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The Development and Standardization of a Reflective Eye Movement Questionnaire

Barbara Ann Arneson

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THE DEVELOPMENT AND STANDARDIZATION OF A REFLECTIVE
EYE MOVEMENT QUESTIONNAIRE

by

Barbara Ann Arneson

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Submitted to the Graduate Faculty

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in partial fulfillment of the requirements

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1977

This thesis submitted by Barbara Ann Arneson in partial fulfillment of the requirements for the Degree of Master of Arts from the University of North Dakota is hereby approved by the Faculty Advisory Committee under whom the work has been done.

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MOVEMENT QUESTIONNAIRE

Department Psychology

Degree Master of Arts

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ABSTRACT

Researchers have reported that when people are asked a question requiring reflection, they frequently look briefly to one side or the other before answering. The direction of this reflective eye movement has been shown to be a reliable individual characteristic and has been related to various physiological, intellectual, and personality characteristics. Recent reflective eye movement research has focused more specifically on the relationship between gaze shift directionality and cerebral hemispheric functioning. Results of these studies suggest that direction of eye movements is related to the cognitive content of the reflective questions. However, inconsistencies seem to exist between what the various researchers suggest to be the nature of this relationship. After reviewing the findings of these studies, it was apparent that considerable differences in methodological approaches and interpretations of results could account for these inconsistencies. Therefore, the purpose of the present research was to develop a standardized reflective eye movement questionnaire and procedure for its administration which would provide a set of questions that would reliably elicit lateral eye movements (left, right), and non-lateral eye movements (up, down, stare).

In Experiment I, 27 female and 24 male right-handed subjects were individually administered a 125 item questionnaire by one of six trained interviewers. The questionnaire consisted of representative

items from each of 18 subcategories of question types and was developed from both original items as well as items utilized in other reflective eye movement research. During the face-to-face interview, the interviewer recorded the subject's initial eye movement response following the completion of each question. Valid eye movements were scored diagrammatically as either lateral or as non-lateral. On the basis of the individual responses per question, the results of this experiment indicated that only questions eliciting lateral movements met the selection criteria for inclusion in the final questionnaire. The category distribution of the 22 items selected as strong left or right movement questions did not support the assumption that functional differences in the hemispheres would be reflected in the direction of eye movements elicited by a particular question type. Consequently, the value of these sets of items as an instrument for assessing reflective eye movements was questioned.

Experiment II was designed to assess the reliability of the 11 right movement items and the 11 left movement items selected in Experiment I. Utilizing the same procedures as in the previous experiment, 15 male and 15 female right-handed subjects were administered the 22 item questionnaire. The results indicated a very low correlation between the directions of gaze shifts produced by the questions in the previous experiment and those produced by the same questions in this experiment. Consequently, these findings raise considerable doubt as to the reliability of the eye movement phenomenon itself as well as to its usefulness as a tool for indicating differential hemispheric functioning were substantiated.

Possible explanations for the findings of these two studies were discussed.

INTRODUCTION AND REVIEW OF THE LITERATURE

When people are asked a question requiring reflection, they frequently look briefly to one side or the other before answering. This phenomenon, often referred to as lateral eye movement or reflective eye movement, was first reported by Teitlebaum (1954) and since that time has been investigated basically along two lines of research. One research focus has emphasized the delineation of relationships between reflective eye movements and numerous physiological, intellectual, and personality characteristics of the individual and is based on the assumption that eye movement directionality is consistent for a given individual. The second line of research has focused more specifically on the variables that seem to account for reflective eye movements such as type of question used to elicit movements and various situational variables that seem to interact with the phenomenon.

While the present study emerged as a result of dissatisfaction with the procedures and results reported primarily in the research of the second focus, an overview of the literature of both lines of research, with an emphasis on the latter, is presented in order to provide a broader perspective of the reflective eye movement research as a whole.

Reflective Eye Movements and Characteristics of the Individual

Teitlebaum reported in a 1954 article that there appeared to be a relationship between eye movements and mental concentration in a group

of patients undergoing psychotherapy. He found that a greater number of rhythmic eye movements occur when an individual is engaged in deep mental concentration (i.e., "lost in thought") than when he is not. Based on these observations, Teitlebaum suggested that eye movements have potential as an objective indication of mental concentration. This idea was reintroduced into psychological literature by Day (1964). Based primarily on his clinical observations of psychiatric patients, Day noted that when an individual is seated directly across from the questioner, he will typically break eye contact with the questioner and make a lateral eye movement after he has been asked a question requiring reflection. Day noted that the direction of movement, either right or left, was fairly consistent for an individual. Duke (1968) experimentally confirmed this consistency by demonstrating that within a single testing session, the direction of reflective eye movements was a relatively reliable characteristic of the individual. Thus it became possible to classify individuals as "left-movers" or "right-movers" on the basis of the direction of the majority of eye movements that a subject made prior to responding to a series of reflective questions.

Day (1964, 1967a, 1967b, 1968) suggested that the characteristic direction of eye movement for a given individual has a variety of psychological and physiological correlates, such as quality of language usage, expression of anxiety, brain wave patterns and response to psychotherapy. Within the dimensions of personality, for example, Day (1967a) described left-movers as passive individuals who tend to focus attention on internal, subjective experiences, and right-movers as more active individuals who tend to focus their attention on more external, objective stimuli.

Bakan (1969) explored these characterizations further by examining their possible relationship with hypnotic susceptibility. He proposed that Day's description of the internalized, subjective orientation of the left-mover paralleled descriptions of a "good" hypnotic subject. To test this proposal he administered the Harvard Group Hypnotic Susceptibility Scale to a group of right-movers and to a group of left-movers, and, as predicted, he found that left-movers were more susceptible to hypnosis than were right-movers.

. This relationship between personality characteristics, hypnotic susceptibility, and characteristic direction of eye movements for an individual was examined further in a study by Gur and Reyher (1973). Utilizing three hypnotic susceptibility scales (the Harvard Group Scale, and two scales--the Right Induction Scale and the Left Induction Scale--constructed to take into account the differential personality characteristics of right-lookers and left lookers, respectively), these authors found that eye movement directionality is an influential factor only when considered with respect to susceptibility scales specifically designed for that purpose. More specifically, these authors failed to replicate Bakan's findings of a significant difference between right and left lookers on the Harvard Scale. However, when the personality characteristics of right lookers and left lookers were considered in the design of the hypnotic susceptibility measures, Gur and Reyher's findings supported Bakan's contention that eye movement directionality and hypnotic susceptibility are related.

In addition to the personality difference between right- and left-movers, physiological differences have also been explored. In a

primarily descriptive study, Day (1967b) found that the Electroencephalographic (EEG) records of left-movers showed greater amplitude and lower frequency in general electrical activity than right-movers. Bakan and Svorad (1969) examined the relationship between amount of resting EEG alpha activity and direction of reflective eye movements and found that left-movers produced more alpha activity than right-movers. Furthermore, hypnotizability scores were obtained for these subjects and were correlated both with amount of alpha production and with eye movement directionality. Results indicated a relationship between these three indices such that left movers produced more EEG alpha activity and were more susceptible to hypnosis than were right movers. These findings are consistent with earlier research implicating a relationship between eye movement directionality and hypnotic susceptibility (Bakan, 1969).

Numerous other differences between right-movers and left-movers have been studied and include the following distinctions: (a) individuals who look consistently to the left when asked to respond to a number of reflective questions tend to major in the humanities and classics, while consistent right-movers tend to choose majors in the sciences and quantitative areas (Bakan, 1969); (b) right-movers tend to have higher quantitative scores on the Scholastic Aptitude Test (SAT) and left-movers tend to have higher verbal scores (Bakan, 1969); (c) on a task of visual attention (Stroop Color-Word Interference Test) right-movers are subject to significantly less interference than left-movers (Bakan and Shotland, 1969); (d) left-movers use more imagery, are more artistically diverse, and are more creative than right-movers (Harnad, 1972); (e) left-movers

tend to be more extreme in their reaction to persuasion in either a pro or a con direction, while right-movers are associated with more moderate responses (Sherrod, 1972); (f) left-movers score significantly higher on the humanistic index of the Tompkins Polarity Scale (Ashton and Dwyer, 1975); and (g) left-movers and females are relatively more responsive to facial cues, whereas right-movers and males are relatively more responsive to verbal cues (Crouch, 1976).

In an attempt to explain the numerous differences between individuals designated as right-movers or left-movers, Bakan (1969, 1971) has suggested that the lateral eye movement phenomenon is "symptomatic of easier triggering of activities in the hemisphere contralateral to the direction of the eye movement" (Bakan, 1969, p. 930). In other words, consistent right-movers depend on the left hemisphere, while the right hemisphere is more important for left-movers. Bakan indicated that the implications of this differential dependence on one or the other hemisphere is related to the functional differences or asymmetries that have been shown to exist between them. A variety of clinical and experimental evidence has shown that the hemispheres in man's brain are specialized for different cognitive functions. Studies of individuals with brain damage (Bento, 1962; Bogen, 1969; Gazzaniga, 1970; Hecaen, 1962; Wada and Rasmussen, 1960) and research with normal, non-brain damaged individuals using tachistoscopic and dichotic listening techniques (Kimura, 1966, 1967; White, 1969) suggest that the two cerebral hemispheres of the human brain serve different functions, the left hemisphere serving verbal and mathematical functioning and the right hemisphere serving spatial and musical functioning.

In view of the literature on hemispheric specialization and Bakan's suggestion that lateral eye movement is an index of an individual's relative dependence on a particular cerebral hemisphere, Weiten and Etaugh (1973) examined the differences between right- and left-movers on a number of tasks that were related to hemispheric specialization. As predicted, they found that right-movers had greater verbal analytical skills, lesser perceptual-motor skills, better quantitative scores on the SAT and were more likely to major in scientific or quantitative fields in college than left-movers.

While the bulk of the eye movement research seems to render fairly consistent support both to Day's and Bakan's observations, there are also a number of studies which report results that are inconsistent with these authors' findings. For example, Etaugh (1972) investigated relationships between lateral eye movements, handedness, and personality characteristics. She reported significant correlations between direction of eye movement and a number of personality factors, but not in the manner expected by the earlier research of Day or Bakan. Etaugh found that left-movers, contrary to Day's (1967a) observations of left-movers as less assertive and more highly focused on inner, emotional states than right-movers. While several explanations were offered for these discrepancies, the one with perhaps the greatest implication for future research was Etaugh's questioning of the reliability of the phenomenon itself. While she supported the idea that the phenomenon is consistent for a given individual in a single session, she questioned whether the phenomenon was consistent for a given individual across sessions (i.e., test-retest reliability).

Soon after the appearance of Etaugh's (1972) article, Bakan and Strayer (1972) addressed the problems of the reliability of lateral eye movement and reported a fairly high test-retest reliability ($r=.78$) for their subjects. Similarly, Etaugh and Rose (1972) reported moderate consistency ($r=.55$) of the eye movement phenomenon over at least short intervals of time. Together, these two studies provide marginal support for the consistency of reflective eye movement direction over time for a given individual.

Templer, Goldstein, and Penick (1972) also approached the issue of test-retest reliability of lateral eye movements, but, unlike the results of either Bakan and Strayer or Etaugh and Rose, they found a lack of stability of eye movement direction for a given individual across time. This lack of consistency generated doubts similar to those raised by Etaugh (1972) concerning the relationship which might exist between the phenomenon and stable characteristics of the individual. In addition to the low test-retest reliability, Templer et al. also reported low inter-rater reliability among judges who attempted to rate eye movements, particularly in instances in which they were rating movements with minimal lateral components to directionality. Consequently, they asserted that the reliability of the judgment of observers within and between the different lateral eye movement studies is questionable and to alleviate this possible source of error in future research, the eye movement phenomenon should be explored under well-specified and standardized conditions.

In summary, researchers have discovered that when people are asked a question requiring reflection, they frequently look briefly to

one side or the other before answering. The direction of this lateral eye movement has been reported to be a reliable individual characteristic and has been related to a variety of personality physiological and cognitive measures. Left movers tend to focus attention on internal, subjective experiences while right movers tend to focus attention on more external, objective stimuli. Furthermore, left movers tend to produce more EEG alpha activity and are more susceptible to hypnosis than right movers. Finally, left movers tend to have lower quantitative scores on the SAT than right movers. Bakan (1969, 1971) has interpreted these differences as reflecting differential dependence on the cerebral hemisphere contralateral to the characteristic direction of gaze shift for a given individual.

Reflective Eye Movements and the Variables that
Affect Them

Bakan's (1969) speculation that eye movement directionality is an indication of cerebral hemispheric activation contralateral to the direction of the eye movement provided a basis for the investigation of perhaps one of the most important variables influencing the eye movement phenomenon--the type of reflective question used to elicit the movement. That is, since the cognitive activity in which a person is engaged may differentially influence direction of eye movements (as suggested by Bakan), and since certain questions differ in cognitive demand (and, thus, in their ability to differentially engage the hemispheres), the importance of examining the relationship between direction of eye movement and type of questions used to elicit the movements was recognized.

The effect of kind of reflective questions used to evoke eye movements had not been investigated adequately in any of the studies mentioned in the section above, but a number of more recent studies have focused on this effect and have provided support for the existence of a relationship between eye movement directionality and the processing of differing kinds of questions. Kocel, Galin, Ornstein, and Merrin (1972) "suspected" that the type of question might be an important variable in view of evidence indicating differential specialization of the cerebral hemispheres for different cognitive functions (summarized in Kocel et al., 1972). To test this "suspicion" they designed 20 questions that were expected to engage primarily the left hemisphere (verbal, mathematical) and 20 questions expected to activate primarily the right hemisphere (spatial, musical). The authors presented these questions in blocks (to enhance their cognitive demand characteristics) to each of 29 subjects and recorded eye movements on videotape equipment. The first eye movement following each question was judged for its lateral component. Their results indicated that while both types of questions were equally effective in evoking lateral eye movements, subjects made a significantly higher percentage of right lateral eye movements in response to the "left hemisphere" questions (verbal and mathematical) than in response to "right hemisphere" questions (spatial and musical), indicating a significant effect of the cognitive demand characteristics of their questions on eye movement directionality. They also evaluated the distribution of direction of eye movements for each subject across the combined sets of questions to test the hypothesis that individuals tend to shift either predominantly right or left, and confirmed that

the lateral eye movement directionality is a reliable characteristic for at least some individuals. However, they noted that an individual's tendency to move his eyes in one direction is strongly modified by the cognitive demands of the questions.

In accordance with Kocel et al. (1972), Kinsbourne (1972) confirmed a relationship between the processing of different kinds of questions and direction of lateral eye movement. He presented to each of 20 right-handed and 20 left-handed subjects three sets of questions: 20 verbal (scales 1 to 3 of Proverbs Test), 20 numerical (simple calculations and problems based on quantitative ability section of the Medical College Admissions Test Study Book and the Graduate Record Examination Study Book) and 20 spatial (requiring subjects to visualize and specify spatial relationships of familiar local landmarks and visual arrangements). Eye movements were recorded on a video recorder and the first gaze shift and the first head movement after the completion of each question were judged for direction (up, down, left, right). It was found that for right-handed subjects, horizontal eye and head movements were generally to the right during the verbal portion, showed no difference during the numerical portion, and were generally to the left during the spatial problems. Among left-handed subjects, there was little distinction between eye/head movement directionality and type of question. Kinsbourne concluded that left-handed subjects lack hemispheric specialization and, consequently, the specific demand characteristics of the questions are not processed as efficiently as they are in right-handed subjects.

Weiten and Etaugh (1974) offered additional support for the hypothesis that the cognitive demands of reflective questions influence

lateral eye movement directionality. They presented 48 right-handed subjects with four sets of 12 questions each: verbal (interpretation of proverbs, spelling, definition of words), numerical (moderately difficult arithmetic problems selected from the Numerical Ability Subtest of the Differential Aptitude Tests), spatial (requiring visualization of spatial relations), and musical (familiar piano melodies which the subject was asked to identify). All questions were administered orally (except for the musical items which were administered via tape recordings) by a male experimenter seated directly across a desk from the subject. The questions were presented in homogeneous sets to half of the subjects and in mixed sets to the other half of the subjects, to test the hypothesis that the presentation of the questions in homogeneous sets would emphasize the demand characteristics of the questions and, therefore, elicit more eye movements in the expected direction.

A video camera was situated directly behind the experimenter, focused on the subject's eyes to record the subject's first eye movements following the end of each question. Eye movements were scored as either right, left, invalid (i.e., if the subject was not looking at the experimenter at the end of the question or if there were any doubts about direction of movements), or none (i.e., subject did not change his gaze before answering). Analysis of the data indicated that verbal and numerical questions elicited a greater proportion of lateral eye movements to the right than did the spatial or numerical questions as predicted. Furthermore, they reported that question sequence (homogeneous versus mixed) had no significant effect on the proportion of right movements observed for each of the four types of

questions.

Whereas the aforementioned studies focused primarily on the effect of cognitive characteristics of the questions used to elicit lateral eye movements, Schwartz, Davidson, and Maer (1975) investigated the effects of varying the affective tone of questions. On the basis of research implicating the right hemisphere in the regulation of affective tone they predicted that the emotional content of a question would also affect the directional shifts in eye movements and that this "affective quality" would be distinguishable from the more cognitive (verbal versus spatial) demand characteristics of the questions. Two experiments were performed involving a total of 24 right-handed subjects. Each subject was administered 40 questions composed of equal numbers of verbal-nonemotional, verbal-emotional, spatial-nonemotional, and spatial-emotional questions, which were presented in a counterbalanced order. Direction of the first lateral eye movement following each question was recorded. Emotional questions resulted in greater right hemisphere activation (more left movements) than comparable non-emotional questions regardless of cognitive content. In support of the authors' prediction, the interaction between emotional content and cognitive demands of questions showed that emotional-spatial questions elicited the greatest number of left-movements and that nonemotional-verbal questions elicited the greatest number of right movements.

