FURTHER EXPERIMENTAL EXPLORATION OF THE RELATIONSHIP
BETWEEN HEMISPHERIC FUNCTION AND DEFENSE MECHANISM PREFERENCE

By

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ABSTRACT

FURTHER EXPERIMENTAL EXPLORATION OF THE RELATIONSHIP BETWEEN HEMISPHERIC FUNCTION AND DEFENSE MECHANISM PREFERENCE

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Ph.D. Dissertation

A growing body of literature from both neuropathological and normal subjects suggests a relationship between hemispheric laterality of function and personality. The reported studies of the experimental work in this area with normal subjects are based on the Conjugate Lateral Eye Movement (CLEM) as the primary measure of laterality. Most of these studies have used the Defense Mechanism Inventory (DMI) as the measure of defense choice.

Data obtained in a previous study of hearing persons whose first language was sign language demonstrated this population to be uniquely lateralized. This laterality data was used in the present study to examine a hypothesized relationship between laterality and defense choice. The tachistoscopic (T-Scope) paradigm was used and a laterality coefficient (LC) was computed as the measure of laterality. Defense choice was measured by a composite score of the DMI. Based on a previous study in this area, it was hypothesized that left hemisphere reliance would be associated with DMI subscales of Turning Against the Other (TAO) and Projection (PRO); whereas right hemisphere reliance would be associated with Intellectualization (INT) and Reversal (REV). This was predicted to be observable in a negative correlation between LC and DMI scores. Use of the T-Scope paradigm also permitted an additional comparison of the relative performances of the separate hemispheres with the personality variables in question.

Potential moderating variables attendant to the grouping of the original study were addressed statistically resulting in an enhanced significant positive correlation between LC and DMI. A negative correlation was predicted, however. Review of related studies suggests that this outcome is consistent with previous findings only when incorporating the complex role of anxiety, and/or emotion in producing hemispheric shifts in activation level.

Results also suggested that the separate hemispheres may differ in their participation in the Laterality/DMI relationship, with left hemisphere playing a more integral role in its relationship to reliance upon Intellectualization and Reversal in the subject. Discussion of these relationships suggests that they are highly complex. Simplistic or dichotomized understandings of these isses are not adequate to the data. Theory and directions for future research are also discussed.

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FURTHER EXPERIMENTAL EXPLORATION OF THE RELATIONSHIP BETWEEN HEMISPHERIC FUNCTION AND DEFENSE MECHANISM PREFERENCE

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Philosophers have pondered for centuries the enigmatic relationship of mind, body, thought and action. Personality theorists have troubled over these relationships in terms of cognition, affect, behavior and neurophysiology. In 1964 Reyher said, "At the present time linkages between neurophysiological, intrapsychic and behavioral processes are virtually unknown, and will remain unknown until a method is developed that will produce phenomena in which these linkages are observable and in which the component processes are manipulable." (p. 107) We are, twenty years later, still studying neuropsychological phenomena with no direct link between substrate and function; between neuron, idea, plan and execution.

In these last two decades however, advances have not only been made, but the field of neuropsychology has burgeoned into one of the most rapidly growing sciences of the twentieth century. Many of these advances have come with the rapid growth of diagnostic technology and the subsequent power to reproduce neuroanatomy and neurophysiology in the "hard copy" of nuclear imaging. Many more have been the result of the rapidly growing body of literature on the functions of the two cerebral hemispheres.

It is the purpose of this study to further explore the question of whether a relationship exists between substrate and function. Specifically, the goal will be to evaluate whether the two cerebral hemispheres differ in their participation in the personality of the individual.

Factors Affecting Lateral Dominance

Data from studies of neuroanatomy reveal that the two cerebral hemispheres differ in structure (Geschwind & Levitsky, 1968; Witelson & Pallie, 1973). And a growing body of research on unilateral brain damage (Geschwind, 1970; Milner, 1971), split-brain patients (Gazzaniga, 1970; Gazzaniga & Sperry,1967), clinical anaesthesia of the brain (Wada & Rasmussen, 1960) and from performance of non-brain injured persons on psychological tests (Kimura, 1973; Studdert-Kennedy & Shankweiler, 1970; White, 1972) has provided substantial evidence that the right and left hemispheres perform different specialized functions in higher-order psychological processes in nearly all right-handed persons. Specifically, the left hemisphere is considered to be specialized for verbal language functions; the right for perceptual, visuo-spatial and emotional functions. More recent research has suggested that the two hemispheres differ in overall cognitive strategy as well, with left being more suited to analytic, sequential problem solving and organization methods, while right is more holistic, global and simultaneous in its approach to mentation (Springer & Deutsch, 1981). Finally, a considerable body of research has accumulated to support differences between the hemispheres in both the comprehension and expression of emotion (Campbell, 1982).

These structural, functional and cognitive differences between the hemispheres may be related. Recent radioisotope studies raise the possibility that the anatomical organization of right hemisphere may be congruent with its particular conceptual skills (Gur, et al, 1980). The right cerebral cortex appears to have a higher relative concentration of white matter as compared to the left hemisphere. Tucker (1981) points out that this finding is supportive of earlier clinical observations that "the receptotopic distribution of information across the cortex is focal and discrete in the left hemisphere, but more diffuse and generalized in the right hemisphere" (p. 38). Each hemisphere's pattern of organization at a neuronal level then, may be uniquely suited to its preferred cognitive operations. In Tucker's view the left hemisphere's more focal and discrete organization seems compatible with the more analytic cognitive strategy associated with it; and the right hemisphere's more diffuse and global organization is consistent with its holistic cognitive strategy, due to the high degree of interconnection among regions within the right hemisphere.

These structural differences are also observable over time. Major structural differences observed between the hemispheres of the adult are reportedly observed as early as the neonate stage, in the same relative distribution (Marie, 1975). While major structural differences appear to be relatively stable, functional specialization varies over the course of development and is thought to settle by completion of maturation in established hemispheric dominance for specific functions and stable patterns of hemispheric functioning within individuals (Lenneberg, 1967).

Although stable hemispheric patterns of function endure in adult individuals, there are wide ranging differences ACROSS individuals in the degree of hemispheric specialization and/or sharing in the subserving of these functions, as they are traditionally understood. This wide range of individual differences is manifest in structure as well. Levy (1983) says, "Human brains differ at least as much as human faces." (p. 465) While certain statistical regularities exist in observations of the right hander's brain and its normative functioning Levy further notes, "a quite substantial minority differs from the group-typical pattern." (p. 465) Studies also suggest that various factors influence individual differences in reliance on the strategies of one or the other hemisphere, or "hemisphericity" as Bogen calls it. These factors include handedness, gender (Levy, 1978), bilinguality (Vaid & Genesee, 1980), early cerebral damage (Lenneberg, 1967), culture (Zook & Dwyer, 1976) and language deprivation (Curtiss, 1977).

Three other factors which have been observed to affect hemisphericity were evaluated in a previous study by this author (Rogan, 1983). These were: 1) bilinguality, 2) deafness, and 3) the natural acquisition of a visuo-spatial language (i.e., sign language).

Bilinguality and Hemisphericity

In a review article Vaid & Genessee (1980) summarized the literature as: "...generally supportive of the hypothesis that hemispheric processing of language in early bilinguals resembles the pattern characteristically noted in monolinguals, but that late second language (L2) acquisition engages the two hemispheres differently." (p. 435) These differences are also reported by Sussman, et al (1982) in their study of hemispheric specialization in bilinguals. Rogan (1983) summarized these as:

1. Bilinguals DO lateralize to the left for language;

2. Bilinguals are LESS left lateralized for language than are monolinguals;

3. Right hemisphere's participation in L2, especially for second languages acquired in adulthood, appears highly likely.

4. As a group the bilinguals clearly revealed a high degree of variability in hemispheric language representation compared to the consistent patterns of left hemisphere dominance for the single language of monolinguals (p. 10).

Deafness And Hemisphericity

A small but solid literature suggests that pre-lingual deafness is also a factor affecting lateral dominance, with lessened laterality being the observed phenomena. This observation has been based on case reports of neuropathology (Poizner, et al., 1983) as well as experimental studies of lateral function (Poizner et al., 1979).

The issues attendant to deafness which bear directly on any research conducted using this population are extensive and complicated. They are also beyond the scope of this paper. To include them in full explication at this juncture would be distracting. Because they are foundational understandings regarding any psychological research of this population however, two appendices (Appendix A and Appendix B) are provided which overview this basic information. The body of this paper will merely reference these variables as they are relevant. The reader who is not conversant with these issues is cautioned, therefore, to review these documents before proceeding, to assure their understanding.

The deaf have come under the scrutiny of neuroscience because of their natural usefulness in evaluating one of the major explanatory hypotheses regarding the nature of lateral dominance - the importance of the cortical region known as the left temporal plane, which is larger than the corresponding region of the right hemisphere (Geschwind & Levitsky, 1968). This anatomical difference had been thought to provide a biological basis for the specialization of the left hemisphere for language. Left hemisphere in this view is seen as having a greater capacity to process auditory stimulation, which may be required for optimal analysis and manipulation of the highly complex input of human language. Persons who are deaf obviously do not process auditory stimulation of the complexity of speech. Congenitally deaf persons never did. Deaf persons were thought by researchers therefore to provide an excellent test of this biological theory of lateral dominance for language. If this theory is correct, such persons, when suffering left hemisphere damage, should not manifest aphasic symptoms seen in hearing right handed persons suffering similar damage. They would be expected to have acquired either no dominance or, right hemisphere dominance for language. Such an expectation makes case reports of deaf persons who have suffered left hemisphere damage particularly interesting. These case reports were summarized by Rogan (1983):

> These observations of existing reports of left hemisphere damage in Deaf persons suggest that complete right dominance for language does not result from auditory deprivation, and that left lateralization is greater for sign that is dependent on a spoken language than that which is independent of it. Complex auditory stimulation does not appear to be a necessary ingredient for left lateralization for spoken language (p. 144).

Experimental investigation of asymmetries in deaf persons have been conducted primarily in the visual mode and have also suggested unique laterality patterns in these persons. In normal subjects such studies have been conducted in various ways. The objective of investigators is to lateralize inputs — to present stimuli to only one hemisphere. One of the oldest of these methods takes advantage of the natural split in the visual pathways. In humans this split divides our visual world into two fields, each of which projects into the hemisphere on the opposite side. If the visual pathway on one side is stimulated (via stimuli in one visual field) for a very short time before conjugate lateral eye movement can change the field by scanning (under 200 msec.), it allows investigators to compare the abilities of the separately stimulated hemispheres. While other methods have been used, this tachistoscopic presentation, as it is called, seems to be the most frequently used. Classic patterns of cerebral specialization in neurologically normal right handed hearing persons show a right visual field/left hemisphere advantage (LHA) for language stimuli and a left visual field/right hemisphere advantage (RHA) for faces, geometric shapes, dot localization and other visuo-spatial stimuli (Poizner & Lane, 1982).

Though few in number, experimental studies of the hemispheric functioning of otherwise neurologically normal deaf persons are heuristic. They typically consist of visual tachistoscopic presentation of words, visuo-spatial and sign language stimuli. Summarizing these studies Rogan (1983) says, "Consistent with the clinical literature, left lateralization for language is possible without complex auditory stimulation, but the resulting patterns of hemispheric specialization are different from those in which it is present." (p. 53). Specifically, deaf subjects when compared to hearing, tend to be left lateralized for words, but not significantly so, whereas hearing subjects produce greater asymmetries (Poizner et al 1979). These findings were based on comparisons of groups of hearing and deaf subjects. A related observation has been that within their experimental groups, the individual scores of deaf persons were marked by a high degree of variability.

Considering this occurrence in their experimental study, Neville & Bellugi (1978) further examined the data on the basis of the language acquisition history of their deaf subjects. They found that non-signing, non-speaking deaf subjects were not lateralized for visual spatial tasks while those deaf subjects who were native signers (whose parents were deaf and used sign as their primary mode of communication) showed evidence of significant LEFT lateralization. This function however, is within the traditional domain of RIGHT hemisphere in hearing right handers. The authors concluded in that study, "both biological and experiential factors, such as language acquisition and the MODE of language acquisition, interact in determining the functional organization of the brain." (p. 254)

It is important to note that their deaf subjects were either non-lateralized persons who learned neither speech, nor sign language via natural acquisition; or those left lateralized (for verbal stimuli) subjects who learned sign language naturally in their family home. It was not the bilingual status of these deaf persons that had been addressed methodologically, rather whether they had acquired ANY formal language naturally.) Further controlled studies of these two groups of subjects were suggested by the authors. If language acquisition variables do contribute to the unique cerebral organization of these deaf subjects, then it would also be desirable to evaluate the contribution of this variable to the neuropsychological functioning of persons who have normal hearing, thereby eliminating the contribution of the deafness itself.

(With regard to the first non-lateralized group, it is neither possible nor desirable to set up a controlled study in which either deaf or hearing children were deprived of language in order to evaluate the contributions of this language deprivation experience to their subsequent cerebral organization. One case has been reported however, in which these circumstances tragically occurred naturally in the life of one hearing child, Genie (Curtiss 1977). Careful and lengthy observation of Genie over several years from early adolescence to adulthood produced the picture of a woman who was deprived of language, was right handed (lateral dominance had occurred), and who had acquired language during adolescence. Her language skills (acquired after the posited critical time for dominance for language) had the limits characteristic of left hemidecorticates (was telegraphic and without passive negation, complex syntactic functions, etc.). Her right hemisphere was electroencephalographically active during language tasks and her scores on standardized measures of right hemisphere functions were higher than any recorded. Therefore under these conditions of early language deprivation, that language which was acquired was subserved by right hemisphere and did not include complex syntactic functions. This suggests that in the default of left specialization during a time critical for this outcome, the right hemisphere will subserve this function, but will do so less competently.

