is on top? (See the Appendix for the complete scale.)

RESULTS

Scoring of Eye Movements

Informal Situation 1 - Eye movements were recorded each time the subject broke away from a central point. Eye movements were scored for lateral direction (right and left). The lateral eye movement index, typically used in experiments of this kind (Ehrlichman and Weinberger, 1978), of R-L/R+L was used.

Experimental Situation 2 and Situation 3 - All eye movements were scored at the completion of the experiment. The first lateral eye movement after the presentation of the visual stimuli (slides) or audio stimuli (taped questions) was scored using the clock-face procedure discussed by Ehrlichman and Weinberger (1978). Lateral and vertical eye movements were scored using this procedure. Only lateral eye movements were used to complete the index of R-L/R+L.

LEM Distribution Within Each Situation[1]

The distribution of LEMs was skewed in all three situations. In the informal situation 70 subjects (69.3 percent) of the subjects demonstrated a left-biased LEM index and the remaining 30 subjects (29.7 percent) demonstrated a right-biased LEM index. In the other two experimental situations this trend was reversed. During the

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[1]Subjects who demonstrated any amount of left- or right-sided bias in each situation are reported here. Subjects who exhibited an absence of bias, and all missing cases are identified on page 75.

first experimental situation (slide presentation) 32 subjects (31.7 percent) demonstrated a left-biased LEM index whereas 65 subjects (64.4 percent) demonstrated a right-biased LEM index. During the second experimental situation (audio presentation) 39 subjects (38.6 percent) demonstrated a left-biased LEM index and 57 subjects (56.4) demonstrated a right-biased LEM index.

Binomial tests were computed to determine whether differences in the proportion of left movers and right movers could be expected by chance alone. For the informal situation, and the slide situation, the difference was significant ($p.<.05$). This was not the case for the audio situation where the proportions did not significantly differ from chance.

Binomial tests were then computed for males and females separately. The results for females were similar to that of the whole group; for the slide and informal situation, the number of left and right movers was significantly different than that which would be expected by chance. For males, however, only during the informal situation was the number of right and left movers different than that expected by chance.

Correlations[2] were computed between the LEM indexes

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[2]For all correlations, all cases with valid values for the pair of variables used to compute a coefficient were included in the computation of that coefficient. Depending on the analysis, the minimum pairwise N of cases was 52 or 63.

for each situation (see Table 1). The LEM index computed for the second situation correlated significantly with that computed for the third situation. The correlation computed between LEM indexes for the first and third situation was also significant.

Table 1

Correlations Between LEM Indexes for Each Situation

	Situation 1	Situation 2	Situation 3
Situation 1	--	--	--
Situation 2	.23	--	--
Situation 3	.29*	.46**	--

LEM Classification Within Each Situation

Subjects were classified as right movers or left movers if their eye movements were right or left respectively on 65% of the trials for each situation separately.[3] Individuals who did not meet this criterion were classified as bidirectional. In terms of the R-L/R+L score, right and left movers' scores ranged from +.30 to +1.00 and -.30 to -1.00, respectively. The number of subjects categorized in each group within each situation is reported in Table 2. In the informal situation 50 subjects were classified as left movers, 18 subjects were classified as right movers and 32 subjects were classified as bidirectional. The data on one

[3]Criteria of consistency for lateral eye movement are typically set around 65 or 70 percent and was therefore deemed appropriate for the present experiment.

subject could not be evaluated because of a malfunction on the audiotape. In the two experimental situations this left-bias was reversed. During the first experimental situation (slide task) 22 of the subjects were classified as left movers, 49 subjects were classified as right movers and 27 were classified as bidirectional. Three subjects demonstrated only stares, only up and down eye movements, unscorable trials or a combination of these non-lateral movements. There data was not included in the analysis. During the third experimental situation twenty-four subjects were classified as left movers, forty subjects were classified as right movers and thirty-seven were classified as bidirectional.

Table 2

LEM Classifications for Each Situation

SITUATION	LEFT MOVERS	RIGHT MOVERS	BIDIRECTIONAL
FIRST (INFORMAL)	50	18	32
SECOND (EXPERIMENTAL)	22	49	27
THIRD (EXPERIMENTAL)	24	40	37

The LEM classifications were computed separately for males and female subjects and are reported in Tables 3 and 4 respectively. For females, two subjects' data were excluded during the slide situation as they only demonstrated non-lateral movements. For males, one case was excluded from analysis due to a malfunction on the audiotape during the first situation. One case was excluded from the male sample during the slide situation because he exhibited only non-lateral movements.

Table 3

LEM Classifications for Males

in Each Situation

SITUATION	LEFT MOVERS	RIGHT MOVERS	BIDIRECTIONAL
FIRST (INFORMAL)	20	7	7
SECOND (EXPERIMENTAL)	8	15	11
THIRD (EXPERIMENTAL)	9	14	12

Table 4

LEM Classifications for Females

in Each Situation

SITUATION	LEFT MOVERS	RIGHT MOVERS	BIDIRECTIONAL
FIRST (INFORMAL)	30	11	25
SECOND (EXPERIMENTAL)	14	34	16
THIRD (EXPERIMENTAL)	15	26	25

Relationships Between LEMs and Other Variables

The Relationship Between LEMs and Trait Affect

A series of Anovas were computed for each situation separately with LEM groups serving as the independent variable and scores on the positive and negative dimension of the PANAS trait affect scale as the dependent variables. Within each of the three situations LEM groups did not differ on positive and negative affect scores of the PANAS (see Tables 5 and 6).

Table 5

Means and Standard Deviations on the Positive Affect Dimension of the PANAS For Each Situation X Group

	Left Movers	Right Movers	Bidirectionals
Situation 1 (Informal)	X=3.6 S.D.= .60 N=50	X=3.5 S.D.= .50 N=18	X=3.5 S.D.= .53 N=32
Situation 2 (Slide Task)	X=3.7 S.D.= .63 N=20	X=3.6 S.D.=.47 N=45	X=3.6 S.D.= .62 N=27
Situation 3 (Audio Task)	X=3.6 S.D.= .62 N=24	X=3.6 S.D.= .55 N=38	X=3.5 S.D.= .51 N=37

Table 6

Means and Standard Deviations on the Negative Affect Dimension of the PANAS For Each Situation X Group

	Left Movers	Right Movers	Bidirectionals
Situation 1 (Informal)	X=2.2 S.D.= .65 N=50	X=2.3 S.D.= .56 N=18	X=2.5 S.D.= .81 N=32
Situation 2 (Slide Task)	X=2.2 S.D.= .58 N=20	X=2.3 S.D.=.80 N=45	X=2.2 S.D.= .63 N=27
Situation 3 (Audio Task)	X=2.3 S.D.= .73 N=24	X=2.2 S.D.=.57 N=38	X=2.4 S.D.= .81 N=37

Anovas were also computed separately for males and females for each situation. Again, LEM groups served as the independent variable and scores on the negative and positive dimensions of the PANAS trait affect scales served as the dependent variables. For both males and females in each situation, the LEM groups did not differ on positive and negative affect scores on the PANAS.

A second series of Anovas were computed for each situation separately with LEM groups serving as the independent variable and scores on the four dimensions of the Scales of Emotional State serving as the dependent variables. Similarly, the LEM groups did not differ in their mean affect scores on the four dimensions of the Scales of Emotional State in each of the three situations (see Tables 7-10).