The majority of the studies described thus far have focused primarily on the horizontal (lateral) components of eye movements that follow certain reflective questions. Kinsbourne noted in his

1972 study that in addition to this horizontal dimension, some questions elicit vertical eye movements (up, down). In fact, he found that his spatial questions elicited significantly more up movements than his verbal questions. This finding suggested that both vertical and horizontal aspects of reflective eye movements might be important indicators of the mode of information processing which a person uses in response to questions differing in cognitive demand characteristics.

In order to further examine both horizontal and vertical dimensions of eye movements with respect to differing cognitive tasks, Galin and Ornstein (1974) studied eye movement directionality in subjects whose vocations emphasized either verbal-analytic (lawyers) or spatial-holistic (ceramicists) cognitive modes. Subjects were presented with three sets of twenty questions each: a verbal set (14 semantic, 2 logic, 4 math), a spatial set (designed to elicit visualization of complex forms), and a "neutral" set (designed to be amenable to both verbal or spatial processing). Their eye movements were recorded on video tape and later judged for both vertical and horizontal components. Regarding the effect of question type on eye movement directionality, the results indicated significantly more down movements on verbal questions than spatial questions and significantly more stares on spatial questions than on verbal questions. Also, while the differences were in the direction predicted, i.e., more right movements on verbal questions, significant differences were not found between question types in the horizontal dimension of the eye movements elicited. This latter finding was attributed to both the extreme cognitive specialization of the subject sample as well as the possibility of overly

demanding or inhomogeneous question sets. Consequently, a second study was undertaken in which a modified question set consisting of 20 verbal (10 definitions, 5 proverb interpretations, and 5 phonemic items) and 20 spatial (less complicated than before and designed to focus on spatial orientation with respect to the person) was administered to a non-specialized group of subjects. Following the same procedure of recording eye movements used in the first part of the study, results indicated a significant effect of question type in both the vertical and horizontal dimensions of eye movements such that verbal questions elicited more down and right movements and fewer stares than did spatial questions. The authors concluded that both vertical and horizontal components are important indications of differential cognitive involvement even though the interpretations of vertical movements is not as clear as the interpretation of horizontal movements. Furthermore, they asserted that both components should be included in studies utilizing reflective eye movements as indicators of hemispheric functioning.

Ehrlichman, Weiner, and Baker (1974) performed a series of experiments in which they attempted to replicate and extend the findings for both horizontal and vertical eye movement shifts in response to questions designed to elicit differential hemispheric processing. In the process of doing this they also introduced a new variable into the reflective eye movement research--the effect of experimenter location. It is interesting to note that prior to this series of studies, the location of the experimenter had not been considered as a possible influence on eye movement directionality, yet two different procedures were being used. In research focusing on preferred eye movement

directionality for a given individual (as reviewed in the first section of this chapter) the experimenter usually sat facing the subject, while in the studies investigating effect of questions differing in cognitive demand characteristics on an individual's direction of eye movement, the subject usually sat facing a video recorder lens and sometimes had an experimenter seated behind him. In order to investigate effects of experimenter location, Erlichman et al., used both face-to-face and video recording procedures while examining the effect of questions on horizontal and vertical gaze shifts.

In their first experiment subjects were presented with two sets of 40 questions each: a spatial set intended to involve the right hemisphere and a verbal set intended to involve the left hemisphere. The spatial questions were designed to elicit various kinds of visual imagery and the use of spatial concepts. Also included in the spatial set were four questions that required the subject to hum musical phrases. The verbal questions were designed to require both the use of syntactic and semantic knowledge of language as well as the use of logic. Eye movements were recorded by a video camera and were later scored by two experimenters. Subjects displayed a strong vertical gaze shift difference between verbal and spatial questions (more ups for spatial, more downs for verbal), but did not show a difference in horizontal gaze shifts between question types.

Because these significant vertical and nonsignificant horizontal components of gaze shift did not replicate results in previous eye movement research, the authors decided to examine gaze shifts in a face-to-face interview situation. In so doing, they felt that this procedure

would both enable the experimenter to use eye contact with the subject to increase the chances that the subject's gaze would be in a centered position at the end of each question as well as eliminate the possible influence that the instructions used in the first experiment (i.e., to look at the camera until the entire question had been read) may have had on a subject's eye movement behavior. A new group of subjects was administered the same set of questions (except for a minor change in the spatial set). The only change in the setting and procedure was that an experimenter sat across from the subject, read the questions, and recorded the direction of the subject's gaze shift. The results of this experiment were similar to those obtained in the first one. That is, verbal questions elicited more downward gazes than spatial questions and there was no significant effect of question type on horizontal gaze shifts.

Since both experiments failed to show the expected effect of question type on eye movement directionality, especially with regard to the horizontal component, a third experiment was run. This time the authors used both their own questions as well as the questions used by Kocel et al. (1972), and employed both video camera and face-to-face interview conditions for each subject. Consistent with the findings in the previous two experiments, there was no significant effect of question type on horizontal gaze shift in either condition of this experiment. The tendency for verbal questions to elicit more downward gazes than spatial questions held only for Ehrlichman et al.'s questions, and not for Kocel's questions. In addition, stares occurred more frequently to spatial questions than to verbal questions. The

authors reported that similar patterns of results were obtained under the two conditions of experimenter location (i.e., video camera and face-to-face) and, therefore, the difference in procedure could not account for the continued discrepancy between their findings and those of previous research. They concluded that the effects of verbal and spatial questions on eye movement directionality appear to be reliable only for the vertical and not the horizontal dimension. Consequently, they contended that future research on gaze shifts should not be limited to examining the lateral direction eye movements.

Practically simultaneous with the Ehrlichman experiments, Gur (1975) was examining the effect of experimenter location on eye movement directionality. However, unlike Ehrlichman, her major emphasis was to study the experimenter location variable as a primary influence on the direction of an individual's eye movements when responding to a series of questions. Moreover, she was not interested in the vertical dimension of eye movements in the different conditions and, consequently, measured only the lateral directions of gaze shifts. In her experiment she used a within subject design in which each subject served in both experimenter location conditions. The two sessions were separated by a week and were counterbalanced across subjects. Within each session, the subject was administered one of two "equivalent" questionnaires consisting of 60 items: 20 verbal (explanation of proverbs), 20 numerical (solution of arithmetical problems) and 20 spatial (visualization and identification of spatial relationships of familiar places and visual arrangements). In the experimenter-facing-subject condition, the experimenter sat across from the subject, asked the questions, and

recorded direction of eye movements. In the experimenter-behind-subject condition the experimenter administered the questions while seated behind the subject and the subject faced a video camera. Eye movements in this latter condition were recorded on video tape and later judged for directionality by two independent raters. Results indicated that in the experimenter-facing-subject condition, subjects tended to move their eyes in a consistent direction irrespective of the nature of the question type. However, in the experimenter-behind-subject condition, a significant effect of question type on eye movement directionality was found such that spatial items produced more movements to the left and numerical problems produced about equal proportions of right and left movements. Gur classified her subjects as "unidirectional" or "bidirectional" according to the number of eye movements in a particular direction within a particular condition, and concluded that direction of gaze shift in response to questions is determined by both problem type and the individual's characteristic preference for use of a certain hemisphere. The influence of the first factor seemed to be maximized when the experimenter was seated behind the subject, whereas the experimenter-facing-subject condition seemed to maximize the second factor. In an attempt to explain the differential effect of experimenter location, Gur suggested that perhaps the more personal nature of the face-to-face procedure detracts from the question type being the most salient stimulus and, consequently, the situational variable (i.e., location of experimenter) may be interacting with variables related to hemispheric activation to produce the direction of gaze shifts.

In summary, recent reflective eye movement research has focused on variables that seem to affect the direction of gaze shift. For example, a number of studies have investigated the effect of question type on eye movement directionality and have reported that questions varying in cognitive content and/or affective quality significantly effect direction of gaze shift in either or both the horizontal and the vertical dimensions. The effect of experimenter location on direction of gaze shift has also been examined but the results of the few studies focusing on this variable have been inconclusive.

Summary and Statement of Problem

It is apparent that considerable differences in methodological approach and interpretation of results have led to controversy in relating the eye movement phenomenon to cognitive functioning. However, despite this, certain relationships are seemingly stable enough to emerge across the different studies. It has been demonstrated that for at least some individuals, eye movement shifts occur in a fairly consistent direction. Various personality, physiological, and cognitive differences between these individuals, classified as either right- or left-movers according to the direction of gaze shifts have indicated that right movers tend to be more externally oriented, less susceptible to hypnosis, and perform better on the quantitative sections of the SAT than left-movers. These differences have been attributed to differential dependence on the cerebral hemisphere contralateral to the direction of the majority of gaze shifts. The role of the cerebral hemispheres in eye movement directionality has been examined more directly by utilizing questions designed to engage either the right or the left

hemisphere. Results of these studies have revealed that direction of gaze shift is related to the kind of question utilized. For example, verbal and numerical questions seem to elicit eye movements to the right while spatial and musical questions seem to elicit eye movements to the left. These findings have suggested that the direction of gaze shift is contralateral to the hemisphere that is processing the particular question. Because of these consistencies with regard to hemispheric specialization and the potentially important implications of the right-left differences in cognitive processing, it seems desirable to pursue further investigation of the phenomenon.

Although the aforementioned consistencies exist across reflective eye movement studies, there are, at the same time, numerous inconsistencies that have been reported. For example, both Kocel et al. (1972) and Kinsbourne (1972) reported more right movements for verbal questions than for spatial questions and no difference between the number of right and left movements for numerical questions, while Weiten and Etaugh (1974) reported that both their verbal and their numerical questions elicited a greater proportion of movements to the right than did their spatial or their musical questions. Similarly, Ehrlichman et al. (1974) reported inconsistencies between the results of a series of experiments they performed and the results of previous eye movement studies, particularly with regard to the horizontal components of gaze shifts (i.e., these authors failed to find a significant effect of question type on lateral eye movements). Ehrlichman et al. also indicated a difference between the direction of gaze shifts elicited by their questions and those used by Kocel et al. (1972).

Finally, the effect of experimenter location has been examined by both Ehrlichman et al. (1974) and Gur (1975) and each reported different conclusions as to the influence of experimenter location on gaze shift directionality (i.e., the former contends no effect and the latter contends a major effect).

In order to provide a more precise examination of the eye movement phenomenon and its relationship to cognitive functioning, a more thorough examination of the methodological differences which may underlie the inconsistencies discussed above is necessary. One of the most noticeable methodological differences between studies pertains to the nature of the reflective questions utilized to elicit eye movement shifts. In the early research, little attention was paid to the number or kind of questions used, as long as the question was non-factual and caused the subject to "reflect." The kind of question became an important variable when hemispheric activation was assumed to be related to eye movement directionality. Therefore, different researchers began designing questions that would draw on the special processing functions of either the right or the left hemisphere. Each experimenter seemingly had his or her own idea about the content and level of difficulty for a given set of questions and, consequently, each arrived at question sets containing very different kinds of materials. Furthermore, after categorizing question types into verbal, numerical, spatial, musical, or opinion areas, there were inconsistencies between researchers as to which or how many of these categories to use. As a result, the literature offers a picture of different kinds and numbers of questions being used by different examiners who intended to measure similar processes via the eye movement shifts.

Another methodological inconsistency between studies in this area of investigation is the presence or absence of a face-to-face interview. The face-to-face interview had been standard until the effect of question types began to be examined (Kocel et al., 1972). At that point, video recording became the procedure of choice, bringing with it a variety of subtle differences between researchers as to how an accurate video recording of the subject's eye movements would be made. For example, some researchers simply waited until the subject faced the camera on his own volition before asking a question (Gur, 1975; Kinsbourne, 1972; Kocel et al., 1972); one group of researchers instructed the subject to attend to a light above the camera until the question was completed (Galín and Ornstein, 1974), and one asked the subject to focus on the camera until the question had been completely asked (Ehrlichman et al., 1974). Face-to-face procedures were also being used in some studies examining effect of question type on eye movement directionality (Weiten and Etaugh, 1974, Schwartz et al., 1975) and were recommended as long as the interview condition was a relaxed one for both the experimenter and the subject. Studies utilizing and comparing both procedures reported results that were inconsistent with each other (Ehrlichman et al., 1974; Gur, 1975). Thus, no clear preference has emerged.

A third and final methodological difference that may be contributing to the differences in results reported in lateral eye movement research has to do with the methods of recording lateral (right, left) and nonlateral (up, down, stare) movements. Different researchers attended to the various components of eye movement directionality

according to their particular research emphasis. Several studies revealed a primary emphasis on lateral components as the only scoreable components of directionality (Bakan, 1969; Gur, 1975; Kocel et al., 1972; Schwartz et al., 1975; Weiten and Etaugh, 1974a, 1974b, 1974c). The nonlateral dimensions became more of an issue as researchers focused on the complexity of the phenomenon. However, even though these researchers looked at both lateral and nonlateral components, they differed in their definition of what constituted a right, left, up, or down gaze shift. For example, as one of the first researchers to report data on vertical dimensions of reflective eye movements, Kinsbourne (1972) was very sketchy as to what constituted a particular direction of gaze shift. He utilized the categories of right, left, up, and down but simply stated that a particular eye movement was classified "in terms of the direction that best described it," leaving leeway to the judgment of the observer/recorder of gaze shift direction. Clearer definitions of lateral and vertical dimensions of eye movements were used by Galin and Ornstein (1974). They conceived of eye movement direction with reference to the position of a clock and assigned a number from 1 to 12 to each gaze shift. Zero was assigned to "stares." Therefore, when analyzing for lateral eye movements, right movements consisted of scores 1 to 5, left movements, 7 to 11, and nonlateral movements, 6, 12, and zero. In a similar fashion, Galin and Ornstein analyzed for vertical movements by reclassifying the categories. Finally, Ehrlichman et al. (1974) also utilized the "face of a clock" type concept, but unlike Galin and Ornstein, they used a somewhat complicated method of analysis ("centroid method")

that allowed for both the horizontal and vertical dimension of a gaze shift to be computed at one time. These discrepancies regarding the method for categorizing movements would seem to have a direct effect on the conclusions and interpretations that a particular researcher could make.

It is possible that the lack of consensus as to how the eye movement phenomenon is related to cognitive functioning may be due to the methodological inconsistencies which exist between studies. The reflective eye movement phenomenon has interesting possibilities as an indicator of hemispheric functioning, and, more specifically, as an indicator of differential cognitive specialties with the cerebral hemispheres. Consequently, it seems important to develop a standardized method for eliciting and recording/scoring the eye movement response, and, in so doing, provide a measure which can be used reliably in future research.

The primary purpose of this study was to develop a standardized questionnaire and procedure for its administration which would provide a set of questions that will reliably elicit (1) lateral eye movements to the right; (2) lateral eye movements to the left; and (3) nonlateral eye movements (up, down, stares) across right-handed male and female subjects.

EXPERIMENT I

The purpose of Experiment I was to present reflective questions representing a variety of question types to a large number of subjects and, based on an analysis of direction of gaze shifts to these various questions (across subjects), to select those items which were shown to reliably elicit either lateral eye movements or non-lateral eye movements. The selected questions would comprise a final questionnaire whose reliability for eliciting eye movements in the predicted direction would be assessed in Experiment II.

Method

Subjects

Subjects were 72 undergraduate students enrolled in an introductory psychology course at the University of North Dakota. For their participation in the experiment each subject received research credit which could be applied toward meeting the introductory course requirements. All subjects were right-handed (by self report) and were recruited for a study of "interview techniques" with no mention of eye movements. Twenty-one subjects were dropped for exhibiting too many invalid eye movements (see section on scoring eye movements). Of the remaining 51 subjects, 27 were females and 24 were males.

Interviewers

Three male and three female undergraduate psychology majors volunteered to serve as interviewers for this experiment as a means of gaining experience in psychological research. Special care was taken to provide each interviewer with adequate training in observing and recording reflective eye movements. Training began with group meetings in which the phenomenon was introduced and procedures for observing and scoring eye movement directionality were discussed and role-played. Each interviewer then viewed a video tape recording that had been specially developed to give him/her experience in observing and recording gaze shifts. The tape consisted of the eye movement responses of two mock subjects. A 50 item questionnaire that had been constructed to be representative of the kinds of questions that would be used in the actual study (see Appendix A) was administered to each of these "subjects" and a video camera recorded their gaze shifts. Each interviewer viewed this tape and recorded the direction of the eye movements. By having each interviewer observe the same video tape, it was felt that an accurate inter-rater reliability could be calculated. The reliability was the proportion of trials on which all six interviewers agreed as to the direction of eye movement (left, right, up, down, stare), and was computed to be .58.

In an attempt to increase inter-rater reliability, additional training was provided. The interviewers were given a copy of the specific instructions for observing and rating eye movements (Appendix B) which could be easily referred to in case there was a procedural

question. A new video tape was developed which once again consisted of the eye movement responses of two different "subjects" (a male and a female) who were responding to the same 50 item questionnaire administered previously. However, the first subject on this video tape was used more specifically as a training subject in that following her response to each question, there was a brief pause which was followed by a comment as to the actual direction of that particular eye movement. This procedure allowed the interviewers-in-training to record the direction of the eye movement they perceived to have occurred and to compare their recorded direction with the actual direction as observed by the principle investigator during the taping session. This process gave the interviewers a chance to become more accurate in their understanding of eye movements and in recording directional shifts. Following this "training subject," a second subject's eye movements were presented in an uninterrupted interview. Inter-rater reliability was determined on the basis of the scores given to the gaze shifts of the latter subject. There was a noticeable increase in inter-rater reliability which reached .82.

The interviewers met as a group to discuss any questions or problems they were having regarding the recording of the gaze shifts. A portion of the interview of the first subject on the second videotape was reviewed to clarify some of the more subtle recording problems. Following this meeting, each interviewer viewed the second subject on the second videotape once again and from the eye movement recordings, a final inter-rater reliability of .86 was obtained across the six interviewers.