While as stated, several physiological measures suggested right hemisphere involvement in response to these non-language tasks, at the behavioral level Genie's performance of traditional right hemisphere tasks was higher than any recorded in the literature, either on children or adults. Neville & Bellugi's subjects were language deprived also. As noted above, their performances showed an equality of competence across both hemispheres. Data are not available to evaluate whether Genie's right hemisphere is solely responsible for producing these traditionally right hemisphere skills. We therefore cannot assume that her performance was unaided by the contribution of left hemisphere. Nor can we assume that her neuropsychological functioning as a result of language deprivation is not similar to that of the Deaf language-deprived subjects. Language deprivation of the nature experienced by these few reported individuals however, has produced a significant effect on their neuropsychological functioning.

The second group of deaf subjects in the Neville & Bellugi study were those who had learned sign language as their native language — from their parents. They demonstrated a LEFT hemisphere advantage for visuo-spatial material. It would be useful to investigate whether this neuropsychological uniqueness could be attributable to the visuo-spatial language acquisition rather than to their deafness. This group of subjects does have an analogue in the hearing population. It is the hearing children of deaf parents whose first naturally acquired language was sign language. Study of this population therefore, would permit experimental evaluation of the contribution of this unique first language and subsequent bilingual experience.

Replicating the most advanced tachistoscopic methodology for sign stimuli employed by Poizner, et al. (1979), we did this in a previous study (Rogan, 1983). Groups of hearing subjects, whose first naturally acquired language was sign language, were compared with hearing subjects who had learned sign language after adolescence (to evaluate the contribution of acquisition of a visuo-spatial second language after dominance had been established); and with normal non-signing, hearing control subjects. The first group of native signers therefore had the same language acquisition experience as the deaf native signers in Neville & Bellugi's 1978 study -- they learned sign at their parents' knee. Because this previous study figures centrally and foundationally in the present endeavor, it will be reviewed in more detail.

Visuo-Spatial Language Acquisition and Laterality - Foundation Study

In four experimental conditions, stimuli were tachistoscopically presented to these 30 subjects who were equally represented across the three Experimental Groups: Native signers, Late-learn signers and non-signing controls. The four types of stimuli were English Words, Oriented Lines, Moving Signs and Static Signs. (Appendix C contains a complete technical description of the method used in that study.)

All three Groups were compared on Words and Oriented Lines only, whereas the two signing Groups were also compared on tasks involving the two sign language stimuli. Each experimental condition included of 40 trials (20 stimuli randomly distributed and appearing once in each visual field) in which subjects were asked to identify what they saw. They did this verbally for words, in sign for signs, and by point identification with the dominant hand for line orientation. Instructions were also given in the language being tested.

Accuracy of identification per hemifield was the dependent variable. Subject responses were recorded by signing interpreters for all experimental conditions. All subjects completed a one and a half page questionnaire before beginning testing. Test sessions for subjects exposed to all four Experimental Conditions were approximately 1 1/4 hours with a ten minute break during the session. For the Control Group about 3/4 of an hour was required. Order of Experimental conditions was counterbalanced. Two short paper and pencil personality measures (The Defense Mechanism Inventory, Gleser & Ihilevich, , & the California Personality Inventory) were given to subjects with completion instructions. These were taken home and mailed back within the week in self addressed, stamped, anonymously coded envelopes. All subjects returned their questionnaires promptly.

On English words and Oriented Lines it was expected that the late-learn signers and non-signing controls would perform comparably, demonstrating LHA for words and RHA for Oriented Lines, since there is nothing about learning sign language late in life which would be expected to alter traditional dominance patterns. It was also expected that if, as suggested by earlier studies, early bilingual experience involving one visuo-spatial language does affect laterality patterns, then a reduction in reliance on left hemisphere for the processing of verbal stimuli would be obtained in native signers. Additionally, the native

signers should be less left lateralized for words and LEFT lateralized for oriented lines. Late learn signers were expected to show a RHA for signs consistent with late acquistion of a second language; and native signers were expected to show a left hemisphere trend for signs. Finally, motion was expected to engage both hemispheres equally in native signers. These were the laterality patterns observed by Poizner & Lane (1979) in their use of this method comparing Deaf subjects and non-signing hearing controls.

The laterality patterns of the hearing native signers were consistent with the prediction that a visual-spatial first language experience, without auditory deprivation, is sufficient to produce significantly different patterns of asymmetry. There was no significant difference between the groups in overall accuracy, suggesting that any differences which did occur were not due to varying processing abilities among the groups. Because of the experimental design (all three groups compared on only two experimental conditions, with only two groups compared on all four experimental conditions) preliminary analyses were conducted separately. In comparing the two signing groups in the two sign language conditions, analysis of variance revealed a significant interaction effect of Experiment X Hemisphere X Group ($F(2) = 5.13$, $p = .013$) indicating that the groups performed differently across experimental conditions.

Analyses of the performances of the two groups on Static Signs alone revealed a significant Hemisphere by Group interaction ($F(1) = 7.13$, $p = .0156$), and t-tests performed on the mean scores of the separate hemispheres of these two groups revealed a highly significant RHA for both Groups 1 (t corr $(9) = -3.50$, $p = .007$) and 2 (t corr $(9) = -5.06$, $p = .001$). Figure 1 reflects the mean percent correct scores for each hemifield across all groups in all conditions tested. These differences between hemifields were greater for

Group 2, the late learners of sign (-2.80), than for Group 1 (-1.10), the native signers. Comparing the mean LC's calculated for each subject, this difference between Groups 1 and 2 was significant (t pooled (18) = -2.04, p = .05). These findings were consistent with the prediction that acquisition of a second language after adolescence results in greater involvement of the right hemisphere in processing that language.

In processing moving signs an RHA was also produced by both signing groups. This was not a significant RHA for the Native signers (t corr (9) = -.88, p= .399), whereas it was significant for Late learners (t corr (9) = -2.49, p = .034). Again, as expected, the greater reliance on right hemisphere processing was found in the group that had acquired this second language after adolescence.

Insert Figure 1

Both signing groups showed the patterns of RHA for processing sign stimuli reported for the deaf and hearing signers in previous studies (McKeever, et al, 1976; Manning, Goble, Markman, & LaBreche, 1977; Neville & Bellugi, 1977; Poizner & Lane, 1972) including the study from which this methodology was drawn (Poizner, et al., 1979). The Native signers produced a right hemisphere ratio (.882) of nearly the same magnitude as the Deaf Ss in that study (.90). The strong RHA for late learners is not only consistent with the patterns of hearing signers who were used as Controls in previous studies, but as ASL is a second language for this group their RHA is consistent with the laterality patterns for second language processing of bilinguals who acquired that language after

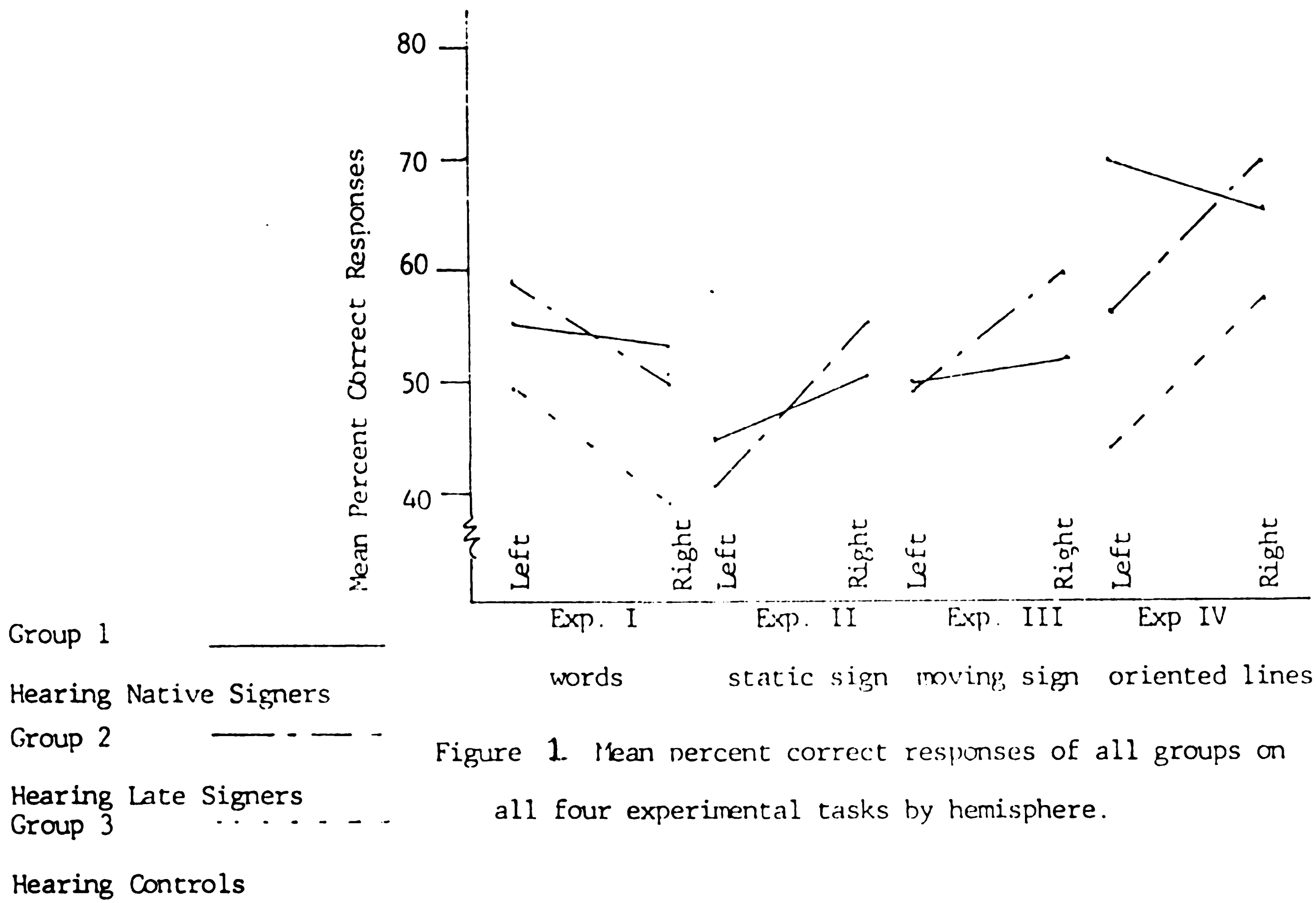

Figure 1. Mean percent correct responses of all groups on all four experimental tasks by hemisphere.

adolescence (Vaid & Genessee, 1980). The underlying theoretical conceptualization of non-dominant hemisphere specialization in processing of a late acquired second language, was supported by this finding.

The results of this study of the processing of sign received further validation by a post hoc analysis of subject's performances on complex versus simple signs. This was an analysis which Poizner had performed on the scores of his deaf Ss to evaluate Kimura's (1974) findings that left hemisphere is better able to function in the processing of complex, but not simple movements. The native signers of this study showed a score nearly equal to that of the Deaf Ss of the Poizner et al. (1979) study.

More germane to this discussion however, are the results of the experimental conditions containing the English words and Oriented Lines. There was an overall Experiment by Group by Hemisphere interaction ($F(3) = 3.63$, $p < .05$), for the three groups compared on these two tasks indicating that stimulus type played a role in the varying performances of the hemispheres of each of the groups. Subanalyses of group performances on English Words revealed that the Non-signing hearing controls reached the expected significant LHA for words ($t(9) = 3.12$, $p = .012$). Though the group of Native signers produced an LHA, as predicted, this difference between the performance of the two hemispheres did not reach significance ($t(9) = .67$, $p = .522$). Their performance on this task is similar to the laterality response pattern to English Word stimuli, found repeatedly in Deaf subjects: a reduction in the difference between the hemifield scores, with only a tendency toward left hemisphere superiority which usually does not reach significance (Poizner & Lane, 1982; McKeever, et al, 1976; Phippard, 1977; Suter, 1982; Manning, et al, 1977; Neville, et al, 1983).

Further analysis of the ways in which the separate hemispheres performed on this task revealed that while the left hemispheres of both native signers and non signers were comparable in their processing ability of words ($t(18) = .96$, $p = .348$), the right hemispheres differed in a way which approached significance ($t(18) = 1.90$, $p = .074$), with a mean percent of correct responses of non-signers of .3850 and of native signers of .5300. This difference did not exist between the two signing groups however, with both right ($t(18) = .46$, $p = .649$) and left hemispheres ($t(18) = -.45$, $p = .660$) of each group performing with comparable accuracy. The way in which signers tend toward reduced laterality for processing words when compared to non-signers then, is in a greater capacity of the right hemisphere accuracy rather than a lessened capacity of either hemisphere. This additional capacity of right hemisphere tended to be the strongest for the native signers.

Subanalyses of all groups' responses to Oriented Lines resulted in a Group by Hemisphere interaction ($F(2) = 6.07$, $p = .0067$), indicating that this stimulus type was responded to differently by the hemispheres of each group. The t-tests for correlated means of hemisphere scores show these differences to be significant for the late learn signers ($t\ corr(9) = -2.41$, $p = .039$) and the non-signers ($t\ corr(9) = -4.47$, $p = .002$) and in the direction of the expected RHA. While the difference score of the relative performance of right and left hemispheres of the native signers was not significant ($t\ corr(9) = 1.25$, $p = .244$), it was in the opposite direction (+.90), suggesting native signers have a somewhat more competent left hemisphere in this visuo-spatial task. On the basis of comparisons using LC's for each subject as the dependent measure, highly significant differences were found between the non-signing control subjects and the native signers, as predicted. This is consistent with the reports of performance of Native Signing Deaf Ss studied by Neville (1977), Phippard (1977), Neville & Bellugi (1978), Neville (1980) and Neville, Kutas and Schmidt (1982). Those Deaf subjects who had no naturally acquired formal language, where this variable could be controlled, showed a RHA for visuo-spatial and language skills while those who had acquired sign naturally produced a LHA for these same skills (Phippard, 1977; Neville 1977; Neville, 1980). The laterality pattern of the hearing native signers then, was like that of the native signing Deaf subjects previously studied.