Table 7

Means and Standard Deviations on the Sleepy-Alert Dimension of Scales of Emotional State for Each Situation X Group

	Left Movers	Right Movers	Bidirectionals
Situation 1 (Informal)	X=8.8 S.D.=3.1 N=49	X=8.0 S.D.=3.0 N=18	X=7.7 S.D.=2.9 N=30
Situation 2 (Slide Task)	X=9.3 S.D.=3.5 N=20	X=8.1 S.D.=3.1 N=44	X=8.1 S.D.=2.8 N=25
Situation 3 (Audio Task)	X=8.2 S.D.=3.3 N=24	X=8.6 S.D.=3.0 N=37	X=8.1 S.D.=2.9 N=35

Table 8

Means and Standard Deviations on the Pleased-Annoyed Dimension of Scales of Emotional State for Each Situation X Group

	Left Movers	Right Movers	Bidirectionals
Situation 1 (Informal)	X=5.2 S.D.=3.1 N=49	X=4.0 S.D.=2.6 N=18	X=5.2 S.D.=3.5 N=30
Situation 2 (Slide Task)	X=4.8 S.D.=2.8 N=20	X=5.1 S.D.=3.5 N=44	X=4.8 S.D.=3.0 N=25
Situation 3 (Audio Task)	X=5.5 S.D.=3.1 N=24	X=4.9 S.D.=3.1 N=37	X=4.9 S.D.=3.3 N=35

Table 9

Means and Standard Deviations on the Depressed-Excited Dimension of Scales of Emotional State for Each Situation X Group

	Left Movers	Right Movers	Bidirectionals
Situation 1 (Informal)	X=8.6 S.D.=3.3 N=49	X=8.0 S.D.=3.0 N=18	X=8.5 S.D.=3.3 N=30
Situation 2 (Slide Task)	X=9.2 S.D.=2.8 N=20	X=8.5 S.D.=3.4 N=44	X=8.2 S.D.=3.5 N=25
Situation 3 (Audio Task)	X=8.1 S.D.=3.2 N=24	X=8.7 S.D.=3.3 N=37	X=8.4 S.D.=3.3 N=35

Table 10

Means and Standard Deviations on the Tense-Relaxed Dimension of Scales of Emotional State for Each Situation X Group

	Left Movers	Right Movers	Bidirectionals
Situation 1 (Informal)	X=6.9 S.D.=3.7 N=49	X=6.8 S.D.=2.4 N=18	X=7.4 S.D.=3.3 N=30
Situation 2 (Slide Task)	X=6.6 S.D.=3.4 N=20	X=7.0 S.D.=3.6 N=44	X=7.8 S.D.=3.2 N=25
Situation 3 (Audio Task)	X=5.9 S.D.=3.6 N=24	X=7.2 S.D.=3.1 N=37	X=7.7 S.D.=3.4 N=35

Anovas were also computed for males and females for each situation separately. Again within each situation, LEM group served as the independent variables and scores on the four dimensions of the Scales of Emotional State served as the dependent variables.

For both males and females the LEM groups did not differ in their mean affect scores on the Sleepy-Alert, Pleased-Annoyed, and Depressed-Excited Dimensions of this scale. Male LEM groups did not differ on the Tense-Relaxed dimension either. But females differed on the Tense-Relaxed dimension for the second and third experimental situation, as indicated in Table 11.

Table 11

Means and Standard Deviations on the Tense-Relaxed Dimension of Scales of Emotional State for Each Situation X Female LEM Groups

	Left Movers	Right Movers	Bidirectionals
Situation 1 (Informal)	X=7.1 S.D.=3.9 N=29	X=6.9 S.D.=2.2 N=11	X=7.2 S.D.=2.8 N=23
Situation 2 (Slide Task)	X=5.8 S.D.=3.3 N=13	X=7.1 S.D.=3.2 N=30	X=8.9 S.D.=2.9 N=14
Situation 3 (Audio Task)	X=4.9 S.D.=2.9 N=15	X=7.5 S.D.=3.2 N=24	X=8.0 S.D.=3.0 N=23

For the slide situation, female bidirectional subjects demonstrated significantly higher scores on the Tense-Relaxed dimension than female left mover subjects. Similarly, for the audio situation, female right mover and bidirectional subjects demonstrated significantly higher scores on the Tense-Relaxed dimension of the Scale than female left movers. There was no significant difference among the groups for the informal situation.

To further examine the relationship between lateral eye movement and affect, correlations were computed between the LEM indexes within each situation and scores on the positive and negative dimensions of the PANAS and each of the four affect dimensions on Russell's Scales of Emotional State. The correlations between each LEM index in the three situations and the affect scores were very low (see Table 12).

Table 12

Correlation Coefficients Between the LEM Indexes and the Affect Measures

	LEM Ratios		
	Situation 1 Informal	Situation 2 Slide Task	Situation 3 Audio Task
PANAS Pos Affect	-.07	-.01	-.04
PANAS Neg Affect	.03	-.03	-.02
SLEEP-ALERT	-.16	-.12	.01
PLEASED-ANNOYED	-.15	-.01	-.05
DEPRESS-EXCITED	-.04	-.03	.06
TENSE-RELAX	.06	.06	.13

Correlations were computed between the LEM indexes within each situation and affect scores for males and females separately. For males, there were no significant relationships found within any situation between any affect score and the LEM indexes. For females, there was a significant relationship found between the LEM index computed for the audio situation and the tense-relaxed dimension of the Scales of Emotional State (see Table 13).

Table 13

Correlation Coefficients Between the LEM Indexes and the Affect Measures for Females

	LEM Ratios		
	Situation 1 Informal	Situation 2 Slide Task	Situation 3 Audio Task
PANAS Pos Affect	-.13	-.02	-.05
PANAS Neg Affect	.08	-.12	-.12
SLEEP-ALERT	-.26	-.12	.07
PLEASED-ANNOYED	-.21	-.08	-.22
DEPRESS-EXCITED	-.06	.03	.20
TENSE-RELAX	.02	.11	.30*

The Relationship Between LEMs and Laterality Measures

An Anova was computed with LEM groups as the independent variable and performance on the chimeric faces task as the dependent variable. Individuals classified as right movers, left movers and bidirectionals within each situation did not differ significantly on the chimeric faces task (see Table 14). When the data were further split by sex, the left, right, and bidirectional groups did not differ on this task.

For each group, t-tests were conducted against the null hypothesis that there was no lateral asymmetry on the chimeric faces task. Within each situation, left movers, right movers and bidirectionals were significantly left-sided for chimeric faces. Overall, bidirectionals and right movers demonstrated larger left-sided biases than left movers.

Table 14

Means and Standard Deviations on the Chimeric Faces Test for Each Situation X Group

	Left Movers	Right Movers	Bidirectionals
Situation 1 (Informal)	X=-.37 S.D.=.46 N=48	X=-.39 S.D.=.40 N=17	X=-.46 S.D.=.40 N=32
Situation 2 (Slide Task)	X=-.35 S.D.=.42 N=20	X=-.44 S.D.=.43 N=43	X=-.38 S.D.=.40 N=27
Situation 3 (Audio Task)	X=-.27 S.D.=.51 N=24	X=-.45 S.D.=.41 N=35	X=-.50 S.D.=.35 N=37

The groups were then split by sex; t-tests were again conducted against the null hypotheses that there was no lateral asymmetry on this task. Within the informal situation both male and female left movers and bidirectionals demonstrated significant left-sided biases on this task. Female right movers also exhibited a significant left-sided bias and male right movers exhibited a marginally ($p<.10$) significant left-sided bias (see Table 15).

Table 15

Means and Standard Deviations on the Chimeric Faces Test for Groups X Sex During Situation 1 (Informal)

	Left Movers	Right Movers	Bidirectionals
Male	X=-.61 S.D.=.41 N=19	X=-.35 S.D.=.43 N=7	X=-.42 S.D.=.42 N=7
Female	X=-.21 S.D.=.43 N=29	X=-.42 S.D.=.40 N=10	X=-.47 S.D.=.40 N=25

Within the second situation (slide task), both male and female left movers, right movers and bidirectional demonstrated significant left-sided biases (see Table 16)..