The interviewers were told that the experiment was "an attempt to investigate what kinds of questions elicit the different kinds of eye movements." An effort was made to keep them naive as to the connection between hemispheric specialization for question type and eye movement directionality, and in so doing, prevent any possible bias in the recording of eye movements.

Questions

In order to develop a questionnaire that would contain questions that were representative of those used in other eye movement research, a number of the major researchers in the lateral eye movement field were contacted and asked to send copies of the questions that they utilized in their research. Upon receipt, each set of questions was carefully analyzed and broken down into five major categories: musical, numerical, opinion, spatial, and verbal. Within each of these major categories the questions were once again broken down into subcategories. Examples of the kinds of questions that were included in these final categories are presented in Table 1.

From the composite of approximately 400 questions (Appendix C) the experimenter selected three to four questions from each subcategory and developed three or four original or modified versions of questions for each subcategory. The final questionnaire consisted of seven questions within each subcategory (with the exception of the Verbal/definition subcategory which contained only six questions) for a total of 125 questions (Appendix D). To assure a counterbalanced order of items within the questionnaire, a question from each of the subcategories was randomly assigned to an 18 question grouping and then the

TABLE 1

SAMPLE ITEMS REPRESENTING EACH SUBCATEGORY OF REFLECTIVE EYE
MOVEMENT QUESTIONS

I. Musical

- A. Verbal - "In the children's song, 'Mary had a little lamb,' do you sing the word 'a' at a higher, a lower, or at the same pitch as the word 'Mary'?"
- B. Non-verbal - "Hum the tune of 'Pomp and Circumstances'."

II. Numerical

- A. Word Problems - "Mark Twain was born in 1835. How old would he be if he were alive today?"
- B. Calculations - "How much is 14×11 ?"

III. Opinion

- A. Personal/emotional - "For you is anger or hate a stronger emotion?"
- B. Nonpersonal/nonemotional - "What do you think is our country's greatest natural resource?"

IV. Spatial

- A. Geometrical - "If you place two equilateral triangles side by side, what other standard geometric figures would you obtain?"
- B. Counting - "How many angles are there in the red cross symbol?"
- C. Verbal (letters) - "What other letter do you get by turning a lower case printed 'n' upside down?"
- D. Geographical/directional - "If a person is facing the rising sun, where is the south with respect to him?"
- E. General - "In which direction does Abraham Lincoln face on a penny?"
- F. Images - "Who looked more like John Kennedy? Bobby or Teddy?"

TABLE 1--Continued

V. Verbal

- A. Proverbs - "What is meant by the proverb: 'Strike while the iron is hot'?"
 - B. Logic/analogies - "Solve this problem: John is better than Phil, and Mike is worse than Phil. Who is worst?"
 - C. Counting/numerical - "How many letters are there in the word Pennsylvania?"
 - D. Spelling - "Spell the word 'therapeutic'."
 - E. Definitions - "Define the word 'economics'."
 - F. "There is something wrong with the following sentence. What is it? 'Everyone of the six soldiers were in their uniforms.'"
-

order of presentation within each of these groupings was randomized. As a further control, two forms of the same questionnaire were developed by dividing the questionnaire in half and presenting the first half of the questions first on Form A and the first half of the questions last in Form B. In other words, two forms consisting of exactly the same questions and differing only in the order of presentation of these questions were developed (Appendix E).

Procedure

The subjects were randomly assigned to one of the six interviewers such that each interviewer saw approximately the same number of male and female subjects. Each subject was tested individually in one of three identical experimental rooms which had been set up in such a manner to provide a homogeneous and symmetrical visual field

for the subject.

Upon greeting the subject at the appointed hour, the interviewer directed him/her to the experimental room where the subject was seated in a chair situated directly across from and facing the interviewer. The interviewer introduced herself/himself and in an attempt to provide a more causal and relaxed atmosphere for the interview gathered some non-threatening personal data from the subject (i.e., name of psychology teaching assistant, subject's major). Following this introductory period, the interviewer read the following instructions to the subject:

This experiment involves the study of various techniques of interviewing and the different ways people respond to different kinds of questions. I have several questions to ask you. In some cases I'm interested in whether or not you get the correct answer. In other cases there is no correct answer, and I'm just interested in what you have to say. Do you have any questions before we get started? Let's begin then (after Crouch, 1976).

These instructions were designed to distract the subject from noticing that his/her eye movements were being recorded. In addition, they were designed to alleviate some of the anxiety that might have occurred if the subject thought that he/she needed to respond correctly to all of the items.

After the instructions had been read, the interviewer began administering the questionnaire. The interviewer read each question and, to insure eye contact prior to completion of the question, the interviewer looked up at the subject for the last three words of each question. The subject's initial eye movement following the completion of the question was recorded diagrammatically by the interviewer. Form A and Form B of the questionnaire were counterbalanced across subjects. (Refer to Appendix F for the breakdown of number and sex

of subjects administered either Form A or Form B by the different interviewers.)

When the interview was completed, the subject was thanked and was requested to complete a handedness questionnaire (Crovitz and Zener, 1962--Appendix G) as a validity check for his/her self-reported right-handedness.

Scoring System for Eye Movements

The direction of the subject's initial eye movement following the completion of a question was recorded diagrammatically by the interviewer (refer to Appendix E). This recording procedure involved having the interviewer draw a line from the midpoint of a circle in the direction of the subject's gaze shift for each question. Any lines drawn directly upward or directly downward were scored as "up" or "down" responses respectively. Those lines containing any horizontal component to the subject's right were scored as right movements. Similarly, those lines containing any horizontal component to the subject's left were scored as left movements. Trials on which no gaze shift occurred within two to three seconds following completion of a question or in which no gaze shift occurred prior to completion of the subject's answer were scored as "stares." If the subject closed or covered his/her eyes before or immediately after the completion of each question, or was not looking at the interviewer during the last three words of each question, the response was scored "invalid." Any subject who exhibited invalid responses to more than 50 percent of the questions was excluded from the data analyses. Utilizing this criterion, twenty-one subjects were dropped from the sampling population.

Results

Validity Check on Subjects' Self-reported Right-handedness

The scores on Crovitz and Zener's (1962) twenty item questionnaire to assess handedness ranged from 14 to 34 ($\bar{X}=22.8$) across the 51 subjects in this experiment. These scores were well within the range obtained in Crovitz and Zener's norming sample in which subjects whose scores were between 14 and 40 were classified as right-handed.

Performance of Individual Subjects Across Questions

In a recent study by Gur (1975), subjects were classified as either "unidirectional" (greater than 70% of a subject's eye movements were in one direction) or as "bidirectional" (less than 70% of a subject's eye movements were in one direction). Gur used these classifications in her assessment of the effects of different experimental procedures (experimenter location) on eye movement directionality. She found that subjects tended to be unidirectional in the Subject-facing-Experimenter condition and that they tended to be bidirectional in the Experimenter-behind-Subject condition. Although the present study utilized only the former procedure (subject facing experimenter), a similar categorization was made to examine the performance of individual subjects across question type. The computations were based on the proportion of eye movement responses to the right or left for the individual subject across questions. Table 2 provides a summary of the number of subjects determined to be unidirectional and those determined to be bidirectional, based upon Gur's 70% criterion.

TABLE 2

NUMBER AND SEX OF SUBJECTS CLASSIFIED AS "BIDIRECTIONAL"
OR "UNIDIRECTIONAL" ACROSS ALL QUESTIONS

	Bidirectional	Unidirectional		Total
		Left	Right	
Male	17	7	3	27
Female	15	5	4	24
Total	32	12	7	51

The difference between number of subjects classified as unidirectional or bidirectional was not significant by a chi-square test ($\chi^2 = 3.32$, $df=1$, $p > .05$). Within the unidirectional category there was no significant difference in the number of "left-movers" and "right-movers" ($\chi^2 = 1.32$, $df=1$, $p > .05$).

Comparisons Between Sub-Categories of Reflective Questions

In order to assess the differences between the eighteen subcategories of questions on the number and direction of eye movements made in each, a two way analysis of variance (subject x question type) was individually computed for each of the valid eye movement directions (left, right, up, down, stare). The means and the results of the five analyses are presented in Table 3. As is seen in Table 3, a significant difference exists between question types for each of the eye movement directionalities.

TABLE 3

MEAN NUMBER OF VALID EYE MOVEMENTS IN EACH DIRECTION FOR EACH
OF THE QUESTION TYPES

Categories	Direction of Eye Movements				
	Left	Right	Up	Down	Stare
1. Musical-Verbal	2.69	2.04	0.12	0.27	0.80
2. Musical-Nonverbal	2.69	1.84	0.16	0.14	1.16
3. Numerical-Word Problems	2.27	1.84	0.24	0.16	0.88
4. Numerical-Calculations	2.35	2.35	0.22	0.14	0.75
5. Opinion-Personal	2.84	2.09	0.12	0.14	0.43
6. Opinion-Nonpersonal	2.71	2.35	0.02	0.16	0.53
7. Spatial-Geometrical	2.14	1.49	0.14	0.12	1.24
8. Spatial-Counting element	2.29	2.09	0.22	0.14	0.96
9. Spatial-Verbal element	2.61	1.96	0.16	0.16	0.96
10. Spatial-Geographical	2.59	1.88	0.09	0.09	0.96
11. Spatial General	2.75	1.75	0.16	0.16	0.67
12. Spatial-Images	2.43	1.69	0.04	0.06	0.67
13. Verbal-Proverbs	3.41	2.54	0.00	0.25	0.80
14. Verbal-Logic	1.84	1.78	0.00	0.25	0.80
15. Verbal-Counting element	3.27	1.92	0.09	0.12	0.57
16. Verbal-Spelling	2.73	2.02	0.16	0.06	0.88
17. Verbal-Grammar	2.63	2.24	0.06	0.24	0.90
18. Verbal-Definitions	2.43	2.08	0.00	0.04	0.53
F ^a	4.81	2.61	2.73	2.00	5.41
P	<.001	<.001	<.001	<.01	<.001

^adf = 17, 450

Comparisons between question types for each of the different eye movement directions were made using the Newman-Keuls test. Table 4 summarizes the comparisons between subcategories of questions for all eye movement measures ($p = .05$ for each comparison).

As is shown in Table 4, the verbal-proverb questions produced significantly more left movements when compared with all other subcategories except opinion-personal and verbal-county and, at the same time, produced significantly more right movements than either spatial-geometrical, spatial-general, or spatial image questions. The verbal-logic subcategory of questions produced significantly more stares than all other question types and significantly more down movements than spatial-image, verbal-spelling, or verbal-definition questions. Furthermore, significantly fewer left eye movements were made to the verbal-logic questions than were made to all other question types except numerical-word problems, numerical calculations, and spatial-geometrical questions. Finally, there were significantly more up movements for the numerical-word problems questions than there were for the opinion-personal, verbal-proverb, verbal-logic, and verbal-definition question types.

Comparisons Between the Major Categories of Reflective Questions

Because the use of specific subcategories of reflective eye movement questions was somewhat unique to the present study, it was considered appropriate to also look at the data in terms of differences that may exist between the question types when combined into their respective major categories (i.e., Musical, Numerical, Opinion, Spatial, Verbal).

TABLE 4

SUMMARY OF THE NEWMAN-KEULS TESTS ON DIFFERENCES BETWEEN SUBCATEGORY MEANS
FOR NUMBER OF EYE MOVEMENTS IN EACH OF THE GAZE SHIFT DIRECTIONS

		Smaller Subcategory Mean																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Larger Subcategory Mean	1. Musical-Verbal														L				
	2. Musical-Nonverbal					S	S		S						L	S			
	3. Numerical-Word Problems						U							U	U				U
	4. Numerical-Calculations							R						U	U				U
	5. Opinion-Personal														L				
	6. Opinion-Nonpersonal														L				
	7. Spatial-Geometrical					S	S		S			S	S			S			
	8. Spatial-Counting element													U	U				U
	9. Spatial-Verbal element														L				
	10. Spatial-Geographical														L				
	11. Spatial General														L				
	12. Spatial-Images														L				
	13. Verbal-Proverbs	L	L	L	L	L	L	L _R	L	L	L	L _R	L _{SR}		L		L	L	L
	14. Verbal-Logic	S	S	S	S	S	S	S _R	S	S	S	S	S _D	S		S	S _D	S	S _D
	15. Verbal-Counting element				L	L		L	L				L _D		L				L
	16. Verbal-Spelling														L				
	17. Verbal-Grammar														L				
	18. Verbal-Definitions														L				

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NOTE: L=Left, R=Right, U=Up, D=Down, S=Stare. Each entry reflects a significant difference for that eye movement direction between the column and the row subcategories.

In so doing, more direct comparisons can be made between the results of this study and the results of other eye movement research as to the effect of different types (major categories) of reflective questions on eye movement directionality. In order to assess the differences between the five major categories of questions in the number and direction of eye movements made in each, data from the subcategories were combined under their respective major category and a two way analysis of variance (subject x question type) was individually computed for each of the valid eye movement directions. The actual means and the results of the five analyses are presented in Table 5.

TABLE 5

MEAN NUMBER OF VALID EYE MOVEMENTS IN EACH DIRECTION FOR EACH OF
OF THE MAJOR QUESTION CATEGORIES

Categories	Left	Direction of Eye Movements			Stares
		Right	Up	Down	
1. Musical	5.37	3.88	0.27	0.41	1.96
2. Numerical	4.63	4.47	0.45	0.29	1.63
3. Opinion	5.55	4.45	0.14	0.29	0.96
4. Spatial	4.94	3.62	0.27	0.24	1.82
5. Verbal	5.40	4.17	0.11	0.34	1.78
F ^a	2.59	2.73	4.09	1.03	5.76
p	<.05	<.05	<.01	>.05	<.001

^adf = 4, 200

As is seen in Table 5, a significant difference exists between question types for left movements, right movements, up movements, and stares. There was no significant difference between the major categories of questions on number of down movements.

For those analyses reaching significance, internal comparisons between categories were performed using the Newman-Keuls test. Table 6 summarizes the comparisons between major categories of questions for all eye movement measures ($p = .05$ for each comparison).

TABLE 6

SUMMARY OF THE NEWMAN-KEULS TESTS ON DIFFERENCES BETWEEN CATEGORY MEANS FOR NUMBER OF EYE MOVEMENTS IN EACH OF THE GAZE SHIFT DIRECTIONS

		Smaller Category Mean				
		1	2	3	4	5
Larger Subcategory Mean	1. Musical			S		
	2. Numerical			U S		U
	3. Opinion		L		R	
	4. Spatial			S		
	5. Verbal			S		

NOTE: L=Left, R=Right, U=Up, S=Stare. Each entry reflects a significant difference for that eye movement direction between the column and the row categories.

The results indicate that the Opinion questions produced significantly more left movements than Numerical questions and significantly more right movements than spatial questions. Significantly more Up movements were made to Numerical questions than were made to

either Opinion or Verbal questions. Finally, Opinion questions elicited significantly fewer stares than any of the other question types.

Item Analysis and Question Selection

The proportion of valid lateral (right, left) and nonlateral (up, down, stare) eye movements was determined for each question across all subjects. Questions which elicited 70% or more of the subjects' gaze shifts in either a lateral or a nonlateral direction were selected for further analysis under the assumption that these particular items are strong lateral or nonlateral gaze shift items. No questions met the criterion for selection as strong nonlateral items. However, 104 out of the 125 original questionnaire items met the criterion for selection of strong lateral eye movement questions.

In order to determine which of these lateral items were "left movement questions" and which were "right movement questions," a difference score between the proportions of left and right movements to each item across subjects was computed. These difference scores were then rank-ordered from largest negative number (most right-movement) to the largest positive number (most left-movement). Eleven items from each extreme were then selected to represent items that would be expected to elicit right or left eye movements respectively. These items and the difference in proportion of left and right movements for each are presented in Table 7.

Interestingly, these two sets of questions are comprised of a mixture of items from various subcategories which had been developed from the original questionnaire. However, this mixture is not in the expected direction wherein the right movement questions are mostly

TABLE 7

QUESTIONS SELECTED TO ELICIT RIGHT OR LEFT EYE MOVEMENTS BASED ON DIFFERENCES
IN PROPORTION OF LEFT MINUS RIGHT EYE MOVEMENT RESPONSES ACROSS SUBJECTS

Right Movement Questions	Subcategory	Left - Right Difference Score
1. For you is anger or hate a stronger emotion?	Opinion Personal-Emotional	-23.0
2. How many windows are there in your house, apartment, or dorm room?	Spatial-Counting	-22.9
3. If 15 cans of food are needed for 7 men for 2 days, the number of cans needed for 4 men for 7 days equals _____?	Numerical-Word Problem	-21.7
4. Twenty-five equals what percent of 125?	Numerical-Calculations	-18.2
5. How many rows of keys are there on a typewriter?	Spatial-Counting	-15.9
6. If you were given a large sum of money, what would be the first thing you would do with some or all of it?	Opinion-Nonpersonal	-11.9
7. Compare the pitch of the word "top" and the beginning of the word "smokey" in the song "On Top of Old Smokey."	Musical-Verbal Element	-11.6
8. What is an English word that begins with "D" and ends with "D"?	Verbal-Spelling	-10.9
9. Visualize sitting in front of a typewriter. Where is the letter "r" relative to the letter "b"?	Spatial-Verbal Element	- 8.1

TABLE 7--Continued

	Subcategory	Left - Right Difference Score
10. How do you spell "society" backwards?	Verbal-Spelling	- 7.7
11. What is the definition of the word "time"?	Verbal-Definition	- 7.3
Left Movement Questions		
1. Spell the word "quarantee".	Verbal-Spelling	+36.8
2. How many letters are there in the word "parallel"?	Verbal-Counting	+35.5
3. In the pictures of Napoleon, which hand does he hold in his coat?	Spatial-General	+34.0
4. Hum or go "da da da" to suggest the theme for the "Longer Ranger."	Musical-Non-Verbal Element	+32.2
5. Which angle is greater: the smaller angle formed by the hands of a clock at 3:35 or the smaller angle formed by the hands of a clock at 1:30?	Spatial-Geometrical	+32.2
6. Hum the part of the "Star Spangled Banner" beginning with the words "What so proudly we hailed."	Musical-Verbal Element	+31.3
7. Spell the word "miscellaneous".	Verbal-Spelling	+31.2
8. Briefly, what is the meaning of this common proverb: "The more cost, the more honor."	Verbal-Proverb	+30.0

TABLE 7--Continued

	Subcategory	Left - Right Difference Score
9. If you could change one thing about yourself what would it be?	Opinion-Personal Emotional	+30.0
10. A person dreams he attends the Metropolitan opera dressed in rags. What do you think this dream means?	Opinion-Nonpersonal	+29.6
11. What is the seventh word of the "Pledge of Allegiance?"	Verbal-Counting Element	+28.3

verbal and numerical items and the left movement questions are mostly spatial and musical items. Instead, the set of right movement questions consist of three verbal, three spatial, one musical, two numerical, and two opinion questions, while the set of left movement questions consist of five verbal, two spatial, two musical, and two opinion questions.