Finally, post hoc analysis of the performances of the individual hemispheres revealed that the native signers and the non-signers differed significantly in the efficiency of left hemisphere for processing visuo-spatial material, ($F(1) = 9.16$, $p = .0054$) with the left hemisphere of native signers reaching the highest efficiency of all groups on all stimuli (mean = .6950). Once again then, the reduced laterality was NOT produced by a decline in performance of either hemisphere, but rather by an increase in performance capacity of left hemisphere. Based on these data, when left hemisphere is able to process visuo-spatial material it gives its best performance.

Overall, groups differed from each other in hemispheric performance not only by direct comparison on separate experimental conditions but also in their hemispheric shifts across tasks. The non-signing controls showed a strong and complete shift of hemisphere superiority across the two experimental conditions in the expected and previously reported directions for right handers. The Late learn signers, while better overall than non-signers, shifted hemisphere superiority in performance significantly across all four experimental conditions, in the predicted directions previously demonstrated by Deaf persons who had acquired sign later in life. The Native signers, with insignificant hemispheric trends only, demonstrated symmetry across all but one experimental condition; static signs, in which they produced the previously demonstrated RHA for this stimulus type. Hemispheric functioning is clearly differentially affected by visuo-spatial first language experience in hearing persons, resulting in a reduced laterality in processing all stimuli when compared to both Late learning sign users and Non-signing controls. This study demonstrated that first language experience is sufficient to produce this pattern previously reported in deaf Ss and inferred to be a result of the absence of auditory stimulation. The author concluded:

> ...if these performances are correctly inferred to be a function of a totally different organization of neuropsychological functioning in this group of hearing native signers, it is the result of their unique first language experience. (p. 127)

and finally,

> Perhaps the most significant contribution this study has made is in identifying a new experimental population which offers this unique laterality pattern as well as skill in a unique language. That sign language can be processed simultaneously with a spoken language adds to its potential to contribute much to our understanding of the interrelatedness of the two hemispheres. And this population permits methodological

consistency of language mode from instructions, to stimuli, to response.

Rogan (1983, p. 144)

One of the most intriguing areas of correlational work on cerebral function to have emerged is that relating personality to the conscious and unconscious determinants of behavior. The uniqueness of the hemispheres in specialized function and in style of mentation has been coupled with the observations that individuals differ in their degree of reliance on the processing capacities of the two hemispheres. This has led analogically to the question of whether these stable differences in hemispheric functioning across individuals may be related to cognitive style: a stable problem solving trait which also varies across individuals. Furthermore, the question arises whether the cognitive style an individual characteristically relies on in approaching problems may be intrinsically related to the unique hemispheric functioning patterns of that individual. And finally, in what way then, may these be related to the most general descriptor of the individual, personality?

Neuropathology

Not unlike the hemispheric research itself, that which examines the relationship between hemispheric function and personality components has been explored via many sources of data. Primary among these personality components have been emotion and cognition. The clinical sources of data from reports of unilateral brain damage, hemispherectomy and unilateral electroconvulsive shock have provided a foundation of observations of impaired and spared behavioral function.

Unilateral Brain Damage

Though clinical reports of unilateral brain damage are among the earliest sources of observation of impaired behavioral function, the contribution of damage to the right hemisphere to more than motor function has been only recently recorded. This is due to several factors, but the comparative subtlety of functions which are impaired when the right hemisphere is compromised is likely the strongest contributor to this lag in recorded neuropsychological understanding. This data base is nonetheless the earliest to suggest that emotions are differentially mediated by the two cerebral hemispheres. Ross (1981) summarized the range of impaired emotional functions resulting from right hemisphere damage in his categorization of the "Aprosodias". These include impaired recognition of emotion in the communications of others, as well as an absence of color, affect and emotional tone in both verbal and gestural expression of the impaired individual.

Hemispherectomy

Reports of the sequelae of hemispherectomy (removal of one of the cerebral hemispheres) in adults have also contributed to the inferential relationship between emotion and the separate hemispheres. A case which exemplifies this clinical literature regarding the removal of the left hemisphere is reported by Smith (1974) as E. C. Immediately following the removal of his left hemisphere, E. C. was unable to answer questions with meaningful speech, but he was able to clearly articulate "expletives and short emotional phrases." (p. 469) Smith observes the differences in removal of left hemisphere in this case, compared to reports of the removal of the right hemisphere:

> Loss of personality values or bizarre behaviour reported after similar cases with right hemispherectomy (Gardner et al., 1955), however, was not observed in E. C. Affective reactions and general behaviour I have observed before and after hemispherectomy were appropriate, and consistent with his wife's report of no noticeable change in emotional responses or in a basically well-balanced personality. (Smith, 1974, p. 470)

In spite of the loss of most expressive language, emotion and personality remain essentially the same without the help of the left hemisphere. To quote from another case history of one 10 year old patient who experienced removal of the left hemisphere:

> ...personality characteristics such as humour, boredom, love

> and frustration are readily exhibited by right hemisphere in a pattern reported by the parents to be substantially the same as before surgery.
>
> (Gott, 1973, p. 1086)

The observations are different when right hemisphere has been removed. Gardner (1955) summarizes the observations of ten adults after removal of their right hemisphere:

> With one exception...they became dependent, regressive and ineffective people. Systematic psychological tests demonstrate that in most of these subjects intellect per se is not the outstanding deficit, for vocabulary and verbalization appear to suffer the least and memory and more complex integrations involving insight, emotional control, initiative, constructive ideation, and imagination that hemispherectomy takes its toll. (p. 501)

Removal of the right hemisphere appears to result in flat unemotional speech, whereas removal of the left hemisphere results in an absence of meaningful speech, leaving none but the most emotional of speech.

Uni-Lateral Electro Convulsive Shock

Documented sequelae of unilateral electroconvulsive shock treatment have added to this construction of right hemisphere's contribution to emotional aspects of personality. The work of V. Deglin, a Russian neurophysiologist who had tested a large number of patients after electroconvulsive shock treatment (ECT), stresses the importance of lateral considerations in depression. His studies suggest that right hemisphere unilateral ECT may be more effective in treating depression than bilateral administration. Unilateral right ECT resulted in his characterization of the "left hemisphere person", who becomes more talkative with a richer and more varied vocabulary while also becoming less expressive. Similar changes in the receptive mode are observed. Natural sounds of coughing, ocean waves, etc., are often unidentifiable to these persons. There is an inability to sing. Visual impairment was observed in an inability to notice essential missing details as well as an inability to see the overall gestalt of an image. Emotional outlook was easygoing and cheerful, suggesting that the left brain is optimistic and cheerful (Deglin, 1976). Deglin suggests this result reflects that the left hemisphere is more active as a result of being freed from competition with the right.

In contrast the "right hemisphere person"´s (left unilateral shock) emotional outlook becomes negative, morose, pessimistic about the present and future. S/he typically complains of not feeling well. Speech activity is greatly reduced, using far more mime or gestures with sharply diminished vocabulary. Speech is limited to simple sentences of isolated words. Understanding of speech is similarly limited. S/he shows a lack of attention to speech that is not very loud, while his hearing for non-verbal sounds is excellent. S/he is more attentive to natural sounds such as the surf than he would be if both hemispheres were working fully and music is readily recognized. Deglin suggests that it is the lack of competition from the left hemisphere that improves performance on these tasks. Such were the observations of the sequelae of unilateral electroconvulsive shock.

Split-Brain Patients

Myriad observations of the unusual behaviors of split brain patients from immediately following surgery to long term post recovery have produced a wealth of theories to describe the relationship between mind and body, brain and behavior. Split brain surgery, or Commissurotomy, consists of surgically cutting the corpus callosum which connects the two cerebral hemispheres. As early animal studies of commissurotomy had shown minimal consequences of split brain surgery on healthy organisms, it was not until the mid 1960's that the Nobel Prize winning work of Roger Sperry illuminated not only the importance of the corpus callosum in humans, but of the separate cerebral hemispheres in behavioral function and consciousness.

Of particular interest to personality theorists were the accounts of some of the bizarre experiences of the disconnection patients. One patient, for example, reported finding his left hand struggling against his right when trying to pull his pants on in the morning. One hand was pulling them up while the other hand was pushing them down. On another occasion the same patient was angry and forcibly reached for his wife with his left hand while his right hand grabbed the left to stop it (Gazzaniga, 1970).

Though these experiences subside with time resulting for the most part in coordination of the two sides of the body, the obvious conflict stirs speculation on how this may be related to neurotic conflict. Galin (1974) believes that these phenomena provide a neurological validation for Freud's notion of an unconscious mind. He points out that right hemisphere's mode of thought is consistent with Freud's description of the "unconscious" and suggests that the functioning of an isolated right hemisphere is similar to processes that are repressed, unconscious, and unable to control behavior directly: "Certain aspects of right hemisphere functioning are congruent with the mode of

cognition psychoanalysts have termed primary process, the form of thought that Freud originally assigned to the system Ucs (unconscious)." (p. 576). Illustrative of this are the extensive use of images, lessened awareness of time and sequence, and a limited language not unlike that of dreams and slips of the tongue.

As his theory is fashioned, Galin (1974) believes that there are several ways in which an ordinary person could function as though they had been surgically disconnected. Each hemisphere is exposed to the same sensory input, though it effectively receives different input because each emphasizes only one aspect of a message. The left will attend to the verbal cues, and the right will attend to the non-verbal cues. Using the classic example of the schizophrenogenic parent, he says, "Imagine the effect on a child when his mother presents one message verbally, but quite another with her facial expression and body language; ´I am doing it because I love you, dear´, say the words, but ´I hate you and will destroy you´ says the face. (p. 576)". He believes that during such moments of disconnection, the left hemisphere governs consciousness while mental events in the right hemisphere continue a life of their own and act as a Freudian unconscious, as an independent reservoir of inaccessible cognition, which may create uneasy emotional states in a person.

Speculative though this theory may be, no clinician can miss the implications of the report by Gazzaniga & LeDoux (1978) of P.S., one of their split brain subjects. P.S. was tested with pairs of visual stimuli presented via bilateral tachistoscope. The picture falling into each visual field was thus processed by the hemisphere opposite that field. P.S. was asked to use his hands to point to pictures that were related to what he had seen flashed on the screen from among several placed in front of him. His right hand pointed to a picture related to one that had been flashed in his right visual field (to left hemisphere) and his left hand pointed to a picture related to one that had been flashed to his left visual field (right hemisphere).

> When a snow scene was presented to the right hemisphere and a chicken claw was presented to the left, P.S. quickly and dutifully responded correctly by choosing a picture of a chicken from a series of four cards with his right hand and a picture of a shovel from a series of four cards with his left hand. The subject was then asked, ´What did you see?´ ´I saw a claw and I picked the chicken, and you have to clean out the chicken shed with a shovel.´
>
> In trial after trial, we saw this kind of response. The left hemisphere could easily and accurately identify why it had picked the answer, and then subsequently, and without batting an eye, it would incorporate the right hemisphere´s response into the framework. While we knew exactly why the right hemisphere had made its choice, the left hemisphere could merely guess. Yet, the left did not offer its suggestion in a guessing vein but rather a statement of fact as to why that card had been picked."
>
> (Gazzaniga & LeDoux, 1978, p. 374))

While the split brain data is enticing, as Kinsbourne (1983) points out, "The brain is known to be integrated". In normal persons this is true. Given the methodological problems attendant to drawing from brain damaged or surgically resected populations only, it is important to note the data drawn from experimental studies of the neuropsychological function of normal persons in exploring these relationships between laterality and personality. Studies of the relationship between hemisphericity and personality style as seen by defense mechanism in neurologically normal subjects have begun to emerge in the experimental literature.

Neuropsychological Experiments With Normal Subjects

Studies of the relationship between hemisphericity in neurologically normal subjects and various personality components have begun to emerge in the experimental literature. These studies have relied primarily on Conjugate Lateral Eye Movement (CLEM) as the measure of hemisphericity. Such characteristics as anxiety (Gur & Gur, 1975; Krikorian & Rafales, 1982), hypnotizability (Bakan, 1969; Gur & Gur, 1974), psychosomatic complaints (Gur & Gur, 1977), cognitive style (Smokler & Shevrin, 1979) and defense mechanism clusters (Gur & Gur, 1977; Shevrin, Smokler & Wolf, 1980; Krikorian & Rafales, 1982) have been found to be related to hemisphericity as measured by CLEM.

Measures

Conjugate Lateral Eye Movement

The measure itself has come through an interesting evolution. The early observations of neurologists (Mott & Shafer, 1890; Penfield & Roberts, 1959) indicated that electrical stimulation of various sites in one of the cerebral hemispheres could result in a turning, or orienting, of the eyes in the direction of the opposite side. This led to the assumption that systematic observations of the directional eye movement of individuals in their response process to certain questions, could be used as a suitable method of measuring the hypothesized contralateral activation. Kinsbourne (1973) had suggested this interpretation of the CLEM phenomenon and further, that a right-left distribution of eye movements may reflect a distribution of actual cognitive function between the cerebral hemispheres (Kinsbourne, 1972). In 1964, Day noted that direction of eye movement to the right or left is consistent for a given individual, so that most persons can be classified as either Right-movers, or Left-movers. An individual makes about 75% of his CLEMs in one or the other direction. Numerous studies have since demonstrated the association between direction of lateral eye movement in response to questions requiring either verbal or visuo-spatial content (Gur & Gur, 1977).