Table 16

Means and Standard Deviations on the Chimeric Faces Test for Groups X Sex During Situation 2 (Slide Task)

	Left Movers	Right Movers	Bidirectionals
Male	X=-.45 S.D.=.45 N=7	X=-.56 S.D.=.48 N=13	X=-.47 S.D.=.37 N=11
Female	X=-.30 S.D.=.40 N=13	X=-.38 S.D.=.41 N=30	X=-.33 S.D.=.43 N=16

Within the audio task, male and female right movers and bidirectionals demonstrated significant left-sided biases on the chimeric faces task. Left mover males demonstrated a significant left sided bias but females did not (see Table 17).

Table 17

Means and Standard Deviations on the Chimeric Faces Test for Groups X Sex During Situation 3 (Audio Task)

	Left Movers	Right Movers	Bidirectionals
Male	X=-.41 S.D.=.51 N=9	X=-.53 S.D.=.34 N=12	X=-.69 S.D.=.30 N=12
Female	X=-.18 S.D.=.51 N=15	X=-.41 S.D.=.44 N=23	X=-.41 S.D.=.34 N=25

An Anova was computed with LEM groups within each situation serving as the independent variable and laterality ratios on the positive images of the image location task serving as the dependent variables. (For all analysis using the image location task, only subjects who clearly pointed to the right, left or straight were included in the analysis.) There were no significant differences among the LEM groups within each situation on the image location task for positive images (see Table 18).

Table 18

Means and Standard Deviations for Positive Images on the Image Location Task for Each Situation X Group

	Left Movers	Right Movers	Bidirectionals
Situation 1 (Informal)	X=2.0 S.D.=1.2 N=36	X=2.2 S.D.=1.3 N=12	X=1.9 S.D.=1.3 N=17
Situation 2 (Slide Task)	X=1.7 S.D.=1.3 N=12	X=1.9 S.D.=1.2 N=29	X=2.5 S.D.=1.4 N=18
Situation 3 (Audio Task)	X=1.6 S.D.=1.2 N=16	X=2.5 S.D.=1.4 N=23	X=2.0 S.D.=1.2 N=24

Additional Anovas were computed separately for male and female LEM groups within each situation serving as the independent variables and laterality ratios on the positive image location task serving as the dependent variables. There were no significant differences in these scores for both male and female LEM groups on this task for any situation.

Within each situation, for each group, t-tests were conducted against the null hypothesis that there was no lateral asymmetry on the image location task for positive images. For each situation, left movers, right movers, and bidirectionals were not significantly lateralized on this task.

The groups were then split by sex; t-tests were conducted against the null hypothesis that there was no lateral asymmetry on the image location task for positive images for males and females separately. Male left movers demonstrated a significant ($p<.05$) right-sided bias on the image location task for positive images during the informal situation. All other tests for males and females for any situation on this task were not significant.

An Anova was computed with LEM groups within each situation serving as the independent variable and laterality ratio on the negative images of the image location task serving as the dependent variables. There was a significant difference in these scores between individuals classified as left movers and the bidirectionals during the first situation ($p < .05$). Left movers demonstrated more of a right-sided bias than bidirectionals. There were no other significant differences among the LEM groups within each situation on the image location task for negative images (see Table 19).

Table 19

Means and Standard Deviations for Negative Images on the Image Location Task for Each Situation X Group

	Left Movers	Right Movers	Bidirectionals
Situation 1 (Informal)	X=1.2 S.D.=.67 N=31	X=2.0 S.D.=1.2 N=12	X=2.4 S.D.=1.9 N=23
Situation 2 (Slide Task)	X=1.1 S.D.=.56 N=12	X=1.9 S.D.=1.6 N=30	X=1.9 S.D.=1.4 N=18
Situation 3 (Audio Task)	X=1.3 S.D.=.52 N=15	X=1.9 S.D.=1.6 N=24	X=1.9 S.D.=1.5 N=26

Additional Anovas were computed for male and female LEM groups within each situation serving as the independent variables and laterality ratios on the negative image location task serving as the dependent variables. There were no significant differences in these scores for both male and female groups on this task.

Within each situation, for each group, T-tests were conducted against the null hypotheses that there was no lateral asymmetry on the image location task for negative images. For each situation, Left movers demonstrated a significant right-bias. Right movers and bidirectionals did not demonstrate significant biases.

The groups were then split by sex; T-tests were conducted against the null hypothesis that there was no lateral asymmetry on the image location task for negative images for males and females separately. For each situation, both male and female left movers demonstrated a significant right-sided bias ($p<.05$) on the image location task for negative images. All other tests for males and female right mover and bidirectional groups were not significant.

To further examine the relationship between LEM and the other laterality measures, correlations were computed between the LEM indexes and the chimeric faces ratio and the image location ratios for positive and negative images separately. The correlation between the LEM index computed for the first situation and the image location task for negative images was positive and significant ($p. < .01$). All other correlations between the between each LEM index in the three situations and laterality indexes were not significant (see Table 20).

Table 20

Correlation Coefficients Between the LEM Indexes and the Laterality Measures

	LEM Ratios		
	Situation 1 Informal	Situation 2 Slide Task	Situation 3 Audio Task
Chimeric Faces-Ratio	-.07	-.10	-.15
Image Loc Neg Index	.31*	.18	.13
Image Loc Pos Index	.04	-.03	.28

Correlations were computed between the LEM indexes and the three lateral ratios for males and females. None of these correlations were significant.

Aggregated Data

Data were then aggregated over the three situations. Subjects who met the +/- .30 criterion in each of the three situations were designated as consistent right or left movers. Subjects who did not meet the +/- .30 criterion in each of the three situations and demonstrated a consistent absence of bias were designated consistent bidirectionals. All other Ss were designated "untraited".

The aggregated data indicated that the number of individuals who could be categorized as consistent right, left or bidirectionals was extremely small. In selecting the sample size, I had assumed that the distribution of left and right movers would be fairly balanced. With that assumption, I had anticipated approximately 25 to 30 subjects in the consistent left and consistent right categories. However, because the obtained distributions were so skewed, only six subjects were classified as consistent right movers, ten subjects were classified as consistent left movers and three were identified as consistent bidirectionals. According to this classification system, 82 were inconsistent or untraited.

The Relationship Between Aggregated LEM Scores and Affect

Despite the small numbers of consistent left movers, right movers, and bidirectionals, Anovas were computed where individuals classified as consistent left, right and bidirectionals served as the independent variables; scores on the positive affect dimension and the negative affect dimension of the PANAS served as the dependent variables. There were no significant differences among the aggregated groups on the positive PANAS scale. There was a significant difference between right movers and bidirectionals on the negative PANAS scale ($p < .05$). Bidirectionals demonstrated a higher negative affect score than right movers. In a second analysis using these aggregated scores as the independent variables, scores on the four dimensions of the Scales of Emotional State served as the dependent variables. There were no significant differences among the aggregated groups on any of these four affect dimensions (see Table 21).