Discussion

The purpose of Experiment I was to administer reflective questions representing a variety of question types to a large number of subjects and, based on an analysis of gaze shift directions to these different questions (across subjects), to select items which reliably elicited either lateral (right, left) or nonlateral (up, down, stare) eye movements. The results of this study indicated that the majority of questions presented tended to elicit predominantly lateral eye movements and that only a few tended to elicit predominantly nonlateral eye movements. Consequently, selection of items for the questionnaire was based solely on those eliciting lateral movements. The final questionnaire was comprised of an equal number of items reliably eliciting either right or left eye movements and, at the same time, representing extremes of a rank ordering based on a difference score between the proportion of left and right movements made to each item.

It was expected that the items selected as right movement questions would be composed of left hemisphere questions (i.e., verbal, numerical) and that the left movement question set would be right hemisphere questions (i.e., musical, spatial). This expectation was not supported by the data. Instead, the selected question sets were

comprised of a mixture of the various categories and subcategories of question types. This finding suggests that different question types may differentially elicit eye movement shifts but not in the directions predicted by hemispheric activation or specialization theory.

Similar inconsistencies in expected effects of different question types on gaze shift directionality were found when examining significant comparisons made both between the various subcategory and between the major category classifications of reflective questions. Perhaps most notable among the subcategory comparisons was the greater number of left movements that were made to the Verbal-proverb items than to nearly all other subcategories. In previous research verbal-proverb questions have been considered to be left hemisphere items and have been shown to reliably elicit right eye movements (Gur, 1975; Kinsbourne, 1972; Kocel et al., 1972). Many other unexpected results occurred when examining the comparative effects of the different major categories of questions on gaze shift directionality. For example, unlike previous research findings, the only significant effects of question type on the lateral dimension of eye movements were with Opinion questions, which elicited more left movements than Numerical questions and more right movements than Spatial questions.

There are several possible explanations to account for the general inconsistencies between the results of this study and the expectations based on previous eye movement research and on hemispheric specialization studies. One such explanation has to do with procedural differences between this and other studies. For example, a larger and more specifically defined variety of reflective questions

was utilized in this study than had been used in previous research. Furthermore, a unique category of items, Opinion questions, was included for comparison with the other, more typical reflective questions. Another procedural difference between Experiment I and the bulk of research investigating the effects of question type on eye movements has to do with the experimenter-facing-subject interview procedure. Unlike Gur's (1975) findings that this procedure would produce more "unidirectional" subjects and eliminate the effects of question type, the results of an analysis of individual subjects' performance across questions indicated that there was no significant difference between the number of subjects who were classifiable as unidirectional or bidirectional. However, the data do not permit additional analysis to assess whether the individual subjects' eye movements were shifting in a direction consistent with cognitive demand characteristics or if they were simply random. This would have been valuable information. A final possible explanation for the results of this study has to do with the category distribution of the twenty-two items selected as the strong left or right questions. The category composition of these items does not support the assumption that functional differences in the cerebral hemispheres would be reflected in the direction of eye movements elicited by a particular question type. The strongest left movement questions were not primarily right hemisphere questions and the strongest right movement questions were not primarily left hemisphere questions. Consequently, doubts are raised concerning the validity of reflective eye movements as an indicator of hemispheric specialization. Experiment II was carried out in order to gather additional information regarding the relationship between reflective eye movements and hemispheric functioning.

EXPERIMENT II

Although the questions selected from the original questionnaire in Experiment I were the items eliciting strongest gaze shifts to the right or left, there is little face validity within each set. That is, the kinds of questions that were selected as right movement / left hemisphere questions do not conform to what has generally been regarded in the literature as a left hemisphere question. Similarly, the nature of the questions selected as left movement/right hemisphere questions do not conform to what has generally been regarded as a right hemisphere question. Consequently, the value of these sets of items as an instrument for assessing reflective eye movements is questionable.

At the same time, however, if these questions were readministered to another set of subjects and if they reliably elicited gaze shifts in the same direction as they had previously, then it could be concluded that perhaps hemispheric specialization may not play the major role in determining eye movement directionality. On the other hand, if hemispheric specialization does play a major role, then perhaps current methods of measuring the eye movement phenomenon may not be effective in dealing with the complexities involved in assessing functional differences between the cerebral hemispheres. If the questions fail to reliably elicit eye movements in the same direction as they had in Experiment I, doubts as to the effects of methodology, the reliability of the phenomenon itself, and the value of eye movement research would

be raised. Experiment II was carried out in order to examine these issues.

Method

Subjects

Subjects were 39 undergraduate students enrolled in an introductory psychology course at the University of North Dakota. For their participation in the experiment, each subject received research credit which could be applied toward meeting the introductory course requirements. All subjects were right-handed (by self-report) and were recruited for a study of "interview techniques" with no mention of eye movements. By the same criterion established in Experiment I nine subjects from the present sample were dropped for exhibiting too many invalid eye movements. Of the remaining 30 subjects, 15 were males and 15 were females.

Interviewers

The same six interviewers that had participated in Experiment I served as interviewers for this experiment. No additional training beyond that received for Experiment I was given.

Questions

The questionnaire was composed of 22 items that had been selected from the questionnaire administered in Experiment I. Eleven of the items had been found to elicit right movements and eleven of the items had been found to elicit left movements (refer to Table 3). These sets of questions were randomly arranged to comprise the questionnaire for this

experiment (Appendix H). Because of the brevity of this questionnaire, only one form was developed and administered.

Procedure

The setting and procedure were identical to those of Experiment I.

Results

Validity Check on Subjects' Self-reported Right-handedness

The subjects' scores on the Crovitz and Zener questionnaire to assess handedness ranged from 14 to 35 ($X=19.6$). Once again, these scores were within the range for right-handedness.

Performance of Individual Subjects Across Questions

The proportion of eye movements to the left or to the right for each subject was computed in order to determine whether he/she was "unidirectional" (i.e., a right- or left-mover) or "bidirectional." Table 8 provides a summary of these findings.

As in Experiment I, there was no significant difference between the number of subjects classified as unidirectional or as bidirectional ($\chi^2=.14$, $df=1$, $p > .05$). Similarly, there was no significant difference in the number of unidirectional subjects classified as either right-movers or left-movers ($\chi^2=.28$, $df=1$, $p > .05$).

Reliability of Questionnaire

To assess the reliability of the eleven items selected to elicit right movements and the eleven items selected to elicit left movements

TABLE 8

NUMBER AND SEX OF SUBJECTS CLASSIFIED AS BIDIRECTIONALS OR
UNIDIRECTIONALS ACROSS ALL QUESTIONS

	Bidirectionals	Unidirectionals		Total
		Left	Right	
Male	8	3	4	15
Female	8	3	4	15
Total	16	6	8	30

(Table 3), a correlation was computed between the left-right difference scores obtained for these questions during Experimental I and the left-right difference scores obtained during Experiment II. These data are summarized in Table 9. Clearly, there is little relationship between the eye movement directions of subjects in the two experiments.

In view of the low reliability figures obtained when correlating magnitude of left-right difference scores (Table 9), a second set of reliability scores was computed based simply on the tendency (not magnitude) for a particular question to elicit eye movements in the predicted direction. Table 10 summarizes the number of questions during Experiment II that elicited eye movements in either the same or different direction than had been elicited during Experiment I.

Because the data in Table 10 are in categories, a contingency coefficient was computed to assess the correlation between direction of eye movements made in the two experiments ($\chi^2=.84$, $df=1$, $p > .05$), $C=.21$). There is no relationship between the predicted direction of

TABLE 9

CORRELATIONS BETWEEN LEFT-RIGHT DIFFERENCE SCORES OBTAINED
IN EXPERIMENTS I AND II FOR BOTH THE RIGHT AND LEFT EYE
MOVEMENT QUESTION SETS

Question Sets	Subcategory	Left-Right Difference Score	
		Experiment I	Experiment II
Right Movement Questions			
1	opinion-personal	-23.0	- 8.7
2	spatial-counting	-22.9	-18.5
3	numerical-word problem	-21.7	-30.4
4	numerical-calculation	-18.2	-11.6
5	spatial-counting	-15.9	0.0
6	opinion-nonpersonal	-11.9	-40.0
7	musical-verbal element	-11.6	- 8.3
8	verbal-spelling	-10.9	+32.0
9	spatial-verbal element	- 8.1	+16.0
10	verbal-spelling	- 7.7	-27.5
11	verbal-definition	- 7.3	+11.5
r=.36			
Left Movement Questions			
1	verbal-spelling	+36.8	+ 5.3
2	verbal-counting	+35.5	- 3.9
3	spatial-general	+34.5	+19.2
4	musical-nonverbal	+34.0	+ 7.7
5	spatial-geometrical	+32.2	-22.7
6	musical-verbal element	+31.3	-17.8
7	verbal-spelling	+31.2	+11.1
8	verbal-proverb	+30.0	0.0
9	opinion-personal	+30.0	- 3.7
10	opinion-nonpersonal	+29.6	- 8.7
11	verbal-counting	+28.3	- 6.9
r=.10			

combined left and right movement questions $r=.23$

NOTE: Refer to Table 3 for actual questions corresponding to numbers listed in this table.

TABLE 10

SUMMARY OF THE NUMBER OF QUESTIONS ELICITING GAZE SHIFTS
DURING EXPERIMENT II IN EITHER THE SAME OR DIFFERENT
DIRECTION THAN WAS PREDICTED FROM EXPERIMENT I

		Experiment II	
		Left Movements	Right Movements
Experiment I	Left Movements	4.5	6.5
	Right Movements	3.5	7.5

eye movement for a particular question (as determined in Experiment I) and the direction of gaze shift elicited by that question during Experiment II.

Discussion

Experiment II was designed to assess the reliability of the eleven right movement items and the eleven left movement items selected in the previous experiment. Because there was little face validity as to cognitive content of these question sets and the direction of eye movements they elicited, it was unclear what results could be expected from the second administration of these items. The results of Experiment II indicated that there was a very low correlation between the directions of gaze shifts elicited by the questions in the Experiment I and those produced by the same questions in the present experiment. It is interesting to note that slightly more than half of the right movement questions produced right movements in this experiment while less than one third of the left movement questions produced left

movements. The remaining questions produced gaze shifts in an opposite direction than had been predicted. Furthermore, upon closer inspection of the kind of questions that produced same-direction gaze shifts and those that produced different-direction gaze shifts, there is no specific relationship between question type and gaze shift that can account for this finding. In other words, the fact that certain questions produced the same direction of eye movements when asked a second time while others did not seems to be a more or less random process rather than one that has been made on the basis of any kind of theoretical or logical predictions. These findings could be attributable to the fact that the question-type/direction of eye movement relationship was a questionable one when the items were originally selected in Experiment I. These results raise considerable doubt as to the reliability of the eye movement phenomenon itself as well as to its usefulness as a tool for indicating differential hemispheric functioning.

GENERAL DISCUSSION

The purpose of these two experiments was to develop a standardized eye movement questionnaire and procedure for its administration which would provide a set of questions that would reliably elicit lateral eye movements to the right, a set of questions that would reliably elicit lateral eye movements to the left, and a set of questions that would reliably elicit nonlateral movements (up, down, stare). The results of Experiment I indicated that only questions eliciting lateral movements met the selection criteria for inclusion in the final questionnaire. It was noted that the category distribution of the twenty-two items selected as strong left or right movement questions do not support the assumptions that functional differences in the hemispheres would be reflected in the direction of eye movements elicited by a particular question type. Consequently, the value of these sets of items as an instrument for assessing reflective eye movements was questioned. The results of Experiment II corroborated this doubt in that the questionnaire was found to have very low reliability upon readministration. In an attempt to explore the possible explanations for this "failure," two major areas will be discussed: (a) possible methodological weaknesses and (b) the reliability of the eye movement phenomenon. In addition, the implications of the results of these experiments for future research and, more specifically, the value of future eye movement research will be addressed.

Methodological Issues

One aspect of the general purpose for this study was to standardize the methodology used in reflective eye movement research. This was justified on the basis of the lack of consistency between methodological approaches used across a number of the experiments that utilized or examined the eye movement phenomenon. However, in the process of standardizing the methodology, the expected results (i.e., selected question sets that would reliably elicit different gaze shift responses) either diminished, reversed, or disappeared. Several factors may have contributed to these findings. For example, the decision to use the face-to-face interview technique in both of the experiments presented in this paper rather than to use hidden video cameras and other mechanical paraphernalia was a possible source of error, especially in view of Gur's (1975) findings that the face-to-face interview inhibits the subject from making eye movements that reflect a hemispheric differentiation of response related to problem type. More specifically, she reported that in a face-to-face interview, subjects tended to be consistent in the direction of their gaze shift, regardless of the type of question asked ("unidirectional"). On the other hand, when the interviewer sat behind the subject, the subject tended to move his eyes differentially according to problem (question) type ("bidirectional"). In the present research, the face-to-face interview was the only interview procedure used. It was interesting to note that unlike Gur's findings, analyses of the number and direction of gaze shifts across questions for each subject in both Experiments I and II revealed that there was no significant difference between the number of subjects who tended to be "unidirectional" and those who tended to be

"bidirectional." It is possible that the discrepancy between these and Gur's findings occurred as a result of the attempt that was made in this research to provide a relaxed interview setting which would theoretically decrease some of the anxiety that may have arisen from the interpersonal nature of the face-to-face interview. In so doing, the possibility of "inducing" a greater tendency to look in one direction for each of the subjects may have been reduced. Unfortunately, even though the results of the present studies indicate that the attempt to provide a relaxed interview setting did not result in significant differences between the number of subjects classified as unidirectional or as bidirectional, the data do not provide any information regarding the possibility that bidirectional subjects' eye movements were haphazard instead of problem related. Consequently, the combined eye movements of both the unidirectional and the bidirectional subjects for each question may very well have negated any of the expected effects of question type on gaze shift directionality. More specific information regarding the nature of the bidirectional subjects' eye movements would indeed be valuable to explicate the results of this research.

Although the data on the number of subjects classified as bidirectional or unidirectional suggest that the face-to-face interview procedure in a relaxed setting does not tend to differentially effect direction of eye movements for an individual subject, there is evidence that the length of the interview may be affecting the "ability" of the various reflective questions to elicit eye movements in the predicted directions. Indications that this has occurred is revealed in the fact that during Experiment I, all question

subcategories tended to elicit a larger number of left eye movements than any of the other possible eye movement directions, while during Experiment II, more right movements were made across questions. One possible explanation for these findings is that during Experiment I, subjects were involved with a quite extensive and lengthy interview during which time they may have become anxious about the number of questions being asked of them. That more left movements would have been made during this period is supported in the results of some recent research implicating an increased frequency of left eye movements during a stressful condition regardless of type of question being asked (Tucker et al., 1977). In Experiment II, subjects were engaged in a much briefer interview and may not have become quite as anxious. This fact does not explain why these subjects tended to make more right movements to the different questions, but does support the idea that the questions administered were not activating the hemispheres in the expected directions.

Another aspect of the methodology in this study that may have contributed to the lack of success in developing a reliable eye movement questionnaire was the way in which eye movements were scored. The instructions for recording gaze shift directionality were very specific (see Appendix B) and, while this specificity was felt to be necessary in order to provide a standardizeable recording technique, it is possible that they were too rigid. For example, in using the specific instructions outlined for this study, eye movements that occurred prior to the completion of the question were scored as invalid. This omission of certain eye movements most likely occurred when reflective questions were phrased in such a way that the subject could predict the completion of the

question, and, therefore, begin to formulate the response prior to the actual completion of question administration by the interviewer. While it is possible that these questions may be exemplary of the kinds of reflective questions that are clearly lateralized and, while any eye movements made to these questions during a period of premature answer formulation may have offered a more accurate indication of hemispheric processing, there is no explanation for the inconsistencies between the results of the present set of experiments involving valid lateral eye movements and those of other eye movement researchers. In fact, the majority of eye movement studies have utilized requirements for recording eye movements very similar to those used in the present research (i.e., eye contact between interviewer or video camera and subject at the end of a question, and the recording of the first eye movement following question completion). However, unlike the present set of studies, these other investigators have for the most part reported significant results consistent with theoretical expectations. Interestingly, the few studies that have deviated from these general procedures for recording eye movements have reported nonsignificant effects. For example, in a recent study investigating the relationship between question type and gaze shift directionality, Crouch (1976) included eye movements made prior to completion of question administration as valid movements. Although this recording procedure prevented some of the omission of eye movements as discussed above, no significant relationships were reported between the various types of reflective questions and gaze shift directionality. It would appear that because the studies using similar recording procedures as well as those using dissimilar

recording procedures have reported findings inconsistent with those reported in the present research, alternative explanations must be considered.