While Ehrlichman & Weinberger (1978) argue that the link between CLEM patterns and hemispheric activation remains unproven (consistent with Reyher's (1964) critique of the substrate/function inferences) they do acknowledge that studies of individual differences in CLEM patterns have produced a fair degree of stability and consistency in their correlates. This question however is complicated by the many conditions that influence CLEM.

The relationship between direction of eye movement and question content is not a direct left hemisphere/verbal, right hemisphere/visuo-spatial relationship. Individuals differ in their reliance on the processing capacities of the two hemispheres as indicated earlier. Women and left-handers tend toward less lateralization. This individual characteristic pattern of response is also influenced by the experimental situation. Gur (1975) demonstrated that though the characteristic response pattern will be more directly related to the problem type of the question when the examiner is behind the subject, a greater percentage of eye movements, indicating reliance on the preferred hemisphere, is observed when the experimenter is facing the subject — regardless of problem type. According to Gur:

> The direction of eye movements in response to questions appears therefore, to be determined by at least two factors:

> (a) problem type and (b) characteristic use of a certain hemisphere by a given individual.
>
> Gur (1975, p. 755)

The author suggests an interpersonal explanation that:

> Anxiety, according to Sullivan (1953), is closely tied-up with interpersonal relationships and tends to stand in the way of an appropriate problem-solving or need related behavior.
>
> Gur (1975, p. 756)

Later studies (Gur & Gur, 1977) added supportive data to this interpretation, resulting in a concept of "hemisphere activation bias" as the phenomenon underlying the tendency to "use" a certain hemisphere in the face-to-face situation, regardless of its greater or lesser ability to handle the specific type of problem.

CLEM then, can measure both the pattern of hemisphericity, in the reliance of an individual on the processing style of the hemisphere which is better able to handle the type of material in question. Or, when the "pressure" is on, CLEM can reflect an exaggerated reliance on the preferred hemisphere of the individual, believed to be due to the influence of anxiety. This may not be the hemisphere best able to handle the material in question and may, therefore, occur at a cost in accuracy. Though the mechanism of this phenomena may not be fully understood, its existence has contributed to some of the earlier and continuing questions about the reliability of this measure of hemisphericity.

CLEM As An Index Of Personality

Concurrently with Day's work as a clinical psychologist, the connection between hemispheric activation bias, as measured by CLEM, and personality, evolved (Day, 1964). In the course of his practice, he noticed that patients tended consistently to look to the left or to the right when answering questions. Further work suggested that the direction of these lateral eye movements might be associated with certain personality characteristics (Day, 1967). Supportive data was published a few years later by Paul Bakan (1969). In advance of Kinsbourne (1973) he proposed that the eye movements are related to hemispheric asymmetry. He saw CLEM as symptomatic of an easier triggering of activity in the contralateral hemisphere. These two lines of inquiry — that of the relationship of CLEM to hemispheric function and the relationship of CLEM to personality, have generated the body of literature supporting a consistent relationship between the phenomenon of CLEM and the previously cited personality traits. The experimental link between hemisphericity and personality characteristics rests heavily on this link.

Defense Mechanism Inventory: a Measure of Defense Cluster

Experimenters in this area of research, have relied heavily on one particular measure of personality, the Defense Mechanism Inventory (DMI) (Gleser & Ihilevich, 1969). Because of this, the demonstrated relationships between laterality and personality are heavily based on the DMI as well. The DMI yields quantitative measures of five basic defense mechanisms:

Turning Against the Other (TAO), characterized by Gleser and Ihilevich (1969) as dealing with conflict "through attacking a real or presumed external frustrating object" (p.52);

Projection (PRO), characterized by "expression of aggression toward an external object through first attributing to it, without unequivocal evidence, negative intent or characteristics" (p. 52);

Intellectualization (INT), (formerly called Principalization), characterized by dealing with conflict by "invoking a general principle that ´splits off´ affect from content and represses the former" (p. 52);

Turning Against the Self (TAS), characterized by "directing aggressive behavior toward S himself" (p. 52);

Reversal (REV), characterized by repression, denial, negation and reaction formation: defenses which deal with conflict by "responding in a positive or neutral" (p. 52) way to a frustrating object.

Concurrent predictive validity of the DMI was demonstrated by Gleser & Sachs (1973). However, validity findings of another study (Vickers & Hervig, 1981) which compared three defense measures: the DMI, the Coping Operations Preference Enquire (COPE), and the scales developed by Jaffe and Naditch (J&N), were equivocal with a trend toward similar patterns of correlation between defenses within instruments. The authors observed that "Overall, the pattern of correlations for the DMI was broadly similar to those found in the other two instruments (p. 635)".

Gleser & Ihilevich (1969) reported correlations between TAO and PRO subscales of r = .63, and between INT and REV of r = .54, in the original Out-Patient sample. subsequent studies have replicated high correlations among these scales. Gleser & Sachs (1973) reported corre = .63 between TAO and PRO; and corr = .51 between INT and REV. And Vickers & Hervig (1981) report correlations between PRO and TAO and between INT and REV of r = .97 and r = .96, respectively.

Several experimental studies are not only representative of the literature, but the state of the art of these findings, as well.

Studies of Hemisphericity and Personality in Normals

The first of these studies by Gur & Gur (1975) exemplifies the methods used by almost all of those that follow. CLEM served as their measure of laterality, using the criteria suggested by Bakan (1969) of greater than 70% of eye movements to the left to classify left-movers, more than 70% to the right as right-movers, and all others, bi-directionals. The experimental paradigm with experimenter facing the subject, was used. This is considered to produce the greatest anxiety.

Twenty-eight right-handed male undergraduates subjects were then grouped as either left-movers (N=12), right-movers (N=8), or bi-directionals (N=8). Preference of defense mode was measured by the Defense Mechanism Inventory (DMI, Gleser & Ihilevich, 1969). When compared on each of these five defenses, the three groups differed on only three. On both PRO and TAO the right-movers (left hemisphere users) were significantly higher than left-movers (right hemisphere users), but they were only significantly higher than bi-directionals (less lateralized) on TAO. These findings were consistent with the author's expectations in that persons using TAO and PRO are seen as individuals who externalize conflict acting against the environment. These defenses require more cognitive verbal elaboration.

Left-movers (right hemisphere users) were significantly higher than right-movers (left hemisphere users) on REV only, but did not differ significantly from bi-directionals. These findings were also consistent with the author's predictions in that REV is seen in an individual's immediate denial of reality, internalization of conflict, and repression of emotions evoked by

external stress, and reaction formation. This was seen as consistent with expectations of how right hemisphere involvement would be manifest in personality.

Smokler & Shevrin (1979), in an elegant study, compared laterality patterns of persons with hysteric personality styles to those with obsessive-compulsive personality styles. While they relied on CLEM in the Experimenter facing Subject paradigm as their index of laterality, they used a more clinical approach to their assignment of personality type. Reasoning that a strongly left hemisphere dominant individual might appear as one who "analyzed virtually everything in a piecemeal, analytic manner even in situations in which this might not be advantageous." (p. 949) they observed how closely such an individual would fit the traditional description of the non-pathological Obsessive-Compulsive personality type:

1. Having a strong tendency to repress disturbing affects,
2. Tending to treat everything in an ideational way even when inappropriate,
3. Favoring a logico-deductive approach to problem solving, rather than a concrete stimulus-bound approach.

Similarly, they reasoned a strongly right hemisphere dominant individual would seem to deal with situations in a global, holistic manner, relying little on analytic strategies. Such an individual would fit closely the classic description of the hysteric personality style having:

1. Strong tendency to repress disturbing ideas,
2. A tendency toward emotional lability,
3. A tendency to solve problems in a stimulus bound, concrete way, rather than using logic.

The authors cite Freud and Charcot as the generators of the long history of clinical observations of such personality types.

Based on these considerations, a screening for personality style was completed using responses to six projected Rorschach cards (I, III, IV, VI, IX, X) in which 316 right-handed undergraduate subjects of both sexes were asked to write down everything they saw in the card. The card was flashed again for 3 minutes and the Subject was asked, "What about the card made it look like whatever you saw? (p. 950)". They were also asked to amplify their description of each percept. Subjects were then asked to self administer the WAIS Comprehension subtest. Subject protocols were judged by trained clinicians, using a list of definitive projective characteristics for obsessive-compulsive and hysterical personality styles drawn from Schafer's (1954) work.

Their objective was to identify individuals with the personality styles — not merely cognitive by-products of left, or right hemisphere function — of either hysteric, or obsessive-compulsive type, as these are defined and implemented in the clinical setting. Though 316 subjects were screened and so grouped, only 75 subjects were actually run due to the unavailability of subjects after the end of the academic semester. The final number run were 26 Hysterics (8 male, 18 female); 15 Obsessive style (7 male, 8 female); 33 Controls (23 male, 10 female). The data were analyzed using a repeated-measures analysis of variance for unbalanced designs with sex and personality style as the two between-subject factors, and procedure and content of question as the two within-subject factors. Percent right-looking scores, determined by dividing the number of right eye movements that could be scored by the total number of movements that could be scored, were used for this analysis.

Results revealed a significant effect for personality and no effect for sex. Highly significant differences in CLEM were seen between hysteric and obsessive-compulsive groups. The authors concluded that hysteric personality style was highly correlated with left looking (right hemisphere user) CLEM, and that obsessive-compulsive personality style was highly correlated with right looking (left hemisphere) CLEM.

These authors see in their results an avenue for observing the relationship between personality as defined in psychoanalytic terms and current knowledge of laterality. They appear therefore, to be searching for a way to observe a posited interface of dynamic (intrapsychic) and cognitive (cortical) processing. They rebut the possibility of criticism of their method as merely itself reflecting "manifestations of right or left hemisphere functioning in projective tests (p. 953)" by arguing that the criteria used are separately defined for several reasons:

> First, they are generated from a theoretical and clinical tradition totally separate from research in neuropsychology and psychobiology. The conceptualizations and assessment of obsessive-compulsive and hysteric function relied on presently were postulated well before and almost indisputably separately from most empirical knowledge of how the left and right hemispheres function.
>
> (Smokler & Shevrin, 1979, p. 953))

While this is true of the assessment measures themselves, it is not altogether true of their theoretical underpinnings, at least not to the extent that the work of Freud is concerned. Though the knowledge of the differential functioning of the individual hemispheres was absent during Freud's era, the

manifestations of these differences in functioning may have been observed and attributed to different neurological explanations. For instance, left hemisphere functions, as we know them today would have been seen as secondary processes, or higher cortical functions; whereas right hemisphere functions could have been seen as less corticated, primary process functions. If one's view of Freud's earlier work is similar to that of Pribram & Gill (1976), then one cannot assume his conceptualizations of personality to be grounded on anything but his work as both a clinician AND a neuropsychologist/psychobiologist. It may be that intrapsychic phenomena, a la Freud, are not so easily "separately defined" (Smokler & Shevrin, 1979, p. 953) from neuropsychological phenomena, and therefore are the meat of an unnecessary struggle for distinction.

The results of this study show that a significant portion of subjects with hysteric personality styles were left-movers in the face-to-face questioning paradigm. Subjects with obsessive-compulsive personality styles tended to be Right Movers. This suggests that to the extent that CLEM can be seen as an index of hemispheric activation, hemisphericity may be integrally related to personality structure, as measured by these more dynamically oriented methods. The authors emphasized that their efforts were to evaluate the relationship of laterality with personality structure, avoiding the criticism that they may be, "...no more than manifestations of right or left hemisphere functioning on projective tests. (p. 953)"

In counterpoint to these however, Smokler & Shevrin (1979b) extended their study and, using 41 of the same subjects in groups of Controls (N=21, 14 men, 7 women), Hysteric (N=14, 5 men, 9 women) and Obsessive-compulsive (N=6, 4 men, 2 women) personality style, compared both their scores for field independence and DMI defense clusters in an effort to replicate previous correlational findings. They found no significant relationship among field independence, as measured by the Rod and Frame Test and the Embedded Figures Test; hemisphericity, as measured by CLEM; or defense cluster, as measured by the DMI, thus failing to replicate the results of Gur & Gur (1975). The Authors consider and reject such possible explanations as "lateral eye movements provide a poor index of hemispheric lateralization", concluding that "insofar as the main differentiation between hysterical and obsessive personality styles is often based upon dynamic as well as cognitive characteristics, it might be useful to consider the possibility that these dynamic factors may have considerable significance with respect to lateralization." (pp. 201-202) No relationship was evidenced between personality style and DMI defense cluster either however, raising validity questions about the DMI.

A recent study by Krikorian and Rafales (1982), while providing data supportive of the existence of a relationship between DMI defense clusters and directional CLEM, highlights further the tenuousness of this relationship. Observing that previous studies (Gur et al. 1975, Hiscock, 1977) suggested that varying levels of arousal can disrupt asymmetrical LEM patterns, they manipulated the arousal level of the stimulus. They did this not by manipulating the interpersonal pressures, as had Gur, Gur & Harris,(1975) (they had the Experimenter out of the room), but rather by varying the intrapsychic sources of presumed emotional arousal (by varying the degrees of emotionally arousing question content). Three arousal levels were used: low, moderate and high; with either verbal or spatial content. An example of high verbal arousal is "Tell me how you feel when someone tells you that you are no good." and high spatial arousal, "Visualize and describe the most upsetting photograph of the

Vietnam War that you have seen." (p. 374)

Consistent with the design of Smokler & Shevrin, subjects were grouped by defensive style, while hemisphericity, as measured by CLEM served as the dependent variable. Group assignment was made by computation of a composite DMI score for each subject. The authors derived this composite DMI score using several factors observed in previous studies. These included:

1. Previous studies produced high intercorrelations of two pairs of the DMI scales.used both the high intercorrelations of two pairs of the DMI scales.

2. TAO was highly correlated with PRO and INT with REV.

3. The Gur & Gur (1975) study reported that one pair, TAO and PRO, correlated with Left-movers, while REV, one of the other pair, correlated with Right-movers.