Table 21

Means and Standard Deviations of the Aggregated Groups on the Affect Scales

	Left Movers	Right Movers	Bidirectionals
PANAS (Positive)	X=3.4 S.D.= .66 N=10	X=3.4 S.D.= .59 N=6	X=2.9 S.D.= .40 N=3
PANAS (Negative)	X=2.3 S.D.= .71 N=10	X=2.0 S.D.=.55 N=6	X=3.4* S.D.= .26 N=3
SOES Sleepy-Alert	X=9.5 S.D.=3.7 N=10	X=7.6 S.D.=4.2 N=6	X=8.4 S.D.=1.5 N=3
SOES Pleased-Annoyed	X=5.6 S.D.=2.9 N=10	X=3.7 S.D.=2.5 N=6	X=6.1 S.D.=2.9 N=3
SOES Depressed-Excited	X=8.2 S.D.=3.1 N=10	X=8.3 S.D=1.8 N=6	X=5.2 S.D=3.7 N=3
SOES Tense-Relaxed	X=5.1 S.D.=3.0 N=10	X=8.5 S.D=2.3 N=6	X=5.3 S.D.=2.9 N=3

In order to further examine the relationship between lateral eye movement aggregated over the three situations and the affect scores, a new variable was created by averaging the LEM ratios across the three situations. The correlations between 'the average LEM' index over the three situations and the affect dimensions were also not significant ranging from -.12 for the correlation between the aggregated LEM index and scores on the Sleepy-Alert dimension of the Scales of Emotional State to .12 for the correlation between the aggregated LEM index and scores on the Tense-Relaxed dimension of the Scales of Emotional State.

The Relationship Between Aggregated LEM Scores and the Laterality Measures

Anovas were computed to compare individuals classified as consistent left, right and bidirectionals on performance on the chimeric faces and the image location tasks. The analysis revealed a significant difference between groups on the image location task for positive images. Specifically, the left movers differed significantly from the right movers ($p < .05$). The left movers demonstrated more of a right-sided bias than did the right mover group. The results also indicated that the bidirectional group also differed from the right mover group on this variable. But since the bidirectional group was comprised of only a single subject, it seems unnecessary to comment on this result. The aggregated right mover, left mover and bidirectional groups did not differ on the chimeric faces task and the image location task for negative images (see Table 22).

Each of the consistent groups' scores on the laterality measures were examined to determine whether subjects were significantly lateralized. T-tests were conducted against the null hypotheses that there was no lateral asymmetry. All groups were significantly lateralized on the chimeric faces task, with right movers demonstrating the greatest left-sided bias ($t = 2.63$, $p<.01$). Only the left mover group demonstrated a significant right-sided bias on both the image location task for positive images ($t = -7.91$, $p < .001$), and the image location task for negative images ($t = -5.28$, $p < .01$).

Table 22

Means and Standard Deviations of the Aggregated Groups on the Laterality Scales

	Left Movers	Right Movers	Bidirectionals
Chimeric Faces Ratio	X=-.32 S.D.=.43 N=10	X=-.53 S.D.=.34 N=6	X=-.32 S.D.=.15 N=3
Image Loc Index (Positive)	X=1.2 S.D.= .26 N=6	X=2.6 S.D.=.70 N=4	X=1.0 S.D.=.00 N=1
Image Loc Index (Negative)	X=1.2 S.D.=.33 N=5	X=2.4 S.D.=1.1 N=4	X=2.0 S.D.=1.4 N=2

The correlations between the average LEM index over the three situations and the chimeric faces ratio and the image location indexes were not significant. They were: -.15 for the chimeric ratio index, .27 for the image location task ratio computed for negative images and .12 for the image location task ratio computed for positive images.

Supplementary Analysis

Positive and Negative LEM INDEXES

LEM indexes were computed separately for subjects' lateral eye movement responses to positive slides, negative slides, and positive audio questions, and negative audio questions. Each of these four affectively-biased indexes correlated significantly with one another (*p*.<.001), (see Table 23). Within condition correlations were substantially higher than between condition correlations.

Table 23

Correlations Between Positive and Negative LEM Indexes

LEM INDEXES	Slides Positive	Slides Negative	Audio Positive	Audio Negative
Slides Positive	-----	-----	-----	-----
Slides Negative	.84**	-----	-----	-----
Audio Positive	.44**	.42**	-----	-----
Audio Negative	.42**	.37**	.69**	-----

Correlations were then computed between the four affectively biased LEM indexes (calculated separately for the positive and negative slides and audio questions) and the affect scales. These correlations were all non-significant ranging from -.17 between the LEM index for negative slides and the sleepy-alert dimension of the Scales of Emotional State to .16 between the LEM index for negative audio stimuli and the tense-relaxed dimension of the Scales of Emotional State.

A second series of correlations was calculated between the four affectively-biased laterality indexes and the other laterality measures: the chimeric faces ratio and the two image location ratios (see Table 24).

Table 24

Correlations Between Affectively-Biased LEM Indexes and Other Laterality Measures

LEM Indexes	Chimeric Faces Ratio	Image Location Index-Positive	Image Location Index-Negative
Slides Positive	-.10	-.11	.25
Slides Negative	-.07	-.06	-.10
Audio Positive	-.20	.07	.12
Audio Negative	-.06	.16	.05

There were no significant correlations between the LEM indexes the image location indexes and the chimeric faces ratio.

The Relationship Between the Affect Scales

The relationship between the PANAS (positive and negative dimensions) and the four dimensions of the Russell Scales of Emotional State were also considered. The correlations between each dimension of these scales are reported in Table 25. The relationships among these variables are in the predicted directions.

Table 25

Correlation Coefficients Between the PANAS and the Scales of Emotional State

SCALES OF EMOTIONAL STATE	PANAS	
	POSITIVE AFFECT	NEGATIVE AFFECT
SLEEP-ALERT	.48**	-.19
PLEASED-ANNOYED	-.42**	.40**
DEPRESSED-EXCITED	.49**	-.49**
TENSE-RELAXED	.31**	-.43**

<u>The Relationship Between the Laterality Measures</u>

The relationship between the Chimeric Faces Task and the Image Location Task was examined by computing correlations between these two indexes (See Table 26). The correlations between these indexes were very low.

Table 26

Correlation Coefficients Between the Chimeric Faces Task and the Image Location Task

	IMAGE LOCATION TASK	
	Positive Images Laterality Ratio	Negative Images Laterality Ratio
CHIMERIC FACES RATIO	-.06	-.12

The Relationship Between the Laterality Indexes and the Affect Scores

To examine the relationship between the affect scores and the other laterality indexes, correlations were computed between the chimeric faces ratio, the image location laterality scores (separately for positive and negative images), the PANAS and the four dimensions of the Scales of Emotional State (see Table 27).

All correlations were non-significant with the exception of a positive correlation between the chimeric faces ratio and the positive affect dimension of the PANAS.

Table 27

Correlation Coefficients Between the Laterality Indexes and the Affect Scales

	Laterality Indexes		
	Chimeric Faces	Image Location Laterality-POS	Image Location Laterality-NEG
PANAS Pos Affect	.24*	.04	.01
PANAS Neg Affect	.11	-.07	.07
SLEEP-ALERT	.07	.13	-.01
PLEASED-ANNOYED	-.10	-.01	-.04
DEPRESS-EXCITED	.09	-.08	-.04
TENSE-RELAX	.01	.16	.13

DISCUSSION

This study was designed to help clarify the prominent methodological and theoretical inconsistencies in the lateral eye movement literature. The results indicate that lateral eye movement is not a cross-situationally consistent trait variable applicable to the majority of the subjects studied.

The investigation did provide supportive evidence that lateral eye movement direction is consistent within a single experimental situation. During the first situation, the majority of subjects were classified as consistent left movers using a 65 percent cutoff as a criterion for inclusion. Alternately during the second and third experimental sessions most subjects were classified as consistent right movers. However, subjects did not demonstrate consistency across the three experimental situations. When data were aggregated only six subjects were consistent right movers, ten subjects were consistent left movers and three subjects were bidirectional. Eighty-two subjects were untraited; they switched back and forth across the three situations.

These results may be interpreted three ways. First, they may indicate that lateral eye movement is not a consistent trait of the person but alternately is situationally specific. Second, lateral eye movement may be a hemispherically biased trait variable affected by situational influences and the present findings are the result of a signal to noise problem. A third interpretation is that lateral eye movement represents an ocular response dependent upon a trait dimension other than cerebral hemispheric activation and that variable's interaction with situational influences.