An issue that is related to the procedure for recording of eye movement directionality and which may have contributed to the results of Experiments I and II was the way in which the eye movements were analyzed. In this study valid eye movements were those containing any lateral component (left, right) and those that were on the median plane of the eye (up, down, stare). Analyses consisted of computing the number of eye movements made in each of these directions to a particular question across subjects using a procedure similar to that used by Galin and Ornstein (1974). Like the findings reported by Galin and Ornstein, the results of Experiment I revealed that both the lateral and nonlateral components of eye movements suggested differential cognitive involvement. However, in comparing between subcategories and between major categories, the pattern of significant differences with a particular eye movement direction were generally unlike those found in the majority of other eye movement experiments (i.e., the direction of eye movements did not necessarily correspond with the cognitive demand of the different question types). It is possible that a more precise method of analyzing/categorizing eye movements, such as Ehrlichman et al.'s (1974) "centroid analysis," would have been more accurate, but it would also have accentuated the vertical dimensions and eliminated analysis of "stares." Furthermore, inasmuch as both the vertical dimensions of gaze shifts and stares are not distributed randomly across question types and because neither is very clearly

understood in terms of the neurological systems that control them, it did not seem appropriate to use the centroid method of analysis. It is unclear at this time as to which method is the more efficient or effective one.

A third methodological issue in this study has to do with the kinds of questions used. In the first experiment, great care was taken to classify questions into the major categories that were typically used in other eye movement studies. Great care was also taken in classifying these questions further into subcategories. When selecting the particular items that would be used on the initial questionnaire, an attempt was made to select questions that represented those used in the eye movement research which were, at the same time, judged not to be too difficult or to include specific references to a particular locale. The questions that were constructed by the author were modeled after the set of representative questions but were carefully designed to emphasize a particular cognitive process. For example, when developing a spatial question, care was taken not to induce a verbal set by the phrasing of the question (i.e., "With your eyes open try to have an image of a woman laughing" as opposed to "Describe the face of a woman laughing"). It was predicted that these specially designed questions would produce "strong" eye movement responses in a direction predicted by hemispheric specialization. The results failed to reflect this prediction. One possible explanation for this finding was that certain question types were mis-subcategorized. More specifically, the extensive subcategorization of questions for the original questionnaire revealed that many of the items could easily have

been classified in more than one subcategory (i.e., a spatial-counting question could be categorized as a numerical-word problem, and vice versa). Rather than utilizing these ambiguous questions, perhaps a more efficient procedure would have been to select or develop only those items that are clearly one type of question or another, and, in so doing, avoid the interactive effects the ambiguous questions might have on the direction of eye movements. However, the possibility that mis-subcategorization truly explains the results of the present research is fairly weak when the comparisons between main categories also failed to produce effects in the directions that would have been expected by the literature on hemispheric specialization. It would seem that a more plausible explanation is that the questions were not selectively activating the cerebral hemispheres or, if they were, the eye movement phenomenon is not an accurate measure of this activation.

Reliability of the Eye Movement Phenomenon
 (or "Do the Eyes Really Have It?")

The methodological issues described above did not offer sufficient explanations for the results obtained in this study. Consequently, a more critical re-evaluation of the eye movement phenomenon and its relationship to type of question and hemispheric activation is presented below.

A major theoretical premise for this study was Kinsbourne's general model of hemispheric activation which states that differential activation of the cerebral hemispheres may lead to a shift in attention and in shifts in physical orientation contralateral to the activated hemisphere (Kinsbourne, 1972). This model easily incorporates gaze

shift behavior as a way of studying the functional differences between the hemispheres when involved in various kinds of cognitive activities. In this study as in others (Ehrlichman et al., 1974; Kinsbourne, 1972; Kocel et al., 1972), the cognitive activities consisted of a variety of questions differing in cognitive demand characteristics. Also, in this study, as in others, the eye movement responses on both the vertical and the horizontal dimensions were found to be significantly affected by type of question. The similarities between studies seem to end at this point of comparison. For example, in a number of studies only the horizontal dimension of gaze shifts was taken into account, and when significant effects of question type were found in the predicted direction, Kinsbourne's model was easily applied as an explanatory model. In the studies that utilized both horizontal and vertical dimensions of gaze shift, Kinsbourne's model was modified to adapt to the vertical dimension which was then explained as reflecting bilateral activation. Yet, this "adapted" model failed to explain the differences between question types and the different vertical movements (up, down, stare). In both the present experiments as well as in a series of studies done by Ehrlichman et al. (1974), the results do not generally fit into Kinsbourne's model for contralateral activation by question type. Nor could the results be clearly explained by the "bilateral" adaptation of this model. Therefore, to paraphrase Ehrlichman, while it would be premature to rule out an explanation of eye movement differences for various kinds of question types based on a model of cerebral localization of activity, the results of this study do not offer support for such a model. In fact, the results of both

Experiments I and II seem to indicate that hemispheric activation may not be related to reflective eye movements. The question remains, however, as to how to account for the inconsistencies between the data from each of the present studies and those of the other eye movement researchers (most noticeably, Kinsbourne, 1972 and Kocel et al., 1972).

Given that procedural differences as described in previous sections of this paper may account for some of the discrepancies between the findings of the present research and those of other researchers, it seems unlikely that methodology alone could be responsible for or explain these discrepancies. Perhaps one other explanation that could be offered assumes that cognitive activity is involved in responding to different questions and influences the direction of eye movements but in ways unrelated to any specific activation of hemispheres. More specifically, Ehrlichman et al. (1974) suggest that an individual's cognitive style may determine that person's tendency to either move his eyes in directions according to the type of question asked (field dependent) or in non-question related directions (field independent). Recent research supports this suggested relationship between cognitive style and gaze shift directionality. For example, Tucker (1977) reports that subjects classified as field dependent tend to make eye movements to reflective questions in directions consistent with differential hemispheric functioning (i.e., left movements to spatial questions, right movements to verbal questions). This relationship was not evident with field independent subjects. Instead, greater field independence was associated with a higher frequency of nonlateral eye movements. Tucker concludes that differences seem to exist between the cerebral functioning of

field dependent and field independent persons such that the latter group of individuals are characterized by greater integration, rather than differentiation, between the cerebral hemispheres. Consequently, it would appear that consideration of a subject's cognitive style is important when utilizing reflective eye movements as an indicator of hemispheric specialization.

In addition to the effect of cognitive style of eye movement directionality, Ehrlichman et al. (1974) also suggest that their research findings support the idea that verbal questions elicit downward movements because an individual tends to direct his eyes downward when reading.

There are other types of explanations of the eye movement phenomenon which are unrelated to models of asymmetrical specialization in the cerebral hemispheres. Libby (1970) has suggested that direction of gaze shift is related to social maturity in that the more mature person will not break eye contact (i.e., make more stare responses) while the more immature person tends to break eye contact. Similarly, Gur (1975) attributed gaze shift directionality to the interpersonal characteristic of the face-to-face interview situation such that when facing another person, the subject diverts his/her gaze in order to avoid eye contact with the interviewer. Another explanation was offered by Meskin and Singer (1974) who proposed that the direction of gaze shift is determined by the complexity of the visual field in the interview setting with the direction of eye movements consistent in one direction only if one portion of the background field is more novel or complex than the other. Therefore, with regard to this study, in which the

background was symmetrical Meskin and Singer would have predicted a random sequencing of eye shifts which would not be related specifically to cognitive processing or hemispheric activation.

In view of the fact that the results of this study fail to support or be explained by Kinsbourne's activation model and, given the speculative, yet plausible alternative explanations for the eye movement phenomenon, it appears that the validity of the gaze shift phenomenon as a reflection of hemispheric activation is questionable.

Implications for Future Research

On the basis of the findings of this study, it is apparent that an attempt to standardize procedures for eliciting and analyzing eye movements to various types of questions resulted in minimizing or altering the effects. It appears that the eye movement phenomenon is a sensitive and complex one and at present, one can only speculate as to the mechanisms involved in determining gaze shift directionality. To what extent do situation variables, subject variables, or characteristics of the questions asked influence gaze shift directionality? Perhaps an interactive effect involving all of these variables may account for the direction of an eye movement. The present study attempted to focus on one of the least attended to of these variables and found little support for the relationship between eye movements and differential hemispheric processing. However, these findings should not act as a deterrent for further exploration into reflective eye movement behavior in general or its relationship with cerebral functioning in specific. Instead, this research should be a catalyst for future research which will focus more

precisely on the reliability and the validity of both the reflective eye movement phenomenon itself, as well as the numerous variables that appear to affect it.

Because reflective eye movement research remains a potentially valuable source of information for both its practical and theoretical implications, the following suggestions for modification, addition, and consideration in future reflective eye movement experimentation are offered:

1. The procedure of recording the direction of the first movement following a reflective question is limiting in that extent of eye movement is not measured nor does it differentiate between the different lengths of eye movements or multiple shifts that might occur in response to one question. Consequently, Galin and Ornstein (1974) suggest that future research incorporate a quantitative measure (i.e., EOG) of eye position during the entire "reflective period." Utilizing this direct measure can also serve as a reliability check of experimenter recording accuracy.

2. The possible impact of subject variables, as suggested by Ehrlichman et al. (1974) should be assessed more thoroughly in eye movement studies. (While such an assessment would allow for the exploration of one of the many variables that affect eye movement directionality, it is felt that the delineation of this one additional variable may not actually clarify the phenomenon to any great extent.)

3. A final suggestion for future research involves the kinds of questions utilized. In the majority of studies examining the relationship between question type and eye movement directionality, questions

have been developed along two general dimensions--the linguistic and the spatial--and the other classifications of questions have been subsumed under these (i.e., numerical-linguistic/musical-spatial). Because literature on hemispheric specialization has indicated that each hemisphere can process some of the other's "specialties," perhaps a more accurate and precise method of classifying questions would be to categorize questions as to their analytical/logical or to their holistic/gestalt characteristics (Galín, 1975). In so doing, perhaps a clearer effect of question type on direction of eye movement would ensue.

APPENDIX A

TRAINING QUESTIONNAIRE

TRAINING QUESTIONNAIRE

Name _____ Sex M F Recitation leader _____

Interviewer's

Name _____ Date _____

- ____ 1. Mark Twain was born in 1835. How old would he be if
Inv he / / were alive today?
- ____ 2. What is the primary difference between the words / /
Inv "mischief" and "malice"?
- ____ 3. In which hand does the Statue of Liberty / / hold her
Inv torch?
- ____ 4. In the children's song "Mary Had a Little Lamb," do
Inv you sing the word "a" at a higher, lower, or at the
same pitch as / / the word "lamb"?
- ____ 5. Solve this problem: Al is worse than Sam and Al is
Inv better than Rick. / / Who is best?
- ____ 6. Which way does Jefferson face / / on a nickel?
Inv
- ____ 7. If you draw a line from each of the upper two corners
Inv of a square to the midpoint of the bottom line of the
square, what / / three figures result?
- ____ 8. What is meant by the proverb: Strike while the / /
Inv iron is hot?
- ____ 9. Hum or go "da da da" to suggest the tune of / / "The
Inv Wedding March."
- ____ 10. Two feet three inches plus seventeen feet / / ten
Inv inches equals _____.
- ____ 11. A person dreams he attends the Metropolitan Opera
Inv dressed in rags. What do you think / / this dream
means?
- ____ 12. What was one of the most important factors in your
Inv deciding to live where / / you live now?
- ____ 13. Visualize a circle being drawn on top of a square.
Inv What is the maximum number of points at which the
two / / figures can intersect?

14. What state is directly / / south of Minnesota?
Inv
15. How much is thirteen times / / eight plus eight?
Inv
16. How many pockets are there in / / a pool table?
Inv
17. What word is this the definition of: a creature who is the / / personification of evil?
Inv
18. If you were president of the United States, what is one thing you would do to help solve the racial problems / / in this country?
Inv
(After you have observed the eye movement) condense your answer to a few words.
19. In the song "jingle bells," do you sing the beginning of the word "jingle" at a higher, a lower, or at the same pitch as / / the word "bells?"
Inv
20. Briefly, what is the meaning of this common proverb?
Inv
A rolling stone / / gathers no moss.
21. Imagine a rectangle. Divide it in half by drawing a line from the upper left hand corner to the lower right. What two figures do / / you now have?
Inv
22. What is $33 \frac{1}{3}\%$ / / of 300 dollars?
Inv
23. What other letter do you get by turning a lower case printed / / "n" upside down?
Inv
24. Visualize your University ID card. Where is your student number on it relative / / to your name?
Inv
25. Envision walking through your house, apartment, or dorm room and tell me how many / / doors there are?
Inv
26. Imagine the face of a serious woman/man making her/him as / / clear as possible?
Inv
27. Name a word that starts with L and / / ends with D.
Inv
29. Spell / / the word "therapeutic."
Inv
30. What is the primary difference between the meanings of the words / / "recognize" and "remember"?
Inv

31. Imagine the lion's head in the MGM movies. Is it tilted to its right or / / to its left?
Inv
32. Hum the tune of "Row, row / / row your boat."
Inv
33. Solve the following arithmetic problem: / / 84 times 14 equals . . .
Inv
34. Define / / the word "economics."
Inv
35. What is the color of the top stripe of / / the American flag?
Inv
36. What qualities do you think most people value / / in their friends?
Inv
37. Make up a sentence using the words / / "code" and "mathematics."
Inv
38. The product of 3 and 10 divided by the product of / / 5 and 9 equals . . .
Inv
39. What do you think is our country's / / greatest natural resource?
Inv
40. Think about the beat and then clap your hands to the beat of: "up on the / / rooftop reindeer" pause. . ."
Inv
41. If 15 cans of food are needed for 7 men for 2 days, the number of cans needed for 4 men / / for 7 days is?
Inv
42. If you could wish for something nice to happen to you, what would / / you wish for?
Inv
43. Twenty-five equals what / / percent of 125?
Inv
44. Hum the tune of / / "Deck the halls . . . "
Inv
45. I'm going to say a series of digits. When I finish I want you to say them back to me: 3-5-1 / / 2-4-1.
Inv
46. Tell me how you feel when / / you are guilty.
Inv
47. Think about the beat and then clap your hands to the beat of: / / "we shall overcome."
Inv



____ 48. Change 8,280 / / feet into yards.
Inv



____ 49. What political figure would you most like / / to
Inv see retire?



____ 50. A person dreams he is climbing a hill, but never
Inv reaches the top. What do you suppose / / this
dream means?

APPENDIX B

INSTRUCTIONS FOR RATING EYE MOVEMENTS

INSTRUCTIONS FOR RATING EYE MOVEMENTS

Please read this before you go in to view the tapes.

Eye movements are to be recorded following the completion of each question.

Scoring categories:

1. Invalid

- When S is not looking at you when you look up to say the last three words of each question.
- If S begins to move eyes before you have said last word of question.
- If S closes/covers eyes before or immediately after the completion of each question.

2. Stare

If the S keeps eyes fixed on you while he/she responds--only count as "stare."

If S looks at you for about 2 - 3 seconds, then moves eyes, or if he/she looks at you throughout response.

(Not "stare" if S is still looking at you at completion of question, but shifts gaze within 1 second after you've finished.)

3. Up

If gaze is directed upwards (with no lateral component, e.g., right or left component) following completion of question.

4. Down

If gaze is directed downwards (with no lateral component) following completion of question.

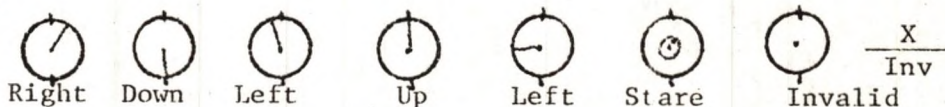
(If person's eyelids lower, but do not close, and you can tell it is downward gaze--count as "down")

5. Lateral movements

Anything not up, down, stare, or invalid following completion of question.

(Sometimes an S will look briefly to one direction then shift to another direction--score the first movement.)

EXAMPLES



If anything else comes up that is not covered in the descriptions above, be sure to note this on the last sheet of the questionnaire.

GOOD LUCK!!!!!!

APPENDIX C

COMPOSITE OF REFLECTIVE EYE MOVEMENT QUESTIONS

COMPOSITE OF REFLECTIVE EYE MOVEMENT QUESTIONS

I. MUSICAL

A. Verbal

1. Hum the part of the Star Spangled Banner beginning with the words "what so proudly we hailed. . ."
2. Hum the first phrase of Happy Birthday.
3. In the children's song, "Mary Had a Little Lamb," do you sing the word "a" at a higher, a lower, or at the same pitch as the word "Mary"?
4. In the song, "Jinglebells," do you sing the beginning of the word "jingle" at a higher, a lower, or at the same pitch as the word "bells"?
5. Compare the pitch of the beginning of the first and third words in:
 - a. Twinkle, twinkle little star . . .
 - b. Rudolph the red-nosed reindeer . . .
6. In the children's song "Mary Had a Little Lamb," do you sing the word "a" at a higher, lower or at the same pitch as the word "lamb"?
7. In the song "Jingle Bells," do you sing the end of the word "jingle" at a higher, lower, or at the same pitch as the word "bells"?
8. Compare the pitch of the beginning of the word "twinkle" and the word "star" . . . in "Twinkle, Twinkle, Little Star."
9. Compare the pitch of the words "red" and "deer" in the song "Rudolph the Red-nosed Reindeer."

B. Non-Verbal

1. Hum the tune of "Rudolph the Red-nosed Reindeer."
2. Hum the tune of "Row, Row, Row Your Boat."
3. Give the tune of Happy Birthday" without words.
4. Hum or go "da da da" to suggest the sound of the theme for the "Lone Ranger."
5. Hum the tune of the "Wedding March."
6. Hum this melody after I do: (E hums first phrase of "La Marseillaise.")