The authors therefore, subtracted the sum of INT and REV scores from the sum of TAO and PRO scores. Subjects were classified according to defensive orientation as, Projectors — those with positive DMI composite scores (TAO + PRO > INT + REV), and Rationalizers — those with negative DMI composite scores (TAO + PRO < INT + REV). By this method sixteen subjects were identified as members of the two experimental groups, Projectors and Rationalizers. Comparisons were made across groups and arousal levels and between the proportion of initial, cumulative and frequent CLEMs recorded for subjects.

There were no significant effects for sex, or order of item presentation. Significant main effects were found for question type and emotional level. Only at the moderate arousal level was there an increase in leftward movement (right hemisphere activation), which was unrelated to content. An overall asymmetry (right movement to verbal; left to spatial) was maintained at this arousal level. Krikorian and Rafales assumed that left hemisphere processing did not decrease, rather relative right hemisphere activation was enhanced. Therefore, the moderate arousal effects were strong enough to override any sub group effects.

While further analysis of the effects of defensive style grouping suggested that these interacted with eye movements, the findings were nonetheless ambiguous. The Gur & Gur (1975) study observed higher REV in left-movers, while Krikorian and Rafales (1982) obtained that relationship only under conditions of high arousal. However, while Gur & Gur (1975) observed right-movers scoring higher on TAO & PRO, the Krikorian & Rafales (1982) group (considered comparable) of positive DMI composite scores, showed "little rightward responding." The authors suggest that their use of "emotion as an additional factor" (p. 379) may explain the discrepancy.

Several other factors may have contributed as well. Selecting subjects on the basis of style of defense clustering could have two potential effects on the outcome measured by CLEM. First, if indeed, as suggested by Shevrin, Smokler & Wolf (1979), life experiences are a powerful variable in the development and use of various defenses, it would be possible that the effect of these experiences could produce a defensive pattern which, if activated by stress, could override a neurological preference in some individuals. Selecting subjects on the basis of their matured characteristic defensive styles could produce groupings which are confounded by the work of such an uncontrolled independent variable: the effect of psycho-social experience. For example, if a bright female were neurologically inclined toward greater reliance on right hemisphere processing, but was also motivated by the rewards of a special relationship with her father to excel in academic pursuits and logico-deductive reasoning she might appear to be reliant on intellectualization as a defense, while neuropsychologically she was right hemisphere dominant.

Additionally, Gur & Gur (1975) suggest that the DMI is a poor differentiator of defense style in bi-directional subjects. Grouping subjects by DMI scores then offers no information regarding the percentage of bi-directionals whose CLEM scores are contributing to overall findings. Krikorian and Rafales give us a clue to overall laterality of subjects by saying that "In general, the major predictions were confirmed. Under low-arousal conditions subjects responded with leftward eye movements to spatial items and rightward eye movements to verbal items. To the extent that LEMs reflect contralateral hemispheric activation, these results confirm the well-established ideas concerning specialization of verbal and non-verbal processing modes between the hemispheres. (p. 377)" This suggests that their total sample was heavily comprised of Right Movers, whereas the Gur & Gur (1975) study by design, compared the defense clusters of BOTH right-movers, left-movers AND bi-directionals. According to Gur, Gur & Harris (1975), in analyzing individual performances, greater differentiation in the E facing the S paradigm did not produce cross-over from left to right movement, rather an increased reliance on a "preferred" direction was observed. Based on the report in that study, in a low arousal (E behind S) condition, 86% of subjects can be predicted to function bi-directionally, with that percentage shifting to 29% in the E facing the S condition. This Bi-directional population behaved much less predictably in their responses to the DMI, tending not to be differentiated easily from either the left-movers or the right-movers, however being closer in DMI scores to the right-movers. One could predict that 29% of any sample then would be comprised

of Bi-directionals who would tend to produce DMI scores which were much closer to those of right-movers. If grouped on the basis of DMI scores only then, it is possible that an overrepresentation of Bi-directionals would be seen in a group of "Projectors". If this were true, a dependent measure based on CLEM could be skewed by the less lateralized performance of bi-directional subjects. As the discrepancy between Gur & Gur (1975) and Krikorian & Rafales (1982) hinges on the relationships of these groups, the contribution of this variable could be at work.

While these studies suggest a relationship between characteristic defense style as measured by DMI and laterality as measured by CLEM, the interpersonal, intrapsychic and methodological plasticity of the laterality measure appears to contribute a substantial amount of ambiguity. Additional clarity might be gained by the use of a different measure of laterality — one which measures the Trait of laterality as minimally affected by these moderating variables. Control for these three sub-groups of subject hemisphericity, (RHA, LHA and Bi-directional performances) then could help to evaluate the contribution of this variable to the subsequent relationship of hemisphericity to defense clusters via DMI. This information may possibly be clouded by the important, but nonetheless obfuscating effects inherent in the fluidity of the CLEM in the studies to date.

Summary

In summary then, based on clinical reports of the effects of cerebral damage, the removal of an entire hemisphere, the effects of commissurotomy, unilateral ECT and neuroanatomy as well as reports of experimental studies of neurologically normal subjects, stable differences in the cerebral hemispheres exist. These differences are structural, functional and cognitive. Individuals differ in their characteristic degree and direction of hemisphericity, or reliance on the two separate hemispheres. These differences in hemisphericity are influenced by handedness, gender, bilinguality, early cerebral damage, culture, language deprivation, deafness and acquisition of a visuo-spatial first language.

The same avenues of research have combined to establish a relationship between hemisphericity and the personality factors of cognition and emotion. While the underlying mechanism of this relationship is as yet unclear, the relationship between the hemispheres and their personality correlates is relatively consistent. The characteristic cognitive strength of the left hemisphere is logico-deductive, analytic, sequential, and verbally mediated thinking, whereas the thought process of the right hemisphere is strongest in visuo-spatial, holistic, imagoic and gestalt functions. At the emotional level a picture develops of the operation of the left hemisphere (without full or normal contribution of the right hemisphere) resulting in a consciousness that is easy-going, cheerful and inclined to deny catastrophic and painful realities. The right hemisphere, when unaided by the processing of the left hemisphere, tends to result in the presence of morose, dysphoric, painful and despondent affect.

An effort to integrate these relationships into a meaningful whole suggests that an individual's characteristic reliance on the processing strategies of one or the other hemisphere would be intrinsically related to their characteristic mode of problem solving, coping and defending. Studies of these potential relationships support such an understanding, but these efforts are still in the germinal stages of inquiry, grappling with complex methodological issues and constraints. Specifically, the plasticity of CLEM, and its apparent sensitivity to various demand characteristics of the experimental setting, has contributed to questions concerning its predictive validity. Groupings based on defensive style do not permit control of the unpredictable response patterns of bi-directionals. The interrelationship of potentially offsetting psycho-social experiences is totally unexplored. Further exploration of the contributions of interhemispheric participation in cognitive processing would elucidate suggestions that such participation may also be contributory. Further inroads could be made by pursuit of some "next steps" to a better understanding of these issues therefore, by:

1. Introduction of a less plastic measure of laterality than CLEM.
2. A methodology which permits exclusion of the unpredictable effects of bi-directionals from comparisons on the laterality measure.
3. An opportunity to investigate the relative contributions of unique psycho-social experiences.
4. A population that is varied in its relative reliance on right hemisphere, while stable in its reliance on left hemisphere.

Present Study

The present study examines the relationship between hemisphericity and characteristic defensive style while building on the previous literature in several ways. It builds on the existing literature by retaining the DMI as the measure of defense. It modifies previous paradigms by using a measure of laterality other than the CLEM. A visual measure of laterality, the tachistoscopic presentation of verbal stimuli, was employed, with accuracy of identification constituting the dependent variable. The "foundation study" (Rogan, 1983) referred to earlier in this discussion (Rogan, 1983) was used as the laterality data base for several reasons. First among these in methodological significance are those related to validity.

An Alternative Measure of Laterality.

The breadth of the original study produced sufficient data and methodological control to strengthen the validity of the laterality measure used. Levy (1983) and Hellige (1983) addressed in considerable detail the methodological pitfalls inherent in doing normative research of lateralization. The majority of the issues they raised and suggestions they made for offsetting these problems were incorporated in the base study. These included:

- A Hemisphere by Task interaction analysis.
- A Hemisphere by Population interaction analysis.
- Level of difficulty of the task was manipulated to standardize the accuracy of responses to 50% for each subject tested before test data were gathered.

- The multi-factor design used was extensively subanalyzed to see how the two-factor interaction patterns had changed.
- In replicating precisely a method used by another researcher, results were obtained which were highly concordant with that study with predictable differences among Subject groups.
- Both LCs and separate hemisphere accuracy scores were used as dependent measures. This assured that the interaction pattern obtained was not an artifact of the rescaling of the dependent variable, often produced by using a laterality index such as LC. This also assured that left and right hemisphere scores from which the index was derived were not obscured, permitting analysis of the form of the interaction.
- Potential peripheral pathway factors were controlled for by varying the nature of the experimental task by varying stimulus type.
- Visual scanning bias was controlled by vertical array of word stimuli.

Additionally, tachistoscopic measures of laterality are based on the assumption that performance patterns on T-Scope presentations reflect actual differences in neurologic functioning. Neville, Kutas and Schmidt (1982) have demonstrated in their work with Event Related Potentials (ERP's) that these measures (more direct because of their capacity to measure activation patterns electroencephalographically), combined with tasks designed to elicit lateral functioning, may be a more sensitive measure of actual neurological functioning than present experimental methods alone. The former combine a neurophysiological measure with a concurrent behavioral activity, whereas the

latter only permit observations of behavior which are inferred to be a function of neurological processes. In these studies they have found that while behavioral measures are not always the same as findings which emerge from ERP's, when behavioral asymmetries are produced, these are directionally consistent with ERP asymmetries. When differences between the measures are seen, it is when only trends toward behavioral asymmetries are observed. In such cases the underlying ERP's demonstrate laterality patterns both in morphological functioning as well as activation level which, though more pronounced, are in the same direction as the behavioral trends. It must, nonetheless, be kept in mind that behavioral performance such as that which is produced by this experimental method is still only inferentially associated with actual neurological functioning.

As the validity questions attendant to use of the CLEM as a measure of laterality have plagued this area of research, information gained from the use of this current tachistoscopic method would be highly valuable.

Research Questions Asked In The Present Study

1. Is there a relationship between laterality and personality?

Gur & Gur (1977) reasoned that persons who rely on the processing style of their right hemisphere would be expected to be more holistic and nonverbal, whereas those relying on their left hemisphere would be expected to use more verbal elaborations in their coping or defense mechanisms. Based on this reasoning they predicted that those relying on the left hemisphere would score higher on defense clusters that externalized conflict and involved verbal elaborations. The DMI subscales which include these defense clusters are TAO

and PRO. (When using the DMI composite score of Krikorian and Rafales (1982) persons scoring highest on these scores are called Projectors). Those relying on the right hemisphere were expected to score higher on defense clusters that internalized conflict in a holistic and preverbal fashion. The DMI subscales which include these defense clusters are INT and REV. (When using the DMI composite score of Krikorian and Rafales persons scoring highest on these scales are called Rationalizers.) These results were obtained by these experimenters. It is the plan of this study to evaluate this finding by using a different method of measuring laterality — one that examines this question with minimal influence of anxiety — the tachistoscope.

Motivated Hypothesis I: Laterality and characteristic defense choice of the individual are related. If this is true then the LC's will be negatively correlated with the DMI composite scores. This outcome (Hm: xy > 0, p = .05) will permit rejection of the null hypothesis.

Null Hypothesis I: Laterality and characteristic defense choice are independent of each other in the function of the individual. If this is true, then the LC's will not be negatively correlated with the DMI composite scores. This outcome (Ho: xy = 0) will not permit acceptance of the motivated hypothesis.

Expected Results: It is expected that a negative correlation will be obtained between the LC and the DMI composite score.

Rationale: It is assumed that the LC measures laterality and that the DMI composite score measures characteristic defense choice. It is believed that a negative LC, which is inferred to reflect left hemisphere dominance, is associated with Projectors, who produce positive DMI composite scores. It is also believed that the converse is also true: that a positive LC, inferred to reflect right hemisphere dominance, is associated with Rationalizers, who produce negative DMI composite scores.

2. Is This Relationship Independent Of Variables Associated With Acquisition Of Sign Language?

While the use of a Hemisphere by Population interaction analysis (the comparison of a population with a unique experience which is expected to produce a unique laterality pattern, with "normal" persons expected to produce traditional laterality patterns) adds validity, it introduces a complicating issue. The expected results were obtained in the original base study and defined a uniquely lateralized population. The inference was drawn that this unique cerebral pattern was the result of a life/environmental experience. Would this unique life experience, by which the original grouping assignment was made, be expected to have an effect on personality as well?

The life experience that this experimental group was the natural acquisition of sign language from their deaf parents. What could be predicted in personality development, given what is known about this experience? There is nothing in the literature to guide our understanding in ths area, as this population had not been identified for study prior to the base study. Indeed, studies of deaf children of deaf parents indicate that they do very well in educational, social, emotional and vocational adjustment (See Appendix A). However, we know nothing of these things about the hearing child of deaf parents.

Clinical knowledge of this population however, suggests that there could be many ramifications attendant to this historical fact of their lives. Typically, the hearing child of deaf parents becomes the interpreter for the family to the outside world. This usually occurs at about 5 or 6 years of age. This function in the family places the child between their parents and EVERYONE who hears. The child communicates for the parents in medical, social, employment and legal situations. They are therefore, processing more mature information than most adolescents must deal with — at a much earlier age. They perceive the attitudes of hearing persons toward their parents and themselves. They feel the stigma. There are myriad ways in which life is different for them. For instance, their parents — not being able to hear: and therefore to monitor their own sounds — produce all of the sounds that most hearing persons screen/inhibit. Love-making is not kept "quiet — the children!". The primal scene therefore, is a quite different experience for these children.