Ehrlichman (1984) stressed that although single-session consistency has been found, LEMs may be situationally specific:

> the fact that people have the same preferred direction of LEMs when retested in a specific room, in a specific lab, in the specific context of being subjects in psychological research, doesn't mean that the direction would be consistent in other situations. After all, even if LEMs are reflecting concurrent hemispheric activation patterns, those patterns may be specific to the affective and interpersonal context of the assessment situation (Ehrlichman, 1984, pg. 4).

Although LEMS have been shown to be affected by a number of variables, pertinent situational factors which may have affected the findings of this investigation include the visual presence versus the visual absence of the experimenter, the stress-invoking potential of the setting, and the asymmetry of the visual field.

As mentioned above, the number of individuals classified as right and left movers in the first situation differed from that in the second and third situation. More left movers were observed in the first situation and more right movers were observed in the second and third situation. As expected, the correlation computed between the LEM indexes in the second situation and the third situation was significant. Situational factors inherent in the first situation that differed in the second and third situation may account for these differences. During the first situation, the experimenter sat across from the subjects and engaged them in an informal conversation. Conversely, during the second and third situations, the experimenter was behind the subject reading the images for the subjects to visualize (second situation) and operating the tape recorder (third situation). A number of investigators have suggested that the gaze behavior of the subject is affected by the gaze behavior of the experimenter. During face-to-face conditions results may be attributable to the experimenters "own subconscious lateral gaze behavior (Kinsbourne 1971)." In his review of the literature, Ehrlichman (1984) reported that before the hemispheric asymmetry model of LEMs, gaze behavior was thought to help regulate turn-taking during conversation and was needed to reduce the distraction of the other person's face during speech planning. Goffman (1963) suggested that the eyes may communicate information about an individual's intentions and expectations in the immediate situation, including the social role he is assuming.

Gur and Gur (1979) reported that face-to-face situations were more threatening and anxiety provoking. Their research indicated that under these conditions subjects exhibited different lateral eye movement patterns than under more 'experimental' conditions.

> We conjectured that the face-to-face situation, being obviously interpersonal, may be more threatening and anxiety provoking. Under such conditions an anxious subject may tend to fall back on certain characteristic modes of response. Thus, when questioned, the subject may tend to rely on that hemisphere which is more compatible with his characteristic cognitive style, even though it might be the "wrong" hemisphere for a particular kind of problem. When the testing situation is "impersonal" (experimenter-behind-subject), less anxiety would be elicited, permitting hemispheric differentiation of response in accordance with the type of problem (Gur and Gur, 1979).

For the current experiment, it is reasonable to assume that the first situation was more anxiety provoking than the second and third situation. Conversational topics during the first situation included how subjects heard about the experiment, college courses they had taken, plans for the future, their hometown, work experience, previous research experience and career goals. The conversation was spontaneous and required the subjects to reveal facts and details about themselves. During this situation, eye movements were recorded surreptitiously and the subject was unaware that the experiment had begun (this was checked when debriefing each subject). This component of the experiment could be accurately described as ambiguous and may have been mildly anxiety provoking. The subjects were not sure what to expect nor were they aware of what was expected of them. They were revealing information about themselves to someone they had not met before. Conversely, during the second and third situation the subjects participated in very specific experimental tasks; the subjects were aware that the experiment was in progress, and they had become more familiar with the experimenter. The tasks did not require the subjects to reveal anything about themselves. The subjects knew what to expect and were merely following directions. These two situations were well defined and less anxiety provoking.[4]

A number of researchers have investigated whether or not asymmetrical stimulation affects the direction of lateral eye movement. Many studies found that visual asymmetry did not appear to affect lateral eye movement direction for normal subjects (Meskin and Singer, 1974;

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[4]It must be stated that although the results indicate that there was no correlation between LEMs and the PANAS or the Russell Inventory as trait measures of affect for any situation, an assessment of the subjects' 'state' anxiety was not conducted.

Rodin and Singer, 1976; and Schwartz et al., 1975). Ehrlichman and Weinberger (1978) reported that there was slight evidence that asymmetry in the visual field affects gaze direction and although it should be avoided it was not a major problem in LEM research prior to that time.

However some investigators have found that extreme forms of visual and body asymmetry do affect LEM direction. Baker (1989, 1990) found that extreme visual asymmetry or body asymmetry affects lateral eye movement direction. In a first experiment, Baker (1990) assessed lateral eye movement direction in a typical setting where the subject faced a blank wall. He then varied the position of the subjects by placing them closer to the right or left wall of the room so that the visual plane in front of the subject was now asymmetrical. Under these conditions, where the subject was closer to the right or left sides of the room, greater lateral eye movement was found in the direction toward the center of the wall which the subject faced. In a second experiment, Baker (198) found that body asymmetry affects the direction of lateral eye movement. In this experiment, the subjects rotated their heads 68 degrees rightward and half of the subjects rotated their heads 68 degrees leftward from the body's trunk position. As predicted, subjects who rotated their heads to the right demonstrated more leftward lateral eye movement and subjects who rotated their heads to the left demonstrated more rightward lateral eye movement.

In the present study, the first situation differed from both the second and third situation in visual and body asymmetry. The design of the first situation was informal so as to measure lateral eye movement in a naturalistic setting; although the subjects' chair was positioned in the center of the desk opposite the experimenter, their body positions could not be controlled. Since the experiment was not supposed to have begun, the subjects were not told to sit straight or look directly at the experimenter. The experimenter was positioned in the center of the subjects' view, and this was visually symmetrical in the sense that there was something on either side of the experimenter- a door to the right (subjects' left) and a blackboard to the left (subjects' right). Under these conditions of partial asymmetry, the situation may have affected LEM response. During the second and third situation the subjects faced a video camera positioned centrally in the room. Behind the camera was a white wall; the subjects were instructed to sit up and look straight ahead. The subjects' view was perfectly symmetrical.

The major goal of this study was to provide evidence that lateral eye movement is an indicator of a stable trait variable resulting from individual differences in hemispheric activation. As discussed above, LEMs were not found to be consistent and further they were not found to be related to chimeric face discrimination - the primary measure of hemisphericity used in the study. The relationship between LEMs and the image location task was perplexing. In the study by Borod et al., (1989), there was a positive correlation between subjects' scores on the chimeric faces task and the image location task. The authors suggested that this relationship indicated that "the more a subject perceived emotional chimeric faces as intense in one hemispace, the more likely the subject was to locate emotional images in the same side of space (Borod et al., 1989, pg.108). In the present investigation, there was an absence of a relationship between the chimeric faces task and the image location task. However, there was a significant left-sided bias for left movers, right movers, and bidirectionals on the chimeric faces task for each situation separately and for aggregated data. In the present study, the left mover group demonstrated a right lateralized bias for each situation on the image location task for negative images. When further split by sex, both male and female left movers demonstrated a significant right-sided bias on this task. Male left movers also demonstrated a significant right-sided bias on the image location task for positive images during the informal situation. For the aggregated data, the left movers also demonstrated a significant right-lateralized bias and were significantly different than the right movers on the image location task for positive images. Hence, the only significant bias that the groups demonstrated on the image location task was in the opposing direction of the chimeric faces task. This finding is contrary to that which would be expected if both tasks reflected the same underlying hemispheric processes.

Two questions can be asked about these results. Does consistent lateral eye movement accurately reflect consistent hemispheric activation? Is the concept of individual differences in consistent hemispheric activation valid? Since the latter question is a more fundamental issue, it will be discussed first.

According to Beaumont (1983), the notion of hemisphericity has been in existence for close to a century. He reports that although different authors use it differently, "it generally indicates the idea that each individual may tend to rely on a preferred mode of cognitive processing which in turn implies the predominant activity of either the left or right cerebral hemispheres (Beaumont, 1983, pg 214)." The simplicity of the dual hemispheric model is attractive and coincides with other dualistic conceptions about humans and their mental processes, i.e., the Yin and Yang, the primary and secondary processes of Freud (Bakan, 1971). However, the simplicity and attractiveness of a model are not evidence of validity.