7. Hum this melody after I do: (E hums "Big Ben")
8. Think about the beat and then clap your hands to the beat of:
 - a. The Star Spangled Banner
 - b. Up On the Rooftop Reindeer Pause
 - c. We Shall Overcome
 - d. Kum Ba Ya

II. NUMERICAL

A. Word problems

1. Mark Twain was born in 1835. How old would he be if he were alive today?
2. Abraham Lincoln was born in 1809. How old would he be if he were alive today?

B. Calculations

1. How much is:

- a. $13 \times 8 + 8$?
- b. $21 \times 6 + 5$?
- c. 14×11 ?
- d. $17 \times 8 - 5$?

2. Solve the following arithmetic problem:

- a. 144 divided by 6×4 ?
- b. 1935 minus 29
- c. Subtract 12 from the product of 13×7
- d. 24 plus 98 minus 17
- e. 84×14
- f. 934 minus 561

3. Multiply:

- a. 123×7
- b. 341×11

4. Divide

- a. 486 by 9
- b. 112 by 8
- c. 154 by 7

5. What is 6 plus 7 plus 4?

6. Add 78 and 89.

7. The square root of 169 equals.

8. $9/24 = ?/8$
9. The square root of 43 equals
10. 25 equals what percent of 125?
11. $33 \frac{1}{3}$ percent of 963 equals
12. (3×10) divided by $(5 \times 9) =$
13. $1/4$ divided by $1/8$ equals
14. The square root of .09 equals
15. $2/7 \times 3/7$ equals
16. 4 and $3/4$ plus 9 and $1/2$ equals
17. 2 feet 3 inches plus 17 feet 10 inches equals
18. Find $3/4$ of 64.
19. What is the square root of 42?
20. Solve:
 - a. $3/5$ of 400 is
 - b. square $75 - 62$
 - c. $4/5$ of 600 is
 - d. the cube of $1/7$ is
 - e. $3/8$ of 720 minus 13 is
21. What is $4\frac{1}{2}\%$ of \$200.?
22. What is $33 \frac{1}{3}\%$ of \$300.?
23. What is $5\frac{1}{2}\%$ of \$200.?
24. What is $3 \frac{1}{8}\%$ of \$400.?
25. What is the square root of 90?
26. The cube of 11 = ?

III. OPINION

A. Personal/Emotional

1. Tell me how you feel when you are anxious.
2. For you is anger or hate a stronger emotion?
3. Tell me how you feel when you are frustrated.

4. Tell me how you feel when you are guilty.
 5. Tell me how you feel when you are miserable.
 6. What are some of the common worries of people your age?
 7. If you could wish for something nice to happen to you, what would you wish for?
 8. If you could change one thing about yourself, what would it be?
 9. What kinds of things do you want most out of life?
 10. What personality trait do you have that you would most like to change?
- B. Non-Personal/Non-Emotional
1. What is your favorite food?
 2. If you could be any living person, who would you be?
 3. What is your favorite color?
 4. If you had to be an animal, what animal would you be?
 5. What part of your body has given you the most difficulty in terms of illness?
 6. What current magazine do you most enjoy reading?
 7. What political figure would you most like to see retire?
 8. What was one of the most important factors in your deciding to come to UND?
 9. If a new student asked you whether or not you like UND, what is the most important thing you would want him/her to know about your experience? (After you have observed the eye movement, condense your answer to a few words.)
 10. What qualities do you think most people value in their friends?
 11. If you could change one thing about your parents, what would it be?
 12. If you could change one thing about this University, what would it be?
 13. If you could give a large sum of money to some one organization, which would you choose?

14. If you were president of the United States, what is one thing you would do to cope with the racial problem in this country?
15. If you were president of the United States, what is one thing you would do about welfare? (After you have observed the eye movement, condense your answer to a few words.)
16. How do you feel about the Women's Liberation Movement? (After you have observed the eye movement, condense your answer to a few words.)
17. If you could give a large sum of money to one or more political parties in the United States, how would you distribute the money?
18. What was one of the most important factors in your deciding to live where you live now?
19. If you were elected president what would be your first act to help solve the poverty problems of this country?
20. If a new student asked you whether or not you liked living in Grand Forks, what would you tell him about the town? (After you have observed the eye movement, condense your answer to a few words.)
21. What do you think is our country's greatest natural resource?
22. Where would you like to go on vacation?
23. How do you feel about the "Black is Beautiful" movement? (After you have observed the eye movement, condense your answer to a few words.)
24. How do you feel about the Black Power movement? (After you have observed the eye movements, condense your answer to a few words.)
25. If you were given a million dollars, what would you do with it?
26. What qualities do you think most women seek in prospective husbands?
27. What do you think this experiment is all about?
28. If you had \$1,000.00 to spend any way you liked, what would you do with it?
29. What do you think about President Ford?
30. What do you think about permitting prayers in the public schools?
31. A person dreams he attends the Metropolitan Opera dressed in rags. What do you think this dream means?

32. What do you think about giving foreign aid to underdeveloped countries?
33. A person dreams he is climbing a hill, but never reaches the top. What do you suppose this dream means?
34. What are the implications of having a woman president?
35. What should be the United States Government's general policy towards dictatorships in foreign countries? (After you have observed the eye movement) condense your feelings into an answer of three words or less.
36. What should be the United States' government's general policy towards the apartheid government of South Africa (After you have observed the eye movement) Condense your answer to a few words.
37. If you had a dollar to spend any way you liked, what would you buy?
38. If you found a lost puppy, what would you do with it?

IV. SPATIAL

A. Geometrical Relationships

1. Solve this problem: there is a cube whose top and bottom surfaces are blue, left and right sides are red and front and back are yellow. If this cube is flipped onto its front surface towards you, what color is the top surface now?
2. If you place two equilateral triangles side by side, what other standard geometric figures would you obtain?
3. If you draw a line from each of the upper two corners of a square to the mid-point of the bottom line of the square, what three figures result?
4. Which angle is greater: the smaller angle formed by the hands of a clock at 2:45 or the smaller angle formed by the hands of a clock at 2:30?
5. Which angle is greater: the smaller angle formed by the hands of a clock at ten after eleven or the smaller angle formed by the hands of a clock at twenty after eight?
6. If you cut a paper cylinder length-wise and then lay it out flat, what shape is the resulting figure?
7. Imagine a rectangle. Divide it in half by drawing a line from the upper left hand corner to the lower right. What two figures do you now have?

8. Visualize a box with a horizontal line drawn from one side to the other through the center and a circle with a diameter the same length as that line. Which figure encloses the greater area?
9. Position a cone so that the point is downwards and place a sphere within the circular opening. What popular food do you now have the shape of?
10. A hexagon is a six-sided figure. Are any two sides parallel?
11. Imagine a square rotating 360 degrees around its axis. What shape would you get?
12. Visualize a circle being drawn on top of a square. What is the maximum number of points at which the two figures can intersect?
13. Solve this problem: If a capital Z is turned upside-down and then rotated to the left 90 degrees (that is, onto its side), what will the resulting figure look like?

B. Counting Element

1. If you cut an Egyptian pyramid into symmetrical halves, how many sides would each half have?
2. How many corners are there in a solid cube?
3. If you connect the opposite corners of an octagon (that is, the shape of a stop sign) how many triangles do you get?
4. How many right angles are there in a printed capital "E"?
5. How many angles are there in the Red Cross symbol?
6. How many line segments are there in a five-pointed star?
7. Tell me how many doorknobs there are in your house, apartment, or dorm room?
8. How many rows of keys are there on a typewriter?
9. Tell me how many windows there are in your house, apartment, or dorm room.
10. Try to picture all the doors in your house, apartment, or dorm room and tell how many door knobs there are.
11. Imagine all the rooms of your house and tell me how many windows you have.
12. How many doors are there at the main entrance of the Administration Building (Twamley Hall)?

13. How many doors are there at the main entrance to the Student Center?
14. How many pockets are there in a pool table?
15. Picture a pyramid like the ones in Egypt. How many sides does it have?
16. Envision walking through your house, apartment, or dorm room and tell me how many doors there are.
17. Envision walking through your house, apartment, or dorm room and tell me how many windows there are.
18. If you are facing the front of a square house, and then walk $\frac{3}{4}$ of the way around to the left, how far to the right do you then have to go to get to the front of the house?

C. Verbal (letters) Element

1. What other letter do you get by turning a lower case printed "n" down?
2. What other letters can you get by rotating or flipping a lower case printed "p"?
3. Visualize sitting in front of a typewriter.
 - a. Where is the letter R relative to B?
 - b. Where is the letter J relative to C?
 - c. Where is the letter L in relation to K?
4. Envision the keyboard of a typewriter. In which corner of the keyboard is the letter P?
5. Name two lower case letters which go below the line of print like the letters "p" and "y".
6. Name two numbers which look the same when written on a page or reflected in a mirror.

D. Geographical/Directional

1. Name a state that borders Colorado.
2. Which of the continental United States border the Pacific?
3. Imagine the Great Lakes area. What are the states that border the Great Lakes?
4. Visualize the map of the United States. What are the states that border Nebraska?
5. Imagine a globe. Name two cities that are on opposite sides of the earth from each other.

6. Visualize a map of the United States. Which city is closer to New York, Boston or Cleveland?
7. Imagine the Great Lakes area. Above what state is the western part of the upper peninsula in Michigan?
8. Which of the continental United States border the Pacific?
9. Name three states that border the Gulf of Mexico.
10. What direction is:
 - a. Indianapolis from Grand Forks?
 - b. Fargo from Minneapolis?
11. If you were traveling from New York to San Francisco, which direction would you go?
12. Imagine you are traveling from Las Vegas to Dallas. Which states do you pass through?
13. Imagine that you are traveling from Denver to Minneapolis, which states do you pass through?
14. Imagine a map of the United States. Where is Chicago relative to Minneapolis?
15. You are heading north, you make two right turns and then a left turn. In what direction are you now heading?
16. You are heading south, you make a left turn and then a right turn. In what direction are you now heading?
17. If you are standing facing a wall and then make a $3/4$ turn to the left, another $1/2$ turn to the left and then a $1/4$ turn to the right, where is the wall with reference to yourself?
18. Imagine driving a car and approaching a "Yield" sign, which is in the shape of a triangle, to which direction does the triangle point?
19. What is the state directly south of Minnesota?
20. What is the state east of Ohio?
21. What is the third state directly south of North Dakota?
22. If a person is facing the rising sun, where is south with respect to him?
23. If you were crossing a street west to east, and a car coming from the south smashed into you, which leg would be shattered first?

24. Imagine that you are relaxing in hot sulfur baths looking westward over the Pacific Ocean in California on a clear, sunny day. Your friend is peacefully resting with his/her back toward your right side. Approximately what direction is your friend looking out over?
25. Picture the last automobile accident that you have seen. In which direction were the cars going?
26. Which direction of the compass does the front of your house, apartment, or dorm face?
27. Does your bed run parallel or perpendicular to University Avenue?
28. What direction of the compass does the front door of your house, apartment, or dorm face?
29. Assuming University Avenue runs due east, in what direction does the Education Building face?
30. Describe how one would go from the kitchen to the front door of your house or apartment.
31. If you are sitting up in your bed, which part of your house, apartment or dorm is to your right?
32. Describe the route by which you came to the Education building today.

E. General

1. There is a profile of George Washington on a quarter. Which way does he face?
2. Which president's face appears on a quarter?
3. There is a profile of Abe Lincoln on a penny. Which way does he face?
4. In which direction does Abraham Lincoln face on a penny?
5. Which way does Jefferson face on a nickel?
6. Which direction is the eagle's head turned on a quarter?
7. Which direction does the picture of Roosevelt face on a dime?
8. On a dollar bill, does George Washington's face look to the right or left?
9. In the pictures of Napoleon, which hand does he hold in his coat?
10. On the TV you watch most often, is the volume control to the right, the left, above or below the screen?

11. In which hand does the Statue of Liberty hold the torch?
12. What is the color of the top stripe of the American flag?
13. If you are the minister at a wedding, on which side of you does the bride stand?
14. The American flag is always pictured with the blue field on one side. Which is it?
15. Tell me on what side Ronald Reagan parts his hair.
16. Looking in the rear view mirror of your car at a car behind you, which side does the driver appear to be sitting on?
17. In the painting "Whistler's Mother," is the woman facing to the left or to the right?
18. Imagine the sequence of colors in the spectrum and the rainbow. Are the sequences the same?
19. Visualize your library card. Where is your student number on it relative to your name?
20. Visualize your driver's license. Where is the date of expiration on it relative to your picture?
21. Imagine the Liberty Statue in the Columbia movies. Is it facing to its right or to its left?
22. Imagine yourself standing in front of an ice cream vending machine. Is the slot to your right or to your left?
23. Imagine you are up at bat with a man on second. You line out deep to the third baseman who tries to double the man off second. Does the third baseman throw to his left or to his right?
24. Visualize a telephone dial. Where does the area code appear relative to the number?
25. Picture a circular telephone dial. As you face the dial, which number appears furthest to the left?
26. Imagine yourself standing in front of a coffee vending machine. Is the money slot to your right or to your left?
27. Imagine the lion's head in the MGM movies. Is it tilted to its right or to its left?
28. Imagine you are at bat with a man on first base. You line out to the second baseman who then tries to double the runner off first. Does the second man throw to his left or to his right?

29. Visualize your social security card. Where is your number on it relative to your name.

F. Images

1. Try to form a mental picture of what I'm going to tell you and tell me when the picture is as clear as you can get it:
 - a. a poodle
 - b. a forest
 - c. an ocean liner
 - d. ex-president Nixon's face
2. With your eyes open, try to have an image of:
 - a. President Gerald Ford's face
 - b. past president John F. Kennedy's face
3. Imagine the face of a serious man/woman making him/her as clear as possible.
4. Imagine the face of a smiling man/woman and try to make him/her as clear as possible.
5. With your eyes open, try to have an image of:
 - a. a man (woman for female Ss) crying
 - b. the face of a person who is sad
 - c. the face of a person who is angry
 - d. the face of a person who is happy
 - e. the face of a member of your family
 - f. the face of an acquaintance whom you see frequently
 - g. the face of someone who is surprised
 - h. a woman laughing (a man laughing)
6. When you visualize your father's face, what emotion first strikes you?
7. Picture and describe the most joyous scene that you have recently been in.
8. Picture and describe the last situation in which you cried.
9. Picture and describe the most anxious scene that you have recently been in.
10. Visualize your face. What part of your face is most expressive of your emotion?
11. Visualize and describe the most upsetting photograph of the Viet Nam war that you have seen.

V. VERBAL

A. Proverbs

1. What is meant by the proverb:
 - a. It's an ill wind that blows nobody good.
 - b. It is better to have a bad peace than a good war.
 - c. Strike while the iron is hot.
 - d. Don't cast pearls before swine.
 - e. Riches serve a wise man, but command a fool.
 - f. The proof of the pudding is in the eating.
 - g. Easy come, easy go.
2. Briefly, what is the meaning of this common proverb:
 - a. Let sleeping dogs lie.
 - b. Don't swap horses in mid-stream.
 - c. When the cat's away the mice will play.
 - d. Too many cooks spoil the broth.
 - e. A rolling stone gathers no moss.
 - f. One today is worth two tomorrows.
 - g. People in glass houses shouldn't throw stones.
3. Interpret the proverb:
 - a. The tongue is the enemy of the throat.
 - b. When they offer you a heifer, come running with a halter.
 - c. Penny-wise, pound-foolish.
4. Explain:
 - a. A watched pot never boils.
 - b. Rome was not built in a day.
 - c. One may ride a free horse to death.
 - d. All that glitters is not gold.
 - e. Hope is the poor man's bread.
 - f. A drowning man will clutch a straw.
 - g. They that are mute want to talk most.
 - h. What saddens a wise man gladdens a fool.
 - i. Don't judge a book by its cover.
 - j. Words cut more than swords.
 - k. Don't throw good money after bad.
 - l. Stitch in time saves nine.
 - m. He that lies on the ground cannot fall.
 - n. Where there is a will, there is a way.
 - o. Riches serve a wise man, but command a fool.
 - p. He who pleased everybody died before he was born.
 - q. All's well that ends well.
 - r. As you make your bed, so you must lie in it.
 - s. It's better to have a good enemy than a bad friend.
 - t. It never rains but it pours.
 - u. Too many cooks spoil the broth.
 - v. The more cost, the more honor.
 - w. Better happy than wise.
 - x. Call no man happy until he is dead.
 - y. A bird in the hand is worth two in the bush.

5. What does this proverb mean?
 - a. The hardest work is to go idle.
 - b. In the mirror everyone sees his best friend.
 - c. A watched pot never boils.
 - d. Better a good enemy than a bad friend.
 - e. If you can't bite, don't show your teeth.
 - f. A poor worker blames his tools.
 - g. Words should be weighed, not counted.

B. Logic/Analogies

1. Beef is to steer as pork is to _____.
2. Richard is to Dick as Margaret is to _____.
3. Solve this problem:
 - a. John is better than Phil, and Mike is worse than Phil. Who is worst?
 - b. Jim is better than Ted, and Ted is better than Bob. Who is best?
 - c. Greg is worse than Joe, and Steve is worse than Greg. Who is worst?
 - d. Al is worse than Sam and Al is better than Rick. Who is best?
 - e. Al is smarter than Sam and Al is duller than Rick. Who is smarter?

C. Numerical Counting Element

1. How many letters are there in the word:
 - a. Pennsylvania
 - b. Washington, D.C.
 - c. anthropology
 - d. establishment
 - e. automobile
 - f. alphabet
 - g. maintenance
 - h. Jefferson
 - i. government
 - j. California
 - k. sociology
 - l. altruistic
 - m. catapult
 - n. Washington
 - o. Montana
2. How many congressmen are there in the United States House of Representatives?
3. What is the ninth letter of the alphabet?
4. Name an English word with nine letters?

5. What is the eleventh letter of the alphabet?
6. Name a word with 3 syllables.
7. What is the seventh word of the Pledge of Allegiance?