The only generalizations which can be made in a predictive vein are speculative at best. Indeed, such an experience would be expected to produce a heightened sense of responsibility very early in the life of the child. They would quickly be a "little adult", aborting the normal span of carefree childhood. But individuals respond differently to this experience. Joanne Greenberg, in the novel In This Sign (1970) paints a bleak, though beautiful picture of her childhood. The story is laced with cynicism and an undertone of anger, while doing a brilliant job of describing her world and the world of the deaf. I have listened to hundreds of interpreters, themselves hearing children of Deaf parents, discuss the book. Some heatedly decry its negative tone, some as aggressively support and endorse it, while others are appreciative of the exposure to the issues — seemingly free of emotional conflicts about it. How then could one predict whether this family experience would predispose one to externalize conflict, or internalize it?

If the research potential of this uniquely lateralized population is to be maximized, then this potential influence must be separated from the relationship under investigation: that between the unique hemispheric function of this population and personality. The correlation of laterality and defense choice therefore, will be ascertained conditioned upon the partialling out of the variance produced by the original group membership.

Motivated Hypothesis II: That there is a relationship between laterality and defense choice which is independent of variables associated with the original group membership. If this is true, then the correlation between LC´s and DMI composite scores will remain significant when conditioned on the partialling out of the variance due to the original group membership. This outcome will permit rejection of the null hypothesis.

Null Hypothesis II: That the relationship between laterality and defense choice is totally dependent upon variables associated with the original group membership. If this is true, then the correlation between LC´s and DMI composite scores will not remain significant when conditioned upon the partialling out of the variance due to the original group membership. This outcome will not permit acceptance of the motivated hypothesis.

Expected Results: It is expected that the correlation between LC and DMI will not be weakened significantly when conditioned upon the removal of the variance due to the original group membership.

Rationale: There is no consistent predicted effect on personality due to the unique psycho-social factors associated with being a hearing child of deaf parents, or of having acquired sign language later in life, which could be expected to over-ride a laterality/defense choice relationship.

3. Does The Inclusion Of Scores Of Bi-Directionals Obscure This Relationship?

The reader will recall that in the base study 29 right-handed hearing Ss were represented in three experimental groups as: Native signers (N=10), Late-learn signers (N=9) and Non-signing controls (N=10). Groups were balanced for gender. Compared on their ability to correctly identify tachistoscopically presented unilateral stimuli of 4 types, only English words, a measure of hemisphere advantage for verbal stimuli are used in this current study.

To evaluate a relationship between laterality and defense cluster, it is important to have a representation of various defense scores (i.e., both positive and negative DMI Composite scores), as well as a representation of various hemisphericity types (i.e., LHA and RHA). A logical question at this point is raised. How can the necessary representation of RHA be obtained from this laterality base study in which two groups were shown to produce a LHA while only the experimental group of Native signers differed — and then by only a reduced LHA for verbal stimuli?

The phenomenon of individual differences aids us here. As Levy (1983) states in discussing functional diversities in normative studies:

> This possibility is of great interest because normative studies of lateralization, although typically revealing the expected perceptual asymmetry on dichotic and lateralized

tachistoscopic tasks for the sample of subjects as a whole, almost always find that a significant minority of subjects fails to display a significant asymmetry and that even among those manifesting the expected direction of asymmetry, there is a large variability in magnitude.

(Levy 1983, p. 466)

while:

I do not believe that studies of unilaterally brain-damaged patients versus normative studies with dichotic or tachistoscopic techniques measure the same factors in individual patients or subjects. The consistency that appears is a consistency with respect to statistical averages; neurological investigations reveal that language is specialized to the left hemisphere in the vast majority of right-handers while normative studies show that, on appropriate verbal tasks, there is a right sensory field advantage for right-handers, as a group. The group inference from normative studies supports neurological findings, and in both cases, I believe hemispheric specialization is being reflected. However, not all right-handers show the expected perceptual asymmetry, and even among those who do, there is a large variation in the degree of asymmetry observed."

(Levy 1983, p. 475)

In fact, the base study produced data which reflected both LHA and RHA in subjects in all groups. Figure 3 displays the numbers of subjects who produced LHA, RHA and bi-directional competence, per experimental group. Therefore, the necessary variability in laterality is present in this base study.

The Gur & Gur (1975) study reported that Bi-directional subjects did not produce consistent DMI scores. Other studies have not controlled for this factor, which could contribute to findings which are obscured by it. This present study permitted statistical comparisons to be made of only those subjects who had demonstrated either a RHA or LHA, thereby controlling the influence of the Bi-directionals. Though the N´s were small, it was believed that any emergent trend would prove instructive.

Insert Table 1.

Motivated Hypothesis III: That Bi-directionally lateralized subjects do not produce consistent DMI composite scores and including them in a correlational study will obscure the LC/DMI relationship which is obtained in persons who are lateralized either to the right or the left. If this is true, then the correlation of LC´s with DMI composite scores will be increased when the scores of bi-directionals is removed from the comparison. This outcome will permit rejection of the Null Hypothesis.

	Group 1	Group 2	Group 3	Tot
RHA	3	1	1	5
Bi-D	2	2	3	7
LHA	5	6	6	17
	10	9	10	29

TABLE 1.

Numbers of Subjects in Group 1 (Native Signers), Group 2 (Late-learn Signers) and Group 3 (Non-Signing Controls) Whose Laterality Coefficients For Accuracy of Identification of Verbal Tachistoscopically Presented Stimuli Reflected a Right Hemisphere Advantage (RHA); Left Hemisphere Advantage (LHA); or No Hemisphere Advantage (Bi-D) In The Base Study (Rogan, 1983).

Null Hypothesis III: That Bi-directionally lateralized subjects do produce consistent DMI composite scores as do lateralized subjects and including them in a correlational study of the LC/DMI relationship will not affect this relationship. If this is true, then the correlation of LC´s with DMI composite scores will be unchanged by the removal of the scores of the Bi-directionals. This outcome will not permit acceptance of the motivated hypothesis.

Expected Results: It was expected that the correlation between LC´s and DMI scores would be increased by the removal of the scores of Bi-directionals from the comparison.

Rationale: It is assumed that those subjects who do not produce LC´s which reflect either left or right hemisphere advantage are Bi-directional in their lateralization. It is believed that these subjects do not fall within the predictive range of this study and that they produce scores on the measure of defense choice which are, for the purposes of this study, spurious.

4. Do The Two Cerebral Hemispheres Participate Differently In The Laterality/Defense Choice Relationship ?

Finally, it was deemed useful to exploit the way in which this uniquely lateralized population differed from comparison groups. Earlier comparisons demonstrated that the reduced laterality displayed by this group was due to a significantly better performance by their right hemisphere than that of comparison groups. No differences between left hemisphere performances were found.

The Krikorian & Rafales (1983) study suggested a possible effect of right hemisphere activation among rationalizers under high arousal conditions. Tucker (1981) suggests that both an inhibitory role of left hemisphere and the observations that "anxiety seemed to impose a processing load specifically on the left hemisphere (p. 22)" may be involved. He says, "The two hemispheres seem to exist in some sort of reciprocally balancing, dialectical relationship, each hemisphere's affective tendency opposing and complementing that of the other. (p. 21)". It would be useful then, to use the separate hemisphere data which is available from the base study to evaluate whether such a relationship exists.

Motivated Hypothesis IV: That the two cerebral hemispheres participate differently in the relationship of laterality and defense choice and that the inhibitory role of left hemisphere may be involved in this relationship. If this is true the relationship between left hemisphere performance scores and defense choice will be greater than the relationship between right hemisphere performance scores. This outcome would permit rejection of the null hypothesis.

Null Hypothesis IV: That the two cerebral hemispheres do not participate differently in the relationship of laterality and defense choice. If this is true, then the relationship between left hemisphere performance scores and defense choice will not differ from the relationship between right hemisphere performance scores. This outcome would not permit acceptance of the motivated hypothesis.

Expected Results: It was expected that a larger correlation would be obtained between the left hemisphere accuracy scores and the DMI composite score, than between the right hemisphere accuracy scores and the DMI composite score.

Rationale: The performance scores of the separate cerebral hemispheres, taken together comprised the LC's used to derive the LC/DMI relationship. It was believed that these two scores would contribute differently to the LC/DMI relationship.

The opposite effect however may not be interpreted as indicating that right hemisphere contributes relatively more to defensive style unless the partial correlation for effect of the experimental group is not significant. This is due to the fact that the right hemisphere scores were unique to the experimental population of native signers, and could therefore, simply be an effect of the original grouping.

Method

Subjects

Group 1 was comprised of 10 hearing adults who are children of Deaf parents and whose first language, acquired naturally was American Sign Language. Five of these were first born. There were seven women and three men. Ages ranged from 20 to 58 with a mean of 43.7 years. All were right-handed as were their parents, with 2 Ss reporting a left-handed grand-parent. Mean years of highest grade completed were 15.9, ranging from 12 to 19 years. None had corrected vision of less than 20/20. Two reported having difficulty learning to do math. None reported a history of neurological problems of Epilepsy or blackouts.

Group 2 was comprised of 9 hearing persons whose first language was English and ho acquired ASL as a second language, after the age of 12. Seven were women and three were men. Ages ranged from 18 to 59, with a mean of 35.8 years. All were right handed, only one reported one left-handed parent, with none reporting a left-handed grand-parent. Four were first born children. Eight reported having learned another language than sign, one as early as 10 years; all others during secondary education. Completed education ranged from 12 years to 20, with a mean of 16.5 years. None reported corrected vision less than 20/20. None reported having had problems learning, nor neurological history.

Group 3 was comprised of 10 Hearing controls whose only language is English and who have no familiarity with ASL. Six women and four men ranged in age from 19 to 47, with mean of 35.7. All were right-handed, one reported one left-handed parent, none reported left-handed grandparents. Only one was first born. Years of education averaged 15.3, ranging from 12 to 20. Four had never learned a second languge, two of those wo did earn a second language did so naturaly in the home, one at age 8. None had corrected vision less than 20/20. None reported learning difficulties or neurological problems.

All subjects were recruited by open letter to relevant organizations in the State of Michigan, requesting their participation (see Appendix C).

Information was acquired on handedness, age, sex, highest academic level achieved, grade point average, profession, birth order, competency in English and ASL, age and method of acquisition of second language, corrected vision and history of neurological events or conditions in an effort to control for these factors. At the same time Informed Consent was obtained in writing. (See Appendix D).

Stimuli and Apparatus

The methodology used by Poizner et al (1979) was used to the extent possible technically. A few changes were made in an effort to improve fixation. All stimuli were presented on Super 8 mm movie film. Four stimulus sets were used, all exposed by a single frame filming technique and described separately per Experimental condition.

The fixation was controlled by the pseudorandom distribution over one fourth (10) of the trials of each stimulus set, of a fixation image (the "(?)" figures of the Helvetica Press-Type Set), which required identification by the subject when seen. This was a totally nonlinguistic task in order to offset any possible effects of competing or complementary effects to the experimental tasks.

Subjects were seated and positioned relative to the projected 8 mm image to assure a visual angle of three degrees of the stimuli center to the left or right of fixation. Distance between fixation point and stimulus; and the distance between Subject and projected image, were varied. For instance, if the subject was seated 76" from the projected surface, then the projected image was adjusted to a fixation/stimulus distance of 4".

Stimuli.

Stimulus Set I consisted of the same 20 high frequency three letter English words used by Poizner, et al (1979), (all words appeared at least 50 times per million in the Thorndike-Lorge count). These were vertically printed (chart pak Velvet Touch lettering, Helvetica Bold 72 PT/M10772C) to eliminate the effects of any scanning from left to right that might take place after exposure. Each word was presented for a total exposure of 112 msec, on two frames of film. The words were centered (3 degrees) to the left or right of fixation point and span (.5 degrees) in width and (1.5 degrees) in height. Words used were: JOY, LEG, SKY, ROW, WAY, ALL, ACT, CRY, LOW, PUT, BOW, TEN, OUT, TEA, SUM, PAN, MAP, NOD, RAY, WHO.

Procedure

A warning stimulus was presented by the fixation point rapidly pulsating (this was done in the production of the film by repeatedly exposing and covering the lens for two consecutive frames each, while filming the fixation point) for 1 second (a total of 18 frames) before the onset of the stimulus. At stimulus onset either the fixation point remained for the duration of the stimulus exposure, or the special fixation image "(?)", appeared for the duration of the stimulus exposure. Subjects were instructed to maintain fixation, signal the presence of the special fixation image when present by raising either index finger, and then to report the stimulus. Approximately ten seconds (180 frames of black film) elapsed between trials, with the subject given the time they required to respond to the film.

Experimental order was counterbalanced across subjects. Subjects received the following instructions:

> You will see a white circle in the center of the screen, like this. It will begin to pulsate, like this. When it does, I want you to focus your attention on it. This design may, or may not, then appear. You must signal when you see this special design by raising either index finger. Do not signal unless you see this design.
>
> At the same time, with or without th special design, a picture will appear either to the left or to the right of the circle. You must then report the word which appeared on the side. You must make this report by voice.
>
> At all times your focus must be concentrated on the circle. There will be no advantage to directing your attention to one side or the oter.
>
> We will do a few practice trials. I will tell you when the actual test begins.

Five practice trials were used in which the special fixation was used twice with s

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with stimuli. A minimum of two correct responses on these trials was achieved before proceeding with actual trials; practice trials repeated if necessary. For the actual test trials responses were recorded on the Subject Answer Sheet (See Appendices).

Subjects were instructed verbally in English. They were instructed to respond in English. These words were recorded on the Subject Answer Sheet under Experiment "Words". five practice trials preceded the 40 test trials. Responses were scored correct only if the complete exact word was reported by Ss. Two of three letters correctly identified were scored as incorrect.