Beaumont (1983) reported that over the last twenty years, evidence for the hemispheric model has been from four sources: lateral eye movements, electrophysiological measures, questionnaires and cognitive tests. In his review of the studies employing these methods, Beaumont (1983) argued that none have provided consistent evidence for the hemispheric model and therefore are not reliable and valid indexes for it. As a result, he concludes that the whole concept of hemisphericity is unfounded and misleading. Although neuropsychological research had identified a number of important asymmetries within the nervous system... "the cerebral hemispheres remain parts of a single neural system inextricably bound into the lower undivided levels of the nervous system (Beaumont, 1983, pg 222)".

Other investigators have provided both physiological and psychological evidence to support the existence of both baseline measures of asymmetric arousal and asymmetries as a result of task performance. For example, Morgan, McDonald, and McDonald (1971) report a test-retest correlation of .89 on baseline EEG arousal asymmetries. Similarly, Ehrlichman and Wiener report a baseline EEG reliability coefficient of .74 for asymmetrical arousal. They also reported a test-retest reliability coefficient of .88 for the difference in arousal asymmetries during task performance.

In a number of studies, Levy and others (Levy, Heller, Banich, & Burton, 1983a, 1983b) have demonstrated consistent asymmetric perception on the perceptual task of viewing chimeric faces. They propose that their findings support the theory that

> the perceptual asymmetry shown by an individual subject results, then, from the joint effects of hemispheric specialization itself and subject's characteristic pattern of asymmetric arousal.......the group-typical asymmetry for right handers was indicative of hemispheric specialization, whereas most of the diversities among individual right-handed subjects were due to individual differences in characteristic asymmetries of hemispheric arousal (Levy, et. al., 1983b, pg. 407).

Even if the theory of asymmetrical hemispheric activation is valid, the claim that lateral eye movement is a valid and reliable index of this asymmetry is still in question. The results of the present study do not support the relationship between LEMs and asymmetric hemispheric activation. In the most comprehensive reviews of the lateral eye movement literature to date (Ehrlichman and Weinberger, 1978 and Ehrlichman, 1984) the status of lateral eye movement as a hemisphericity index was also reported to be suspect. The authors noted that the relationships documented between personality, cognitive and stylistic variables and lateral eye movement were not consistent with that which would be expected by the hemisphericity model. Those that were consistent with the model were not replicable. Other relationships have been found between vertical eye movements and various psychological factors unexplainable by the hemispheric model (Ehrlichman and Weinberger, 1978).

Some of the earlier basic tenets of the relationship between lateral eye movement and hemisphericity have been found not to be true. According to Bakan (1971), in Day's first discussions of the cerebral activation model, he posited that there are an equal number of left and right movers in the general population and that on average a person makes about 75 percent of his lateral eye movements in one direction; the resulting frequency distribution of people by predominant direction of eye gaze is bimodal. The present study confirms that although consistency is found in single session experiments, it cannot be inferred across situations which is presumed in a hemispheric model of lateral eye movement. Many investigations, including the present one, did not find this bimodal distribution but rather one that is multi-modal (Ehrlichman and Weinberger, 1978; Libby and Yakelvich, 1973).

Although the results of the present study do not support the hemisphericity model of lateral eye movement, this does not suggest that LEMs are not related to a consistent aspect of the individual. Another interpretation of the present findings and of lateral eye movement, in general, is that this ocular response is one of many which reflect various underlying personality dimensions interacting with situational factors. These personality dimensions or other factors may be independent of hemisphericity.

Libby and Yaklevich (1973) found that ocular responses were related to different personality dimensions. Specifically, they reported that subjects high on the nurturance dimension of the Edwards Personality Preference Schedule maintained eye contact with an interviewer more than individuals low on this dimension. Subject's high on the personality dimension of abasement looked more often to the left than individuals low on this dimension during a face-to-face interaction. In a post hoc analysis of their data, Libby and Yaklevich (1973) attempted to discern whether the relationship between abasement and lateral eye movement could be explained by the cerebral model of hemispheric activation or situational variance. The authors found that their findings did not support a cerebral activation model. "The post hoc analyses, while not definitive, obviously favor a situationally determined interpretation of the data over the hypothesis that looking direction is determined by cerebral dominance (Libby and Yakelvich 1973, pg 203)." The authors concluded that the door in the experiment interacted with the personality dimension of abasement to draw the subjects orientation to the left. Specifically, under certain conditions (those characterized as anxiety provoking) subjects classified as high on feelings of abasement, may wish to leave or escape. The door to the subjects' left provided such an opportunity.

> When a person experiences shame or embarrassment his primary desire is to conceal himself or disappear. In the present study the only door to the small therapy room used for the experiment was directly on the subject's left. Any thought the subject may have had about disappearing or escaping were inevitably concerned with that door. (Libby & Yakelvich 1973, pg 204)."

The similarities between the experimental setting of the Libby and Yakelvich (1973) study and the first experimental session are striking. Both sessions were face-to-face interview situations, both asked potentially embarrassing questions and both provided a door to the subjects left. Perhaps the high degree of left looking in both sessions may be due at least in part to these factors.

This study did not entirely support a relationship between the subject's lateral eye movement and trait affect. It must be stressed that many of the correlational studies of LEMs with other variables-even those variables proported to be hemispherically biased have not been found (Ehrlichman & Weinberger 1978; Ehrlichman, 1984). Most of the present findings are consistent with the studies cited in the introduction which failed to demonstrate a relationship between affect and lateral eye movement. Hatta (1984) investigated the relationship between LEMs, emotion and right hemispheric involvement. He tested whether subjects would demonstrate more left LEMs in response to an emotional task and was unable to find support for his hypotheses. Hatta (1984) also investigated the relationship between positive and negative emotion and differential cerebral activation. He tested whether a positive affective task and a negative affective task would elicit right and left LEMs respectively but again could not find evidence for a relationship.

Alternately, there have been a number of investigations which support the relationship between LEMs and affect. Although far from conclusive, the single finding that appears to have the most support in the literature on affect and LEM is the relationship between negative affect, the right hemisphere and left LEMs (Schwartz, et. al., 1975; Tucker et. al., 1977; Borod et. al., 1988; Montgomery and Jones, 1984; Waldman, 1987). Waldman's study is of particular interest in light of the results of the first situation of the present investigation. Waldman found a relationship between left LEMs and negative and positive affect in a face-to-face situation, part of which was an informal conversation. As mentioned above, the informal conversation situation of the present investigation was probably the most anxiety provoking as it was ambiguous and the subjects were asked questions about themselves.

Interestingly, it was during this informal situation, that the subjects demonstrated the greatest percentage of left eye movement.

What accounts for the inconsistency in the findings of studies seeking to unravel the relationship between affect and lateral eye movement? Ehrlichman (1984) reported that a major problem with the correlational research was that findings failed to replicate. Schwartz, Davidson, and Maer (1975) found a relationship between left LEMs and emotion. Specifically, the authors reported fewer right LEMs in response to emotional questions than in response to non-emotional questions and more left LEMs in response to emotional than in response to non-emotional questions. Both findings were significant and these results are frequently cited in the literature as supportive of a relationship between the right hemisphere, left LEMs and emotionality. However, in a number of experiments, McDonald and Hiscock (1984, 1992) attempted to replicate and clarify Schwartz et al.,'s results, but failed to do so. In their first attempt, McDonald and Hiscock (1984) reported that although Schwartz et al., found a relationship between affect and right hemispheric activation, it was not clear whether the anxiety arousing questions used actually altered the subject's affective state. Therefore, they compared subject's LEM response to anxiety-producing questions and a direct anxiety manipulation. Their results failed to support the earlier findings. In a second experiment, McDonald and Hiscock (1992) tried to replicate Schwartz et al.,'s results, by duplicating their procedures identically. Again, they found neither the emotion nor cognitive content of Schwartz et al.,'s original questions altered the direction of LEMs. In a third experiment, McDonald and Hiscock (1992) tried to obtain Schwartz et al.,'s findings using the original questions but recording LEMs with electro-oculography (EOG). Again they found neither the emotion nor the content of the questions altered LEM direction. The authors concluded that although Schwartz et al.,'s questions did not elicit high levels of emotion, the problem in duplicating the desired results appeared to be due to the dependent measure of LEM direction.