D. Spelling

1. Spell:
 - a. guarantee
 - b. recommendation
 - c. therapeutic
2. Name a word whose first three letters are:
 - a. SYN
 - b. MAG
3. Name a word that starts with L and ends with D.
4. Name a two syllable word with the stress on the last syllable.
5. Think of a word beginning with L and ending with C.
6. Think of a word beginning with W and ending with F.
7. What is an English word that:
 - a. begins with L and ends with K?
 - b. begins with M and ends with C?
 - c. begins with a C and ends with a K?
 - d. begins with an A and ends with a B?
8. How do you spell "society" backwards?
9. How do you spell "psychology" backwards?

E. Definitions

1. Define:
 - a. winter
 - b. repair
 - c. breakfast
 - d. fabric
 - e. slice
 - f. assemble
 - g. conceal
 - h. enormous
 - i. hasten
 - j. sentence
 - k. justice
 - l. economics
 - m. inflation

2. What is the definition of the word:
 - a. licorice
 - b. pencil
 - c. strength
 - d. time

3. What word is this the definition of:
 - a. a plant used in the making of paper.
 - b. a creature who is the personification of evil.
 - c. a tall flower with yellow petals around a large, dark center.
 - d. a narrow cylinder with lenses at both ends.
 - e. success in any contest involving the defeat of an opponent.
 - f. a yellow elongated fruit.
 - g. government by one man rule.
 - h. a rule which guides conduct.
 - i. a large spotted animal with a long neck.
 - j. a dairy product often eaten by people on diets.
 - k. a meat eating animal native to India.
 - l. fair and impartial meaning of laws.

4. What is the primary difference between the meanings of the words "recognize" and "remember"?

5. What is the primary difference between the words "explain" and "define."

6. What is the primary difference between the meanings of the words "flexible" and "reasonable"?

7. Define charity.

8. What is the meaning of "shame"?

9. In what ways are praise and punishment alike?

10. What is the primary difference between the words "mischief" and "malice"?

11. What is the primary difference between the meanings of the words "pride" and "vanity"?

- F. Grammar
 1. There is something wrong with the following sentence. What is it?
 - a. Everyone of the one hundred soldiers were in their uniforms.
 - b. The man is six feet short.
 - c. In the middle of hanging out the wash, the wind blew down the clothes line.
 - d. He will do it yesterday.

2. Make up a sentence using:
 - a. two forms of the same verb.
 - b. two adverbs.
 - c. two different tenses of two different verbs.
 - d. the words "code" and "mathematics".
 - e. the words "present" and "quest".
3. Give the different forms of the verb "to be".
4. List:
 - a. four adverbs
 - b. four conjunctions
 - c. four parts of speech
 - d. four prepositions
5. Tell me five verbs beginning with R.
6. Tell me four verbs beginning with N.
7. Make up a sentence using the words:
 - a. shock and sadness
 - b. rhapsody and pleasure
8. What is a word that rhymes with "parade"?
9. What is a word that rhymes with "soft"?
10. Name the opposite of reject.

APPENDIX D

LISTING OF REFLECTIVE EYE MOVEMENT QUESTIONS BY CATEGORIES
AND SUB CATEGORIES THAT WERE USED TO COMPRISE
THE QUESTIONNAIRE FOR EXPERIMENT I

LISTING OF REFLECTIVE EYE MOVEMENT QUESTIONS BY CATEGORIES
AND SUB CATEGORIES THAT WERE USED TO COMPRISE
THE QUESTIONNAIRE FOR EXPERIMENT I

I. MUSICAL

A. Verbal

1. Hum the part of the "Star Spangled Banner" beginning with the words "what so proudly we hailed . . . "
2. In the song "Jingle Bells," do you sing the beginning of the word "jingle" at a higher, a lower, or at the same pitch as the word "bells"?
3. Compare the pitch of the words "red" and "deer" in the song "Rudolph the Red-nosed Reindeer."
4. Hum the part of "Row, Row, Row Your Boat" beginning with the words "merrily, merrily, merrily . . . "
5. In the children's song, "Mary Had a Little Lamb," do you sing the word "a" at a higher, a lower, or at the same pitch as the word "Mary"?
6. Compare the pitch of the word "top" and the beginning of the word "amokey" in the song "On Top of Old Smokey."
7. In the children's song "Baa, Baa, Black Sheep" is the word "black" at a higher, a lower, or at the same pitch as the word "sheep"?

B.

1. Hum the tune of "The Wedding March."
2. Hum or go "da, da, da" to suggest the theme for "The Lone Ranger."
3. Hum the tune of "Pomp and Circum stances."
4. Hum or go "da, da, da" to suggest the theme from "Batman."
5. Think about the beat then clap your hands to the beat of "Silent Night."
6. Think about the beat then clap your hands to the beat of "Happy Birthday."
7. Hum the first phrase of "I've Been Working on the Railroad" without words.

II. NUMERICAL

A. Calculations

1. How much is 14×11 ?
2. Twenty-five equals what percent of 125?
3. The square root of 169 equals?
4. The product of 4 and 6 divided by the product of 3 and 3 equals?
5. Solve the following arithmetic problem: 1935 minus 29 equals?
6. What is 75 percent of 200?
7. How much is 13 plus 37 minus 25?

B. Word Problems

1. Mark Twain was born in 1835. How old would he be if he were alive today?
2. If eight men get together at a reunion, and each man shakes hands once with each of the others, the total number of handshakes is _____.
3. If "X" is less than 10, and "Y" is less than 5, then $X + Y$ is less than _____.
4. If 15 cans of food are needed for 7 men for 2 days, the number of cans needed for 4 men for 7 days equals _____.
5. If you have six and a half yards of material, how many feet of material would you have?
6. If a person can buy one dozen apples for \$1.80, how much will 8 apples cost?
7. How many miles are there in 50 kilometers if there are 1.61 miles to a kilometer.

III. OPINION

A. Personal-emotional

1. For you is anger or hate a stronger emotion?
2. Tell me how you feel when you are anxious.
3. If you could change one thing about yourself, what would it be?
4. Tell me how you feel when you are guilty.

5. If you could wish for something nice to happen to you, what would you wish for?
 6. If you could change one thing about your parents, what would that be?
 7. Tell me how you feel when you love someone.
- B. Personal/Non-emotional
1. What do you think is our country's greatest natural resource?
 2. A person dreams he attends the Metropolitan opera dressed in rags. What do you think this dream means?
 3. What was one of the most important factors in your deciding to live where you live now?
 4. If you were president of the United States, what is one thing you could do to help solve the racial problems in this country?
 5. What qualities do you think most people value in their friends?
 6. If you were given a large sum of money, what would be the first thing you would do with some or all of it?
 7. What is the title or the most memorable book you have read in the past three years?

IV. SPATIAL

- A. Geometrical Element
1. If you draw a line from each of the upper two corners of a square to the midpoint of the bottom line of the square, what three figures result?
 2. If you place two equilateral triangles side by side, what other standard geometric figures would you obtain?
 3. What shape would you get if you rotated a square 360° around its axis?
 4. A pentagon is a five sided figure. Are any two sides parallel to each other?
 5. If you cut a paper cylinder lengthwise and then lay it out flat, what shape is the resulting figure?
 6. Which angle is greater: the smaller angle formed by the hands of a clock at 3:35 or the smaller angle formed by the hands of a clock at 1:30?

7. If a capital "Z" is turned upside down and then rotated to the left 90° (that is, onto its side), what will the resulting figure look like?

B. Counting Element

1. How many angles are there in the red cross symbol?
2. If you cut an Egyptian pyramid into symmetrical halves, how many sides would each half have?
3. If you draw a circle on top of a square, what is the maximum number of points at which the two figures can intersect?
4. How many rows of keys are there on a typewriter?
5. How many pockets are there in a pool table?
6. How many windows are there in your house, apartment, or dorm room?
7. How many mirrors are there in your house, apartment, or dorm room?

C. Verbal (letters) Element

1. What other letter do you get by turning a lower case printed "n" upside down?
2. Visualize sitting in front of a typewriter. Where is the letter "r" relative to the letter "b"?
3. What other letters can you get by rotating or flipping a lower case printed "p"?
4. In which corner of the typewriter keyboard is the letter "p"?
5. On a typewriter keyboard, where is the letter "a" relative to the letter "l"?
6. Name three letters that look the same when reflected in a mirror.
7. In which corner of the typewriter keyboard is the letter "q"?

D. Geographical/Directional

1. Which of the continental United States border the Pacific Ocean?
2. Imagine you are traveling from Denver to Minneapolis, which states do you pass through?
3. If a person is facing the rising sun, where is the south with respect to him?
4. What is the state directly west of Illinois?

5. If a person is facing the rising moon, where is the east with respect to her?
6. Name two cities that are on opposite sides of the globe from each other.
7. Imagine driving a car and approaching a "yield" sign, which is in the shape of a triangle, in which direction does the triangle point?

E. General

1. In which direction does Abraham Lincoln face on a penny?
2. In the pictures of Napoleon, which hand does he hold in his coat?
3. In the painting "Whistler's Mother" is the woman facing to the left or to the right?
4. In which hand does the Statue of Liberty hold the torch?
5. On your Social Security card, where is your number relative to your name?
6. When facing a circular telephone dial, which number appears furthest to the left?
7. What is the color of the bottom stripe of the American flag?

F. Images

1. Who looked more like John Kennedy--Bobby or Teddy?
2. When you visualize your father's face, what emotion first strikes you?
3. Picture and describe the most joyous scene you have recently been in.
4. When you visualize your face, what part is most expressive of your emotions?
5. Try to form a mental picture of what I'm going to tell you and tell me when the picture is as clear as you can get it: the face of a person who is angry.
6. Imagine the face of a smiling man/woman and tell me when the image is as clear as you can make it.
7. Try to form a mental image of what I'm going to tell you and tell me when the picture is as clear as you can make it: the face of an acquaintance whom you see frequently.

V. VERBAL

A. Proverbs

1. What is meant by the proverb: "Strike while the iron is hot."?
2. Explain: "He that lies on the ground cannot fall."
3. Briefly, what is the meaning of this common proverb: "The more cost, the more honor."
4. Explain: "It's better to have a good enemy than a bad friend."
5. Explain: "A bird in the hand is worth two in the bush."
6. Interpret the proverb: "Rome was not built in a day."
7. What does this proverb mean: "Shallow brooks are noisy."?

B. Logic/Analogies

1. Beef is to steer as pork is to _____.
2. Solve this problem: John is better than Phil, and Mike is worse than Phil. Who is worst?
3. Apple is to fruit as table is to _____.
4. Solve this problem: Mary is older than Sue and Sue is younger than Jane. Who is youngest?
5. Richard is to Dick as Margaret is to _____.
6. Solve this problem: Al is smarter than Sam and Al is duller than Rick. Who is smartest?
7. Solve this problem: Jim is better than Bill and Bill is better than Eric. Who is best?

C. Counting/Numerical Element

1. How many congressmen are there in the United States House of Representatives?
2. How many letters are there in the word "Pennsylvania?"
3. What is the eleventh letter of the alphabet?
4. Name an English word with six letters.
5. What is the seventh word of the "Pledge of Allegiance?"
6. How many letters are there in the word "parallel?"

7. How many letters are there in the word "psychology?"

D. Spelling

1. Spell the word "therapeutic."

2. Name a word whose first three letters are SYN.

3. What is an English word that begins with "L" and ends with "K?"

4. How do you spell "society" backwards?

5. Spell the word "guarantee."

6. Spell the word "miscellaneous."

7. What is an English word that begins with "D" and ends with "D?"

E. Definitions

1. Define: economics.

2. What is the definition of the word "time?"

3. What word is this the definition of: a creature who is the personification of evil?

4. What is the primary difference between the words "recognize" and "remember?"

5. Define the word "pride."

6. In what ways are "praise" and "punishment" alike?

F. Grammar

1. There is something wrong in the following sentence. What is it?
"Everyone of the six soldiers were in their uniforms."

2. Make up a sentence using the words "code" and "mathematics."

3. Make up a sentence using two forms of the same verb.

4. What is a word that rhymes with "soft?"

5. What word is the opposite of "Assemble?"

6. What is a synonym for the word "enormous?"

7. What word rhymes with "repair?"

APPENDIX E

SAMPLE QUESTIONNAIRE USED IN EXPERIMENT I

SAMPLE QUESTIONNAIRE USED IN EXPERIMENT I

- _____
Inv What is the primary difference between / / "recognize" and "remember."
- _____
Inv How many letters are there in / / the word "parallel?"
- _____
Inv Name a word whose first three / / letters are SYN.
- _____
Inv What is a word that / / rhymes with "soft"?
- _____
Inv In which hand does the Statue of Liberty / / hold the torch?
- _____
Inv Which angle is greater: the smaller angle formed by the hands of a clock at 3:35 or the smaller angle formed by the hands of a / / clock at 1:30?
- _____
Inv If you could change one thing about your parents, what / / would that be?
- _____
Inv How many pockets are there in / / a pool table?
- _____
Inv How much is / / 14×11 ?
- _____
Inv What other letters can you get by rotating or flipping a lower / / case printed "p"?
- _____
Inv Explain: "He that lies on the / / ground cannot fall."
- _____
Inv Hum the part of the "Star Spangled Banner" beginning with the words "what so / / proudly we hailed . . ."
- _____
Inv Solve this problem: Jim is better than Bill and Bill is better than Eric. / / Who is best?
- _____
Inv Imagine driving a car and approaching a "yield" sign, which is in the shape of a triangle. In which direction does / / the triangle point?
- _____
Inv What qualities do you think most people value / / in their friends?
- _____
Inv If "X" is less than 10, and "Y" is less than 5, then $X + Y$ / / is less than ____.
- _____
Inv Hum the tune of / / "Pomp and Circumstances."

Inv Picture and describe the most joyous scene you have / / recently been in.

Inv A person dreams he attends the Metropolitan opera dressed in rags. What do you think / / this dream means?

Inv Hum or go "da da da" to suggest the theme for / / "The Lone Ranger."

Inv Try to form a mental picture of what I'm going to tell you and tell me when the picture is as clear as you can get it: the face of a person / / who is angry.

Inv Visualize sitting in front of a typewriter. Where is the letter "r" relative to / / the letter "b"?

Inv If a person can buy one dozen apples for \$1.80, how much will / / 8 apples cost?

Inv What shape would you get if you rotated a square 360 degrees / / around its axis?

Inv Imagine you are traveling from Denver to Minneapolis, which states do / / you pass through?

Inv Solve this problem: Al is smarter than Sam and Al is duller than Rick. / / Who is smartest?

Inv Tell me how you feel when / / you are guilty?

Inv In the children's song "Mary Had a Little Lamb," do you sing the word "a" at a higher, a lower, or at the same pitch as / / the word "Mary"?

Inv What does this proverb mean: "Shallow / / brooks are noisy"?

Inv Twenty-five equals what / / percent of 125?

Inv If you draw a circle on top of a square, what is the maximum number of points at which the two / / figures can intersect?

Inv When facing a circular telephone dial, which number appears furthest / / to the left?

Inv What word / / rhymes with "repair"?

Inv Spell / / the word "misellaneous."

What is the seventh word of the / / "Pledge of Allegiance."

Inv

Define / / the word "pride."

Inv

How much is 13 plus / / 37 minus 25?

Inv

In what ways are "praise" / / and "punishment" alike?

Inv

Hum the part of "Row, Row, Row Your Boat" beginning with the words / / "merrily, merrily, merrily . . . "

Inv

If a capital "Z" is turned upside down and then rotated to the left 90 degrees (that is, turned onto its side), what will the resulting / / figure look like?

Inv

What is an English word that begins with "D" and / / ends with "D"?

Inv

What is the color of the bottom stripe of / / the American flag?

Inv

If you could change one thing about yourself, what / / would it be?

Inv

Think about the beat then clap your hands to the beat / / of "Happy Birthday."

Inv

Mark Twain was born in 1835. How old would he be if he / / were alive today?

Inv

What is the state directly / / west of Illinois?

Inv

In which corner of the typewriter keyboard is / / the letter "Q"?

Inv

If you were given a large sum of money, what would be the first thing you would do with some or / / all of it?

Inv

How many mirrors are there in your house, apartment, / / or dorm room?

Inv

What is meant by the proverb: "Strike while the / / iron is hot"?

Inv

Beef is to steer as / / pork is to _____.

Inv

Inv



There is something wrong in the following sentence. What is it? "Everyone of the six soldiers were / / in their uniforms."

Inv



Try to form a mental image of what I'm going to tell you and tell me when the picture is as clear as you can make it: the face of an acquaintance whom / / you see frequently.

Inv



How do you / / spell "society" backwards?

Inv



A pentagon is a five-sided figure. Are any two sides parallel / / to each other?

Inv



Hum the first phrase of "I've been working on the / / Railroad" without words.

Inv



For you is anger or hate / / a stronger emotion?

Inv



If you draw a line from each of the upper two corners of a square to the midpoint of the bottom line of the square, what / / three figures result?

Inv



Name two cities that are on opposite sides of the globe / / from each other.

Inv



What is an English word that begins with "L" and / / ends with "K?"

Inv



Define / / the word "economics."

Inv



What word is the / / opposite of "assemble?"

Inv



The product of 4 and 6 divided by the product of / / 3 and 3 equals ____.

Inv



What is the title of the most memorable book you have read in the / / past three years?

Inv



On the typewriter keyboard, where is the letter "a" relative to / / the letter "l?"

Inv



In which direction does Abraham Lincoln / / face on a penny?

Inv



Briefly, what is the meaning of this common proverb: "The more cost, / / the more honor?"

Inv



How many letters are there in / / the word "Pennsylvania?"



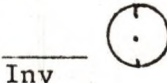
Inv

What is the eleventh / / letter of the alphabet?



Inv

Who looked more like John Kennedy? / / Bobby or Teddy?