Subjects were given a paper and pencil personality measure, the DMI; asked to complete the answer sheet (according to standardized instructions) without filling in their name or other identifying information, and to return it in the self addressed, stamped, coded envelope within one week. All materials were returned by subjects within the designated time.

Measures

The Laterality Coefficient (LC) described by Marshall, Caplan & Holmes (1975), considered to be free of influence due to overall accuracy levels, were computed for all subjects scores for T-Scope responses. This formula is expressed as RC - LC/RC + LC when total mean correct of subject's responses is less than 50%; and RC - LC/RE + LE when total mean correct is greater than 50% (where RC = Right Correct, LC = Left Correct, RE = Right Errors and LE = Left Errors.Mean LC's were used for group comparisons of hemispheric functioning.

Individual accuracy of identification scores for the separate hemifields (separate cerebral hemispheres inferred) were used as the dependent measure of perf

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performance of the separate hemispheres. Group Means were computed and used for group comparisons of individual hemispheric functioning.

The composite DMI score derived by Krikorian & Rafales (1983) were used as the measure of subject defense mechanism preference. Negative DMI composite scores were believed to reflect reliance on rationalized defenses, positive DMI composite scores to reflect reliance on projective defenses. Group Means were used for comparisons of defense choice.

Results

The Laterality Coefficients (LCs) computed on the correct identification per hemifield of tachistoscopically presented English Words (Rogan, 1983) were used as the measure of laterality. Negative LCs indicated greater accuracy of identification in the Right Visual Field (RVF). This was inferred to reflect a left hemisphere advantage (LHA). Positive LCs were interpreted as reflecting a right hemisphere advantage (RHA). The composite DMI scores (Krikorian & Rafales, 1982) were computed ([TAO + PRO] - [INT + REV]) for each subject as the measure of defense choice.

A Pearson Correlation was calculated to compare the LCs of all subjects regardless of original group membership, with their Composite DMI scores. The results approached significance ($r=.27$, $p = .078$). This correlation however, is a positive one, therefore opposite to the direction predicted based on previous studies and therefore opposite in direction to Motivated Hypothesis I, as well. Thus, though the statistic suggests a relationship between laterality as measured by LCs and defense choice as measured by Composite DMI Scores, this relationship is in the opposite direction from those previously reported. LHA was positively associated with negative DMI scores and RHA was positively associated with Positive DMI scores, whereas Gur & Gur (1975) found the opposite relationship. It was important to determine whether the experimental group membership of the original study exerts a moderating influence on this relationship.

To begin to address this question an analysis of variance was performed on the mean LCs of Groups 1, 2, and 3. There was no Main Effect for Group ($F(2) = .956$, $p = .40$) suggesting that groups did not differ in a consistent mean level from one another on this measure. A one-way analysis of variance was performed contrasting the mean LCs of Groups 1 and 2 (the signing groups) with Group 3 (non-signing controls). There was no effect for this grouping pattern ($t(26) = 1.03$, $p = .310$). Thus, signers did not differ significantly from non-signers in their performance on this task. A similar contrast of the mean LCs of Group 1 (native signers) with Group 2 (late-learning signers) resulted in no significant difference as a function of this grouping pattern ($t(26) = .88$, $p = .384$). Thus, difference of age of acquisition of sign language did not have a significant effect on the mean laterality patterns as measured by LC's in English Word identification. This is consistent with the previous analysis of this data (Rogan, 1983).

To evaluate whether any consistent group differences existed on the Mean Composite DMI Scores an analysis of variance was performed on the Mean Composite DMI scores of Groups 1, 2 and 3. There was no Main Effect for Group on this measure ($F(2) = 1.278$, $p = .30$). A one-way analysis of variance was performed contrasting Groups 1 and 2 (the Signing groups) with Group 3 (non-signing controls). This was done to evaluate whether membership in a signing group contributed in any consistent way to the overall outcome. There was no effect for these groupings ($t(26) = -1.54$, $p = .135$). To evaluate the contribution of factors associated with being native signers (i.e., having deaf parents) another one-way analysis of variance was performed contrasting Group 1 with Group 2. No significant difference was found between these groups either ($t(26) = .47$, $p = .641$). Thus, on this measure of defense choice, signers did not differ significantly from non-signers, nor did factors associated with age of acquisition of sign language (the group definition factor) play a role in this outcome.

To further assure that unidentified variables associated with the original grouping were not contributing to the correlational relationship between LCs and Composite DMI scores, a partial correlation was conducted on this data as well. With the variance due to group membership partialed out, the correlation between measures is significant ($r = .339$, $p = .042$). Thus, the Laterality/DMI relationship, when the effects of age of acquisition of sign language are partialled, is stronger ($r = .339$; $p = .042$) than reported earlier (without regard to group) ($r = .270$; $p = .078$). This outcome permitted rejection of Null Hypothesis II.

To evaluate the influence of the Composite DMI Scores of bi-directional subjects on the correlation between measures, a Pearson Correlation was computed comparing the scores on both measures of only those subjects with a positive or negative LC, thereby omitting subjects who demonstrated no lateral preference. The results produced a larger correlation ($r = .317$ compared to $r = .2698$), but due to the smaller number ($N = 22$), only a similar significance level ($p = .075$). The actual DMI means were different enough (mean of -LCs = -12.47; mean of +LCs = 6.6) however, to suggest that this small N could be obscuring the analysis (due to lack of statistical power). This outcome did not permit rejection of Null Hypothesis III. Though inconclusive, these results are nonetheless heuristic in suggesting a greater correlation between LC and DMI in only those subjects who display a lateral dominance pattern.

Finally, to determine the relative contribution of the processing capacity of the separate hemispheres without the possible confounding effects of the Laterality Coefficient itself, a Pearson Correlation Coefficient was computed separately on the mean number of correct identifications in the Right Visual Field (LH), and the Left Visual Field (RH), with the Composite DMI Scores. The correlation coefficient comparing the LH with the Composite DMI Scores approached significance with a negative correlation ($r = -.2892$, $p = .064$), while the correlation of RH was clearly not significant ($r = -.0245$, $p = .450$). Thus, accuracy of identification in the RVF, inferred to be the performance competence of left hemisphere, was positively related to reliance on Intellectualization and Reversal, though not significantly so. Though left hemisphere performance appeared to be more important to the relationship of laterality to defense choice than was the performance of right hemisphere, this outcome did not permit the rejection of Null Hypothesis IV.

Discussion

The correlation between laterality (as measured by the LC's of hemifield accuracy of identification of tachistoscopically presented English words) and defense choice (as measured by the DMI Composite score suggested by Krikorian et al (1983), approached significance. Though this relationship was not strong enough to reject Null Hypothesis I, it was nonetheless suggestive of a weak relationship between laterality and defense choice.

Though the groups of the original study did not differ significantly in their performances on the defense choice measure, factors associated with this original grouping did exert an influence on the laterality/DMI relationship. The correlation obtained was in fact obscured by factors associated with the original grouping i.e., by the life experiences of being raised by deaf parents; of having a visuo-spatial first language; or of having acquired a visuo-spatial language later in life. When the variance due to group differences was partialed out, the correlation reached traditional levels of significance ($p = .05$). Therefore, the relationship between laterality and personality was stronger without the effects due to these unique life experiences. It is not possible to know what these factors were, or how they obscured the underlying relationship between laterality and defense choice. This could be the subject of future research. That the correlation of interest was enhanced by removal of this variance however, permits adoption of Motivated Hypothesis II, that the LC/DMI relationship would be obtained conditioned upon the removal of variance due to factors inherent in the original grouping.

One of the benefits of the tachistoscopic paradigm as the measure of this measure, data was available on the performances of the separate hemispheres. No significant difference was obtained between either the left or right hemisphere and the DMI performance scores. The significance levels obtained however placed the left hemisphere relatively closer to significance ($p = .064$) than that of the right hemisphere ($p = .450$). This suggests then, that the relationship between laterality and defense choice may be tied to the processing of left hemisphere. The two cerebral hemispheres appear to participate differently in the relationship between laterality and defense choice. Left hemisphere appears to be more integrally involved in this Laterality/DMI relationship. Future research in this topic area would be able to illuminate further the determinants of this left hemisphere involvement in defense choice by utilizing this methological advantage of the tachistoscopic paradigm.

Additionally, the LC/DMI relationship described earlier was based on the relative -- not the separate -- performances of both hemispheres. Therefore, the good performance of the left hemisphere, if coupled with an equally good performance by the right hemisphere, would have produced a laterality score which reflected less advantage by either hemisphere. It was the advantage that was used as the measure in that first comparison to the DMI score, not the performance of one or the other hemisphere. The one measure on which the three groups differed demonstrably in the original study (Rogan, 1983) was in the separate hemisphere performances (specifically the right hemisphere). This artifact of the LC as a measure of laterality then, may have produced the variance due to original grouping which exerted a clouding influence (referred to earlier) on the laterality/DMI relationship.

Based on the observation of Gur et al (1975) that bi-directionals did not behave in a predictable way on the DMI, the scores of subjects whose laterality was bi-directional (not reflecting an advantage for either hemisphere) were removed from comparison. The correlation of the LC´s and the DMI Composite Scores increased as a result (r = .317) This supports the Gur´s observation was correct. Because the total number of subjects was reduced significantly by removing these subjects however, the significance level was not greater. Though these findings are inconclusive due to the problem of this reduced sample size, they do suggest that bi-directionality is a variable which should be controlled in future research in this area. However, this did not permit adoption of the Motivated Hypothesis III: that bi-directionals do not produce consistent DMI scores and inclusion of these subjects´ scores to correlational studies of the Laterality/DMI relationship may obscure results.

The interpretive difficulty in the present study rests in the fact that the correlation obtained between laterality and defense choice is in the direction opposite from that demonstrated by Gur & Gur (1975). There are several factors which may account for this:

1. The tachistoscopic measure of laterality may produce results which, when compared to the CLEM, are different.
2. The DMI may not measure the constructs which are important to this correlational investigation.
3. An underlying independent variable may be embedded within either of these measures. or,
4. The differing demand characteristics of the experimental settings may be affecting the outcome in an uncontrolled way.
5. All of the studies involved used a small number of subjects which could account for spurious findings.
6. A combination of the above factors may be at work.

The Tachistoscope as a measure of laterality would be expected to be different from the CLEM for many of the reasons already discussed. As the Gur's have demonstrated so effectively, CLEM is subject to significant malleability due not only to content, but also to interpersonal, intrapsychic and situational variables, which have been inferred to result in anxiety. It can be seen therefore, as an index of the effect these variables have on the varying activation levels of each of the two cerebral hemispheres, with content and stress alternating the governance of response. While content determines hemisphere advantage to a greater degree under low stress conditions, reliance on a preferred hemisphere is believed to be the outcome under high stress conditions (Gur & Gur, 1975).

The studies we are about to examine use the term "stress" interchangeably with anxiety and various experimental manipulations considered to cause it. This is an unfortunate example of how the term serves as a catch-all and as such, can obscure the underlying factors which influence outcome in research. As it is encountered here it appears to describe demands of the environment which activate certain cognitive, physiological, affective and intrapsychic systems in the organism. A more concise use of this term in research should identify the types of systems activated by the specific environmental manipulations. It is hoped that this study and future research will enable such clarification.

Influences Exerted On Laterality By Anxiety

Anxiety affects the measurement of laterality in the tachistoscopic paradigm as well as the CLEM paradigm. Tucker et al (1978) reported a performance decrement in the right visual half-field (left hemisphere performance) in subjects reporting high anxiety on a measure of state anxiety,

in response to tachistoscopic tasks. There was no decrement in the performance of these subjects in the left visual half-field (right hemisphere performance). They used both stress and non-stress conditions and concluded that "Anxiety imposes a processing load specifically upon the left hemisphere, which can draw from the information-processing capacity of that side of the brain." In the low stress condition, there were no performance decrements and the traditional left hemisphere advantage for verbal stimuli was obtained.

While anxiety was not controlled or manipulated in this present study, several methodological factors would suggest that a low stress/anxiety level existed. First, the method of recruitment was based on volunteerism. The recruitment description of the project did not enlist subjects to be evaluated in a judgmental way. Subjects were all aware of the Deaf community and its political, social, medical and psychological needs. They volunteered in response to a request to participate in a study to better understand the neuropsychological function of Deaf persons by studying the processing of sign language. Altruism could be seen as a more primary motivator than performance related esteem issues. The recruitment letter also emphasized the student status of the person conducting the study and the fact that this study was being done in conjunction with the requirements of a doctoral degree. There was no suggestion that this study would be related to major plans, or decisions which would have direct impact on others. Instructions emphasized the procedure subjects should follow with no reference to performance expectations, or contingencies based on performance. Demeanor and dress of experimenters was casual. Nothing was done to convey an undue sense of importance to the subjects. In this regard, this study was comparable to the low stress condition of the Tucker et al (1978) study.

Second, signing subjects were all Registered Interpreters with the Michigan Registry of Interpreters for the Deaf. As such, these people were accustomed to performing their signing and communication skills (reverse sign interpreting requires speech with intonation, emphasis and inflection) in large public gatherings, on television, before large audiences, in courts of law and in medical emergencies. In short, such performance-related pressures as these were a part of the normal functioning of these individuals. This project therefore, held little to challenge their poise.

Third, the interpersonal factors of the Experimenter facing the Subject, shown to induce the difference in the CLEM results obtained by Gur, Gur & Harris (1975) and inferred to be the result of anxiety, was not part of the T-scope paradigm. Rather, subjects' visual fixation was directed to the center of the projected image during the entirety of the 40 trials. Their responses were recorded, in a darkened room, by the recorder who sat behind them. Thus, the interpersonal stress condition was also in the low range. The performance scores in this study then, may be viewed as comparable to those of the low stress condition of the Tucker study (Tucker, et al 1978). As such, the left hemisphere performance scores would be presumed to be essentially unimpaired by anxiety.