The lack of a relationship found between affect and LEMs is not surprising since it is premised on the foundation that a relationship exists between hemisphericity and both lateral eye movement and affect. The relationship between hemisphericity and lateral eye movement was not found in the present study and may be considered, at best, tentative. The dynamics of the cerebral role in affective functioning is equally complex.

As mentioned in the introduction, the role of the right and left hemispheres in affective functioning is a topic of extensive research and controversy. Whether positive and negative affect is housed in one or opposing hemispheres is controversial and was certainly not clarified by the findings of the present study. Recent studies indicate that emotion may not be isolated in either hemisphere but alternately may involve a complex interaction of both. To further complicate matters, different aspects of emotion (emotional expression and perception) may be associated with differential hemispheric and intrahemispheric activation (Davidson and Fox, 1988; Ehrlichman, 1987).

In a number of experiments, Davidson and others (Davidson et al., 1979; Davidson and Fox, 1982; Fox and Davidson 1986; Davidson et al., 1987; Fox and Davidson, 1987; Tomarken and Davidson 1992; Davidson and Fox 1988) consistently demonstrated that differences in right and left frontal cerebral activity were related to individuals' expression of positive and negative affect. Specifically, right frontal hemispheric activation was related to negative affective responses and left frontal hemispheric activity was related to positive affective responses. These results contradict the findings cited earlier demonstrating the relationship between the right hemisphere and all affective functioning, but do coincide with the relationship for females between positive affect and left LEMs in the present study.

In two separate studies Tomarken and Davidson (1988) and Davidson and Fox (1988) demonstrated that resting left and right frontal asymmetries related to future expression of positive and negative affect in children and adults. In a recent study, Tomarken et al. (1992) provided supportive evidence for a relationship between resting hemispheric activation and baseline measures of affect or 'trait' affect measures. Specifically, the authors found that individuals characterized by a stable pattern of increased left anterior activation as opposed to increased right anterior activation reported that in general they experience greater PA and lesser NA on the PANAS.

In the present study, female subjects grouped as bidirectional or right movers during the audio situation demonstrated significantly higher scores on the Tense-Relaxed dimension of the Scales of Emotional State than female left movers. Similarly, female bidirectional subjects demonstrated significantly higher scores on the Tense-Relaxed dimension than female left mover subjects during the slide situation. In addition, a significant positive correlation was found between the LEM index computed for the audio situation and the Tense-Relaxed dimension of the Scales of Emotional State. This finding supports Davidson's and other's notion that the left hemisphere is associated with positive affect. However, this single supportive finding must be viewed with caution since the other findings reported here do not support such a relationship.

The recent theoretical formulation of Heller (1993) provides a more comprehensive view of the neural patterns characteristic of various emotional states and traits. She has collected evidence to support the idea that individual differences in affect are determined by two distinct neural systems: the frontal lobes and the right parietotemporal regions. In this theory, the right parietotemporal regions are not only specialized for the processing of emotion but are involved in the modulation of autonomic arousal and therefore play a more fundamental role in the experience of affect. The frontal lobes are involved in the modulation of emotional valence. The interaction of these two neural systems is responsible for the entire experience of emotion. She further suggests that the two-dimensional structure of affect established by Russell and others of valence and arousal can be explained in terms of these two neural substrates. For example, happiness can be described as the result of increased right parietotemporal activity and relatively high left frontal activation. Fundamental to Heller's (1993) theory is that while the processing of emotion is dependent on hard-wired specialized processes with the right posterior hemisphere, the experience of emotion is a dynamic phenomenon associated with changeable patterns of regional brain activity.

The results of this investigation suggest that lateral eye movement as a trait variable indicative of differential hemispheric activation is undoubtedly oversimplified.

Consistent with Ehrlichman and Weinberger's (1978) and Ehrlichman's (1984) reviews of the literature, the results of this study indicate that the use of lateral eye movement as a hemispheric index is suspect and could be misleading. The relationship between lateral eye movement and trait affect is equally suspect. The use of lateral eye movement to validate other putative indicators of hemisphericity is also unwarranted at this time.

These conclusions are significant given the number of studies that have used and continue to use lateral eye movement as an index of hemispheric laterality. Introductory psychology textbooks have reported that LEMs are indexes of hemisphericity and can be used to identify a person's threshold for experiencing emotion. In a recent introductory textbook in psychology, Davidson (1991) included an activity for students to assess hemisphericity. He listed a series of ten questions used in the Schwartz et al., (1975) study. The following directions were included:

> If on seven or more of the questions you move your eyes to the same direction, you can infer that you are showing more activation on one side of your brain. Remember that this test is valid only for right-handed individuals. People who are left-handed have a more complicated pattern of hemispheric specialization and, without additional testing, it is not possible to unambiguously interpret their eye movement responses.

In second text, Burger (1993) cites research which states that LEMs are indexes of lateralized hemispheric activity and are related to the experience of negative and positive emotion.

> Although not nearly as reliable as EEG data, research suggests that right- handed people who typically glance to the left when engaged in reflective thought are likely to show a higher level of right hemisphere activation when resting. Those who tend to glance to the right are more likely to be higher in left hemispheric activity (Davidson, 1991; Gur & Reivich, 1980). Of course, many other variables affect emotion, but this observation suggests that those who glance to the left may have a lower threshold for experiencing negative emotion while those who look to the right are more likely to experience positive feelings (Burger, 1993, pg 292).

Lateral eye movement is a complicated phenomenon affected by both cerebral activity and situational influences. A fresh look at lateral eye movement and other ocular responses is necessary. Investigations of lateral eye movement and its interactions with other personality and situational factors may be productive.

APPENDIX

CONSENT FORM

Project Title: Styles of Information Processing

Investigator: Dr. E. Katkin

You are asked to be a volunteer in a research study.

The purpose of this research is to study how people process different types of information.

Procedures: If you decide to be in the study, your part will involve:
a) Watching a series of words presented on slides and saying three words that this word makes you think of.
b) Answering questions presented on an audiotape.
c) Making judgments about faces.
d) Generating and reporting on mental images.
e) Completing some short questionnaires.
Your responses to the slide presentation and the audiotape will be videotaped.
Benefits: The benefits of being in this study is that you will receive seven dollars. If you leave the study before finishing, you will be able to keep the money. By being in the study, you will be helping us understand how people process different types of information.
Risks/Discomforts: There is no risk involved with being in this study.

Confidentiality: Any information that we get about you, including your identity, will not be revealed in any report on the results we get from the study.
****

-You do not have to be in this study if you do not want to be.
-You have the right to leave the study at any time without giving a reason and without penalty.
-You have the right to request that your videotape be erased.
-If you have any questions about the study, you may contact
Dr. E. Katkin, at 516-632-7805.
-If you have any questions about your rights as a research subject, you may contact Dr. Robert Schneider, Committee on Research Involving Human Subjects, 516-632-6960.
-Any new information that may make you change your mind about being in this study will be given to you.
-You will get a copy of this consent form to keep.
-If you sign below, it means that you have read (or have had read to you) and have understood all of the information given in this consent form, and you would like to be a volunteer in this study.