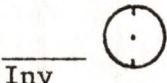
Inv

Solve this problem: Mary is older than Sue and Sue is younger than Jane / / . Who is youngest?



Inv

How many angles are there in the / / red cross symbol?



Inv

In the children's song "Baa, Baa Black Sheep" is the word "black" at a higher, a lower, or at the same pitch as / / the word "sheep?"



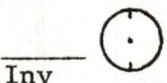
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Solve the following arithmetic problem: 1935 / / minus 29 equals _____.



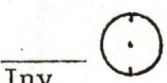
Inv

If you could wish for something nice to happen to you, what would / / you wish for?



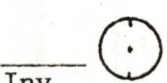
Inv

How many rows of keys are there / / on a typewriter?



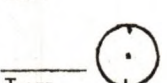
Inv

What is the definition of / / the word "time?"



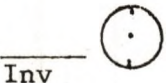
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If you have six and a half yards of material, how many feet of material / / would you have?



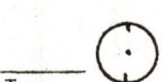
Inv

Think about the beat then clap your hands to the beat / / of "Silent Night."



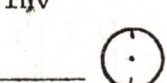
Inv

If you were president of the United States, what is one thing you could do to help solve the racial problems / / in this country?



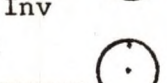
Inv

How many letters are there in / / the word "psychology?"



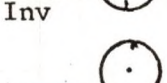
Inv

Make up a sentence using two forms of / / the same verb.



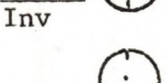
Inv

Apple is to fruit as / / table is to _____.



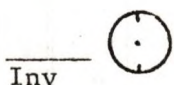
Inv

Explain: "A bird in the hand is worth two / / in the bush."



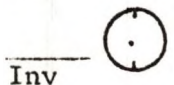
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If you cut an Egyptian pyramid into symmetrical halves, how many sides would / / each half have?



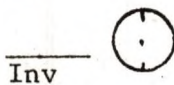
Inv

Compare the pitch of the word "top" and the beginning of the word "smokey" in the song "On Top / / of Old Smokey."



Inv

If 15 cans of food are needed for 7 men for 2 days, the number of cans needed for 4 men for / / 7 days equal ____.



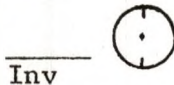
Inv

In the painting "Whistler's Mother" is the woman facing to the left or / / to the right?



Inv

Which of the continental United States border / / the Pacific Ocean?



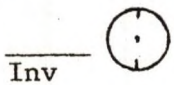
Inv

When you visualize your face, what part is most expressive / / of your emotions?



Inv

In which corner of the typewriter keyboard is / / the letter "p?"



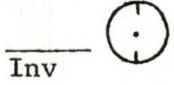
Inv

Hum or go "da da da" to suggest the theme / / from Batman.



Inv

The square root / / of 169 equals ____.



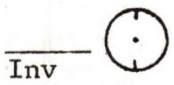
Inv

Name three letters that look the same when reflected / / in a mirror.



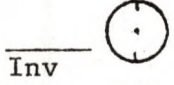
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What is a synonym for / / the word "enormous?"



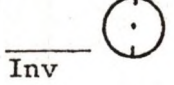
Inv

Interpret the proverb: "Rome was not built / / in a day."



Inv

If a person is facing the rising moon, where is the east with / / respect to her?



Inv

What was one of the most important factors in your deciding to live where / / you live now?



Inv

If you cut a paper cylinder lengthwise and then lay it out flat, what shape is / / the resulting figure?



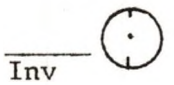
Inv

Compare the pitch of the words "red" and "deer" in the song "Rudolph the / / Red-nosed Reindeer."





















Inv

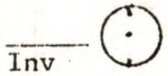
If eight men get together at a reunion and each man shakes hands once with each of the others, the total number / / of handshakes is ____.



Inv

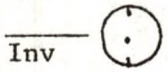
Tell me how you feel when / / you are anxious.

- ____ Inv  On your social security card, where is your number relative / / to your name?
- ____ Inv  Richard is to Dick as / / Margaret is to _____.
- ____ Inv  Name an English word / / with six letters.
- ____ Inv  When you visualize your father's face, what emotion / / first strikes you?
- ____ Inv  Spell / / the word "guarantee."
- ____ Inv  If you place two equilateral triangles side by side, what other standard geometric figures / / would you obtain?
- ____ Inv  What do you think is our country's / / greatest natural resource?
- ____ Inv  In the song "Jingle Bells," do you sing the beginning of the word "Jingle" at a higher, a lower, or at the same pitch as / / the word "bells?"
- ____ Inv  If a person is facing the rising sun, where is the south with / / respect to him?
- ____ Inv  Imagine the face of a smiling man/woman and tell me when the image is as clear as you / / can make it.
- ____ Inv  How many congressmen are there in the United States / / House of Representatives?
- ____ Inv  Make up a sentence using the words / / "code" and "mathematics."
- ____ Inv  Hum the tune of / / the "Wedding March."
- ____ Inv  How many windows are there in your house, apartment / / or dorm room?
- ____ Inv  Tell me how you feel when / / you love someone.
- ____ Inv  What is 75 / / percent of 200?
- ____ Inv  What other letter do you get by turning a lower case printed / / "n" upside down?
- ____ Inv  Explain: It's better to have a good enemy than/ / a bad friend.



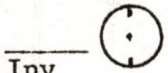
Inv

Spell / / the word "therapeutic."



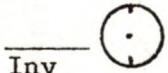
Inv

If there are 1.61 miles to a kilometer, how many miles are there / / in 50 kilometers?



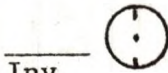
Inv

Solve this problem: John is better than Phil, and Mike is worse than Phil. / / Who is worse?



Inv

In the pictures of Napoleon, which hand does he hold/ / in his coat?



Inv

What word is this the definition of: a creature who is the / / personification of evil?

APPENDIX F

NUMBER AND SEX OF SUBJECTS ADMINISTERED EITHER FORM A OR FORM B
OF THE EYE MOVEMENT QUESTIONNAIRE BY EACH OF THE SIX INTERVIEWERS

NUMBER AND SEX OF SUBJECTS ADMINISTERED EITHER FORM A OR FORM B
OF THE EYE MOVEMENT QUESTIONNAIRE BY EACH OF THE SIX INTERVIEWERS

SUBJECTS

MALE

FEMALE

	FORM A	FORM B	FORM A	FORM B	TOTAL
PB	3	4	4	3	14
	0	1	1	1	3
LE	3	3	3	3	12
FEMALE	2	0	1	1	4
LA	2	3	4	3	12
	1	3	2	2	8
RM	4	2	2	3	11
	0	1	0	1	2
DC	3	2	2	3	10
MALE	1	0	1	0	2
JH	3	3	4	3	13
	1	1	0	0	2
TOTAL	18	17	19	18	72
	5	6	5	5	21

NOTE: Upper portion of each square denotes number of subjects in that particular category who were administered the questionnaire. Lower portion of each square denotes number of subjects whose data was not used because they exhibited too many invalid responses.

APPENDIX G

CROVITZ AND ZENER'S HANDEDNESS QUESTIONNAIRE

CROVITZ AND ZENER'S HANDEDNESS QUESTIONNAIRE

Name _____

Discussion Section _____

Date _____ Sex M or F
(Circle one)

GTA _____

Answer the following questions carefully. Imagine yourself performing the activity described before answering each question. Answer by drawing a circle around the appropriate set of letters appearing to the left of each question whose meanings is:

Ra = right hand always

La = left hand always

Rm = right hand most of the time

Lm = left hand most of the time

E = both hands equally often

X = do not know which hand

- (1) Ra Rm E Lm La X : is used to write with.
- (2) Ra Rm E Lm La X : to hold nail when hammering.
- (3) Ra Rm E Lm La X : to throw a ball.
- (4) Ra Rm E Lm La X : to hold bottle when removing top.
- (5) Ra Rm E Lm La X : is used to draw with.
- (6) Ra Rm E Lm La X : to hold potato when peeling.
- (7) Ra Rm E Lm La X : to hold pitcher when pouring out of it.
- (8) Ra Rm E Lm La X : to hold scissors when cutting.
- (9) Ra Rm E Lm La X : to hold knife when cutting food.
- (10) Ra Rm E Lm La X : to hold needle when threading.
- (11) Ra Rm E Lm La X : to hold drinking glass when drinking.
- (12) Ra Rm E Lm La X : to hold toothbrush when brushing teeth.
- (13) Ra Rm E Lm La X : to hold dish when wiping.
- (14) Ra Rm E Lm La X : holds tennis racket when playing.

APPENDIX H

REFLECTIVE EYE MOVEMENT QUESTIONNAIRE USED IN EXPERIMENT II

REFLECTIVE EYE MOVEMENT QUESTIONNAIRE USED IN EXPERIMENT II

- _____
Inv 1. How many windows are there in your house, apartment,
/ / or dorm room?
- _____
Inv 2. Spell / / the word "miscellaneous."
- _____
Inv 3. In the pictures of Napoleon, which hand does he hold
/ / in his coat?
- _____
Inv 4. What is an English word that begins with "D: and
/ / ends with "D"?
- _____
Inv 5. Briefly, what is the meaning of this common proverb:
"The more cost, / / the more honor"?
- _____
Inv 6. What is the definition of / / the word "time"?
- _____
Inv 7. How many rows of keys are there / / on a typewriter?
- _____
Inv 8. What is the seventh word of the / / "Pledge of
Allegiance"?
- _____
Inv 9. Which angle is greater: the smaller angle formed
by the hands of a clock at 3:35 or the smaller angle
formed by the hands of a / / clock at 1:30?
- _____
Inv 10. Compare the pitch of the word "top" and the beginning
of the word "smokey" in the song "On Top of / / Old
Smokey."
- _____
Inv 11. If 15 cans of food are needed for 7 men for 2 days,
the number of cans needed for 4 men for / / 7 days
equals _____.
- _____
Inv 12. A person dreams he attends the Metropolitan opera
dressed in rags. What do you think / / this dream
means?
- _____
Inv 13. If you could change one thing about yourself, what
/ / would it be?
- _____
Inv 14. For you is anger or hate / / a stronger emotion?
- _____
Inv 15. Twenty-five equals what / / percent of 125?

- _____
Inv 16. Hum or go "da da da" to suggest the theme for / /
"The Lone Ranger."
- _____
Inv 17. How many letters are there in / / the word "parallel"?
- _____
Inv 18. If you were given a large sum of money, what would
be the first thing you would do with some or / /
all of it?
- _____
Inv 19. Hum the part of the "Star Spangled Banner" beginning
with the words "What so / / proudly we hailed . . . "
- _____
Inv 20. Spell / / the word "guarantee."
- _____
Inv 21. How do you / / spell "society" backwards?
- _____
Inv 22. Visualize sitting in front of a typewriter. Where
is the letter "r" relative to / / the letter "b"?

REFERENCES

REFERENCES

- Ashton, V. L., & Dwyer, J. H. The left: Lateral eye movements and ideology. Perceptual and Motor Skills, 1975, 41, 248-250.
- Bakan, P. Hypnotizability, laterality of eye-movements and functional brain asymmetry. Perceptual and Motor Skills, 1969, 28, 927-932.
- Bakan, P. The eyes have it. Psychology Today, 1971, 4, 64-69.
- Bakan, P. Lateral eye movement consistency and academic aptitude: Failure to replicate. Perceptual and Motor Skills, 1975, 41, 85-86.
- Bakan, P., & Shotland, R. Lateral eye movement, reading speed, and visual attention. Psychometric Science, 1969, 15, 93-94.
- Bakan, P., & Strayer, F. F. On reliability of conjugate lateral eye movements. Perceptual and Motor Skills, 1972, 36, 429-430.
- Bakan, P., & Svorad, D. Resting EEG alpha and asymmetry of reflective lateral eye movements. Nature, 1969, 223, 975-976.
- Benton, A. L. Clinical symptomatology in right and left hemisphere lesions. In V. B. Mountcastle (Ed.), Interhemispheric relations and cerebral dominance. Baltimore: Johns Hopkins Press, 1962.
- Bogen, J. E. The other side of the brain: I, II, III. Bulletin of the Los Angeles Neurological Society, 1969, 34, 73-105, 135-162, 191-220.
- Crouch, W. W. Dominant direction of conjugate lateral eye movement and responsiveness to facial and verbal cues. Perceptual and Motor Skills, 1976, 42, 167-174.
- Crovitz, H. F., & Zener, K. A group test for assessing hand and eye dominance. The American Journal of Psychology, 1962, 75, 271-276.
- Day, M. An eye movement phenomenon relating to attention, thought and anxiety. Perceptual and Motor Skills, 1964, 19, 443-446.
- Day, M. An eye movement indicator of individual differences in the physiological organization of attentional processes and anxiety. The Journal of Psychology, 1967a, 66, 51-62.
- Day, M. An eye-movement indicator of type and level of anxiety: Some clinical observations. Journal of Clinical Psychology, 1967b, 23, 438-441.

- Day, M. Attention, anxiety and psychotherapy. Psychotherapy: Theory, Research and Practice, 1968, 5, 146-149.
- Duke, J. D. Lateral eye movement behavior. The Journal of General Psychology, 1968, 78, 189-195.
- Ehrlichman, H., Weiner, S. L., & Baker, A. H. Effects of verbal and spatial questions on initial gaze shifts. Neuropsychologia, 1974, 12, 265-277.
- Etaugh, C. F. Personality correlates of lateral eye movement and handedness. Perceptual and Motor Skills, 1972, 34, 751-754.
- Etaugh, C. F., & Rose, M. Lateral eye movement: Elusive personality correlates and moderate stability estimates. Perceptual and Motor Skills, 1972, 37, 211-217.
- Galin, D. Two modes of consciousness and the two halves of the brain. In R. E. Ornstein (Ed.), Symposium on consciousness. San Francisco, Calif.: Viking Press, 1975.
- Galin, D., & Ornstein, R. Individual differences in cognitive style-I. Reflective eye movements. Neuropsychologia, 1974, 12, 367-376.
- Gazzaniga, M. S. The bisected brain. New York: Appelson-Century-Crofts, 1970.
- Gur, R. E. Conjugate lateral eye movements as an index of hemispheric activation. Journal of Personality and Social Psychology, 1975, 31, 751-757.
- Gur, R. E., Gur, R. C., & Harris, L. J. Cerebral activation, as measured by subjects' lateral eye movements, is influenced by experimenter location. Neuropsychologia, 1975, 13, 35-44.
- Gur, R. E., & Reyher, J. Relationship between style of hypnotic induction and direction of lateral eye movements. Journal of Abnormal Psychology, 1973, 82, 449-505.
- Harnad, S. R. Creativity, lateral saccades, and the nondominant hemisphere. Perceptual and Motor Skills, 1972, 34, 653-654.
- Hecaen, H. Clinical symptomatology in right and left hemisphere lesions. In V. B. Mountcastle (Ed.), Interhemispheric relations and cerebral dominance. Baltimore: Johns Hopkins Press, 1962.
- Kimura, D. Functional asymmetry of the brain in dichotic listening. Cortex, 1967, 3, 163-178.
- Kimura, D. Dual functional asymmetry of brain in visual perception. Neuropsychologia, 1966, 4, 275-285.
- Kinsbourne, M. Eye and head turning indicates cerebral lateralization. Science, 1972, 176, 539-541.

- Kinsbourne, M. Direction of gaze and distribution of cerebral thought processes. Neuropsychologia, 1974, 12, 279-281.
- Kocel, K., Galin, D., Ornstein, R., & Merrin, E. L. Lateral eye movement and cognitive mode. Psychometric Science, 1972, 27, 223-224.
- Libby, W. L., Jr. Eye contact and direction of looking as stable individual differences. Journal of Experimental Research in Personality, 1970, 4, 303-312.
- Meskin, B. B., & Singer, J. L. Daydreaming, reflective thoughts, and laterality of eye movements. Journal of Personality and Social Psychology, 1974, 30, 64-71.
- Schwartz, G. E., Davidson, R. J., & Maer, F. Right hemisphere lateralization for emotion in the human brain: Interactions with cognition. Science, 1975, 190, 286-288.
- Sherrod, D. Lateral eye movements and reaction to persuasion. Perceptual and Motor Skills, 1972, 35, 355-358.
- Teitelbaum, H. A. Spontaneous rhythmic ocular movements: Their possible relationship to mental activity. Neurology, 1954, 4, 350-354.
- Templer, D. I., Goldstein, R., & Penick, S. B. Stability and inter-rater reliability of lateral eye movement. Perceptual and Motor Skills, 1972, 34, 469-470.
- Tucker, D. M. Hemispheric differentiation, integration, and cognitive style. 1977 (Unpublished manuscript).
- Tucker, D. M., Roth, R., Arneson, B., & Buckingham, V. Right hemispheric activation during stress. Neuropsychologia, 1977, in press.
- Wada, J. A., & Rasmussen, T. Intracarotid injection of sodium amytal for the lateralization of cerebral speech dominance: Experimental and clinical observation. Journal of Neurosurgery, 1960, 17, 266-282.
- Weiten, W., & Etaugh, C. Lateral eye movement as related to verbal and perceptual-motor skills and values. Perceptual and Motor Skills, 1973, 36, 423-428.
- Weiten, W., & Etaugh, C. Lateral eye-movement as a function of cognitive mode, question sequence, and sex of subject. Perceptual and Motor Skills, 1974a, 38, 439-444.
- Weiten, W., & Etaugh, C. Lateral eye movement consistency is related to academic aptitude. Perceptual and Motor Skills, 1974b, 38, 1203-1206.

Weiten, W., & Etaugh, C. Lateral eye movement as related to mathematical and musical problem solving. Perceptual and Motor Skills, 1974c, 39, 481-482.

White, M. J. Laterality differences in perception: A review. Psychological Bulletin, 1969, 387-405.