____
Subject Name

____
Signature Date

____
Investigator Date

Free Association Stimuli-(Slide Task, Situation 2)

Words high in emotional intensity, pleasantness and goodness.

1. Baby
2. Happy
3. Friendly
4. Music
5. Kiss
6. Beautiful
7. Family
8. Kind
9. Heart
10. Bride

Words high in emotional intensity, unpleasantness and badness.

1. Fear
2. Hate
3. Disgusting
4. Grief
5. Despise
6. Sin
7. Wicked
8. Evil
9. Anger
10. Depressed

<u>Experimental Questions</u> (Audio Task, Situation 3)

1. What is the primary difference between pleasure and fun?
2. Picture and describe a situation in which you experienced extreme dislike.
3. Visualize you face. What part of your face is the most expressive of sadness.
4. Picture and describe a situation in which you felt truly happy?
5. Tell me how you feel when you are relaxed and contented.
6. What is the primary difference between depressed and sad.
7. Picture and describe the last situation in which you felt extreme sorrow.
8. Tell me how you feel when you experience achievement.
9. Visualize you face. What part of your face is the most expressive of happiness.
10. Make up a sentence using the words miserable and depression.
11. Picture and describe the most disgusting scene from the most distressing movie you have ever seen.
12. What is the fundamental meaning of the word joy.
13. Make up a sentence with the words surprise and cheerful.
14. Tell me how you feel when you are frustrated.
15. Visualize your face. What part of your face is the most expressive of fear.
16. Picture and describe the nicest scene from the most beautiful movie you have ever seen.
17. Picture and describe the last situation in which you laughed.
18. What is the primary difference between guilt and shame.
19. Tell me how you feel when you are anxious.
20. Visualize you face. What part of your face is the most expressive of enthusiasm.

THE "WHICH STRANGE FACE LOOKS HAPPIER?" TEST

INSTRUCTIONS

Each page of the booklet shows two strange-looking faces, one face at the TOP of the page, one face at the BOTTOM of the page. Your task is to look at the pair of faces and decide which one looks happier to you. There are no right or wrong answers.

Do not try to analyze the faces. Just look at them quickly and get a general impression as to which one looks happier. If you have a difficult time deciding, it may help to squint your eyes.

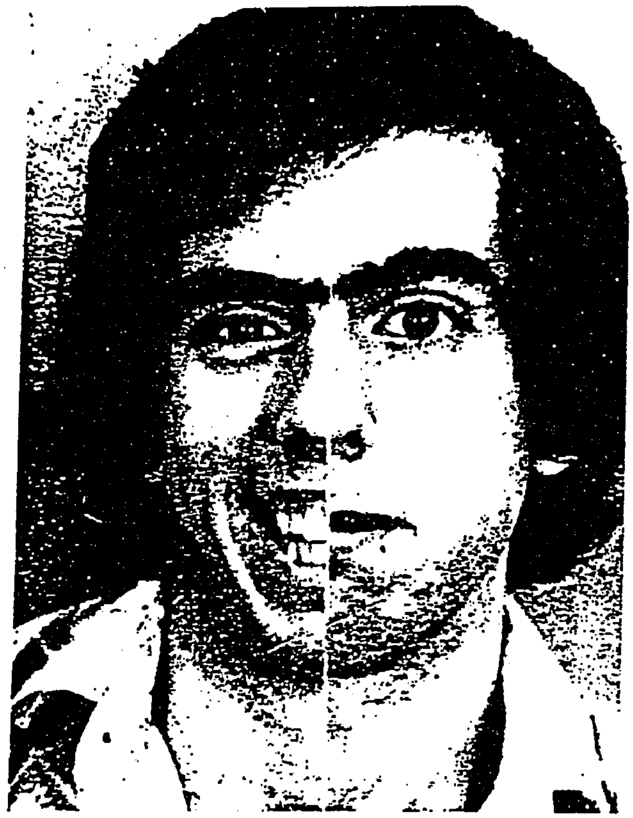
On your answer sheet, there are 3 spaces for each pair of faces on a page, with the words TOP, EQUAL and BOTTOM written in the left-hand margin.

If the TOP face looks happier than the bottom face, check the space next to the word TOP. If the BOTTOM face looks happier than the top face, check the space next to the word BOTTOM. If it is impossible for you to decide which face looks happier, check the space next to the word EQUAL, but only check the space next to EQUAL if the two faces look exactly equally happy.

Once you mark your answer for a pair of faces, go on to the next page. Do not turn back, and do not let your judgements be affected by your memory of previous judgements you made. Judge each pair as well as you can, using your overall impression as to which face looks happier.

1

TOP



Bottom

IMAGE LOCATION TASK

POSITIVE IMAGES

VISUAL

1. Imagine seeing a brilliant red sunset over the ocean.

2. Imagine seeing a bright meadow filled with flowers.

AUDITORY

1. Imagine hearing a babbling brook flowing over pebbles.

2. Imagine hearing a baby giggling while being tickled.

TACTILE

1. Imagine the feeling of cuddling in the winter with a furry blanket.

2. Imagine the feeling of floating on the ocean on a warm sunny day.

NEGATIVE IMAGES

VISUAL

1. Imagine seeing a bloody face that's been disfigured.

2. Imagine seeing a fire burning through your house.

AUDITORY

1. Imagine hearing someone screaming rape in Central park.

2. Imagine hearing the screeching siren of an approaching ambulance.

TACTILE

1. Imagine the feeling of a throbbing pain from a toothache.

2. Imagine the feeling of running your fingers down a blackboard.

HOW YOU FEEL MOST OF THE TIME

Please describe how you feel most of the time by placing a line through each of the following scales. Use the first scale as a guide, but feel free to place your marks anywhere along the lines.

very — somewhat — in between — somewhat — very

sleepy ________________________________ alert

pleased ________________________________ annoyed

depressed ________________________________ excited

tense ________________________________ relaxed

The PANAS

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you generally feel this way, that is, how you feel on the average. Use the following scale to record your answers.

1	2	3	4	5
very slightly or not at all	a little	moderately	quite a bit	extremely

______ interested	______ irritable
______ distressed	______ alert
______ excited	______ ashamed
______ upset	______ inspired
______ strong	______ nervous
______ guilty	______ determined
______ scared	______ attentive
______ hostile	______ jittery
______ enthusiastic	______ active
______ proud	______ afraid

SUBJECT CODE ________________ SEX ________________

We would also appreciate your filling out this brief questionnaire about handedness. Thank you.

Which hand do you use when:	RIGHT HAND	LEFT HAND	EITHER HAND
WRITING	______	______	______
THROWING A BALL	______	______	______
BRUSHING TEETH	______	______	______
EATING WITH A SPOON	______	______	______
DRAWING	______	______	______
PLAYING A GAME WITH A RACQUET	______	______	______
HOLDING A MATCH WHILE STRIKING IT	______	______	______
DEALING CARDS	______	______	______
HAMMERING	______	______	______
USING A SCREWDRIVER	______	______	______
COMBING HAIR	______	______	______
CUTTING WITH A SCISSORS	______	______	______

Please indicate which hand each of these members of your family writes (or wrote) with:

MOTHER____	BROTHER 1____	SISTER 1____	DAUGHTER 1____	SON 1____
FATHER____	BROTHER 2____	SISTER 2____	DAUGHTER 1____	SON 2____
	BROTHER 3____	SISTER 3____	DAUGHTER 3____	SON 3____
	BROTHER 4____	SISTER 4____	DAUGHTER 4____	SON 4____

Which eye do you use to look through a telescope? ______ ______ ______

right eye left eye either

When you clasp your hands together, which thumb is on top? ______ ______

R thumb L thumb

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