Fourth, the English Word stimuli were wide in variety, common in usage and were presented in equal distribution to both hemifields. As such, the stimuli could not be considered to contain material which would produce either significant or consistent arousal.

Fifth, subjects took the DMI materials with them, completing them at home in the setting of their choice (albeit, though advised otherwise, this could have been in the company of others in their home environment.).

Finally, performance of left hemisphere is expected to be negatively affected by anxiety. Yet, all subjects produced the traditional LHA for English Words except the native signers. Their left hemisphere performances were significantly better than all others; their reduced laterality due to greater right hemisphere performance.

This study can be seen then, as demonstrating the laterality patterns produced by the tachistoscopic presentation of material in the low stress condition. To make the proper comparison of the Laterality/DMI relationship obtained in this study then, a true low stress measure of CLEM in its relationship to the DMI Composite Score would be necessary. The only study to offer this data to date, is the Krikorian et al (1983) study. Herein, we find some clarity.

In that study, though subjects were grouped based on their production of either negative (greater reliance on INT and REV than TAO and PRO) or positive (greater reliance on TAO and PRO than INT and REV) Composite DMI scores, the degree of stress/anxiety was manipulated on the CLEM measure via three "arousal" conditions. These were low, moderate and high, based on question content. Though most of their discussion focused on the differences between these two groups at the higher levels of arousal, the data is reported for performances at the low level of arousal. The reader will keep in mind that Gur & Gur (1975) found that right-lookers (LHA) produced DMI scores which were higher in INT, whereas, left-lookers (RHA) produced higher scores on TAO and PRO. And these findings were based on CLEM in the high anxiety condition of Experimenter facing Subject. The present study based its predictions on their results.

What we find when we review the Krikorian and Rafales (1982) data, is the possible answer to the positive correlation between laterality and the DMI

Composite Score obtained in the present study where, based on the Gur's results, we predicted a negative correlation. Figure 2 contains the percentage of inferred left hemisphere activation obtained for low, moderate and high arousal levels for all subjects, positive DMI subjects and negative DMI subjects by Krikorian, et al (1983), Gur, et al (1975) and the present study.

Insert Figure 2

Using this Figure, we can easily see that in the low arousal condition, Krikorian's data is consistent with our current findings in a left hemisphere advantage for all subjects. For those subjects with positive DMI Composite scores Krikorian's data reflects a right hemisphere advantage, as does this present study. Those who produced negative DMI Composite scores in Krikorian's study produced a left hemisphere advantage, as did negative DMI scoring subjects in this study.

In Krikorian and Rafales (1982), rather than the Positive DMI Group displaying the expected LHA for verbal material predicted by the Gur & Gur (1975) study, under low arousal conditions this group displays a greater percentage of left looking (RHA) in cumulative duration (.46755 of right looking) and cumulative frequency (.46064 of right looking). Only when the direction of the first eye movement was used as the measure did a slight trend toward greater right looking (LHA) appear (.5234 of right looking). The Negative DMI group, associated with left-looking (RHA) in the Gur et al (1975) study, produced a very strong reliance on left hemisphere in this low arousal condition, in cumulative duration (.57024 of right looking), cumulative

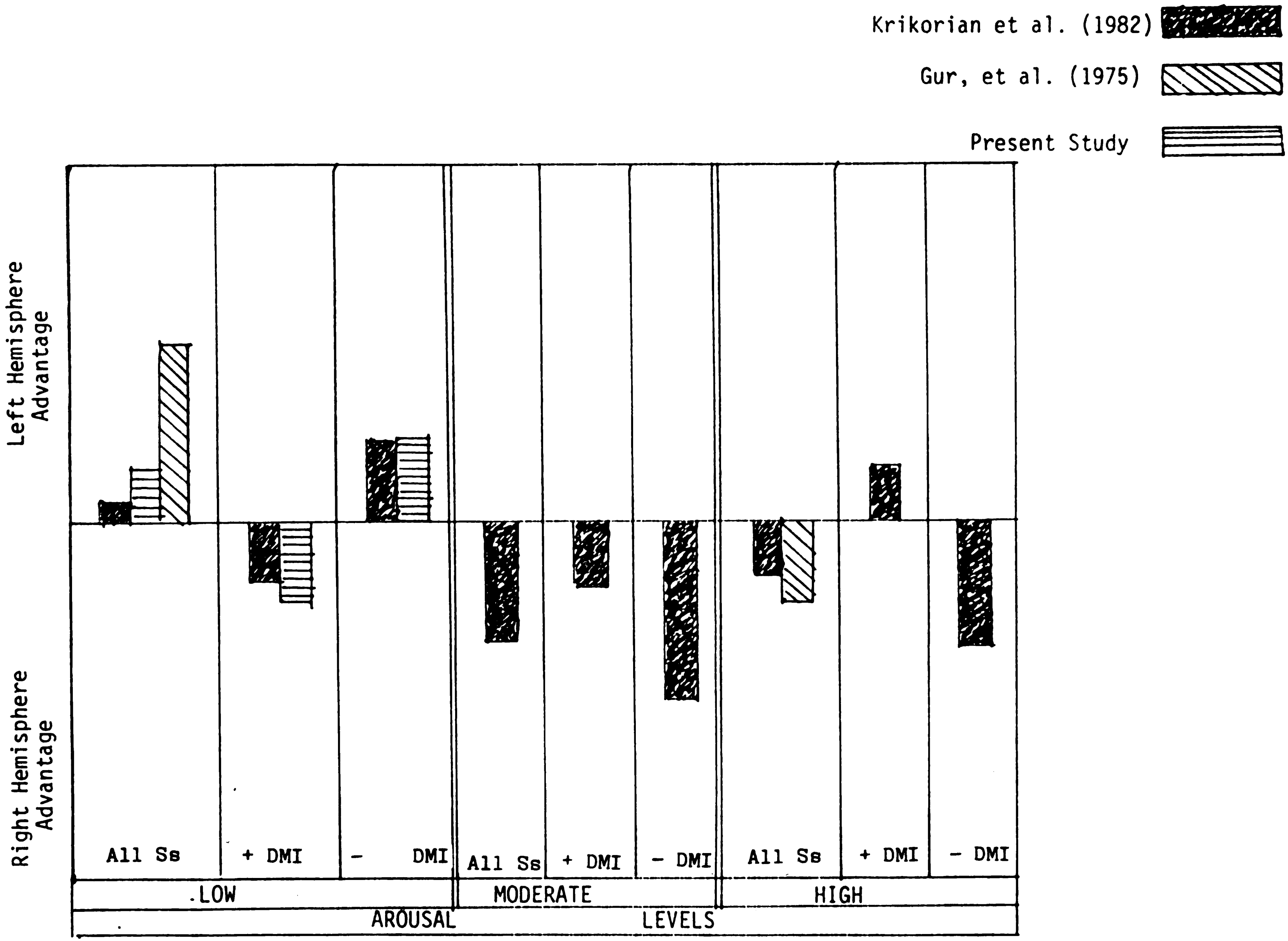

Figure 2. Percentages of Right Looking/Right Visual Field Superiority for three studies across low, moderate and high arousal levels.

frequency (.55393 of right looking) and direction of first eye movement (.59375 of right looking). At the high arousal level these relationships reversed in the Krikorian study. Though not reaching significance in each case, in this high arousal condition these Laterality/DMI relationships were in the opposite direction. The results of the present study then, based on low anxiety, are actually consistent with the Krikorian et al (1983) findings.

Additionally, the data from the Gur et al (1975) study which isolated the contribution of stress inherent in the experimental paradigm (experimenter facing, vs. experimenter behind the subject) is also consistent with the understanding of this shift in laterality. This data was produced by the same subjects in each of the two paradigmatic conditions. The group percentage of inferred left hemisphere activation was greatest in the low stress condition, shifting to greater right hemisphere activation (below .50 of right looking behavior) in the high stress condition. This supports the understanding that a shift in laterality appears as a function of anxiety/stress level.

Combined these data suggest that persons who rely on the processing strategies of the left cerebral hemisphere when under low stress, tend to produce negative DMI Composite Scores (greater reliance on INT & REV) (Krikorian & Rafales, 1982). These same individuals, when under high degrees of stress tend to process verbal information with a handicapped left hemisphere, relying more on their less competent right cerebral hemisphere (Krikorian & Rafales, 1982; Gur & Gur, 1975). Accordingly, those individuals who rely on the right cerebral hemisphere for processing verbal material in low stress conditions produce positive DMI Composite Scores (greater reliance on TAO & PRO) (Krikorian & Rafales and this present study). Under high degrees of stress these same individuals will rely more on the processing of their left hemisphere for verbal material than on their right (Krikorian & Rafales, 1982; Gur & Gur, 1975).

Issues Related To Personality

In dealing with the inverse correlation produced in this present study, six possible explanations were identified. Of those, the one that has not yet been discussed, was the second, "The DMI does not measure the constructs which are important to this correlational investigation." There is reason to suggest that the DMI may not be a reliable measure of the constructs under investigation in this study. This consideration brings us to the personality constructs examined in this study.

In a study by Reyher and Moses (in press) the authors did not find the performances they expected of their subjects on the DMI, though other aspects of their investigation were conclusive. They suggested several reasons why the DMI may not be an accurate measure of the more dynamic factors they were investigating. These included: "the categories of the DMI are heterogeneous, subjects are not asked to visualize the stimulus narratives, cognitive processes rather than affect mediate subjects' choice of defense mechanisms, and subjects' verbalization of their mentation is susceptible to influence by considerations of social desirability/social anxiety." (In press) Most important to the present study may be their identification of the cognitive rather than affective mediation of subjects' defense mechanism choice on the DMI, as well as the susceptibility to influence by social/interpersonal factors.

Smokler & Shevrin, (1979) did not find a correlation of CLEM with any of the DMI subscales. These authors also questioned the constructs which the DMI may be measuring and their applicability to the traditional clinical/dynamic approach they had taken to operationalizing defensive style. Addressing the subscale heterogeneity concern, they said, "The DMI appears to be based on a different clustering of defenses from our own [clinical criteria for defining personality] (Smokler & Shevrin, 1979, p.953). They observed that their schema isolated hysteric and obsessive-compulsive personality styles, whereas the Gur & Gur (1975) study (to which they were comparing their results) found correlations of eye movement with DMI defense clusters (such as PRO and TAO) that are not usually thought of as either hysteric or obsessive defenses.

The present study however, did produce a correlation between neuropsychological reliance on left hemisphere and defense mechanism reliance on INT and REV. As the composite score was used, we do not know which of these subscales contributed more to this relationship, or if either did separately. In this low stress condition it is not surprising to us at a content level, that this relationship obtained. It suggests that there is an association between intellectualization and left hemisphere processing style. This is consistent with what one would expect. It is believed that obsessive-compulsive personality styles rely heavily on logical, intellectual approaches to problem solving -- even as Smokler & Shevrin have described, "Could a strongly left-hemispheric individual appear as one who analyzed virtually everthing in a piecemeal analytic manner even in situations in which this might not be advantageous?" (p. 949) It would be interesting to know whether the Gur & Gur (1975) subjects who endorsed DMI items indicating reliance on intellectualization, would have produced right-looking CLEM had they been tested in a low stress (Experimenter behind the Subject) paradigm. In addition to these content issues which seem consistent with the present findings, the correlation produced by this study, using the DMI, was also consistent with the data reported by Krikorian and Rafales (1982).

What may be a differentiating variable then, between the Smokler & Shevrin (1979) and the Moses & Reyher (In press) experiences with the DMI, in contrast to the correlations obtained in this study, those reflected in Gur & Gur (1975), and those reported by Krikorian et al (1982), may be the different levels of personality which these groups of studies were examining. Smokler & Shevrin (1979) and Moses and Reyher, (In press) were evaluating a clinical understanding that included the active flow of the dynamics of the individual as that is incorporated in their cognitive processing. The present study, the Krikorian & Rafales (1982) study and that of Gur & Gur (1975) however, essentially evaluated the very basic hemispheric functioning strategies used at an information processing level. It may very well be that this entire subject area is even more complex than had been expected.

The information processing strategies in a low stress condition may have a more face valid relationship with characteristic styles of defense based on the different cognitive strategies of the two cerebral hemispheres. When stress is involved and the dynamic process is engaged it may elicit, more significantly, the overall personality of the individual in a dynamic rather than a static way.

If this were true, then in low stress conditions a more information processing measure of laterality for various types of material would be indexing a basic capacity to utilize defenses which rely on these strategies. For example, left hemisphere processing strategy is sequential, syntactic and analytic, which would be consistent with a capacity to develop more complete and elaborate use of intellectualization and rationalization. The right hemisphere lends itself to a more gestalt, analogic way of processing information and would therefore, lend itself more to a defensive style which is global and analogic. While these hard wiring patterns may exist in the low stress conditions, when stress is increased and anxiety becomes part of the performance level of the individual, it may be that the dynamics of the individual will be most influential in producing hemispheric activation -- a dynamic rather than a static response to the environment. At both the dynamic and the neurologic level Freud's concept of "Facilitation" comes to mind. La Planche & Pontalis (1973) summarize it as a

> Term used by Freud at a time when he was putting forward a neurological model of the functioning of the psychical apparatus (1895): the excitation, in passing from one neurone to another, runs into a certain resistance; where its passage results in a permanent reduction in this resistance, there is said to be facilitation; excitation will opt for a facilitated pathway in preference to one where no facilitation has occurred. (p. 157)

Both the Moses & Reyher (In press) and the Smokler & Shevrin (1979) were measuring the personality in its more dynamic aspects. It may be that the DMI is a less valid and reliable measure for this domain of functioning, as suggested by the Moses & Reyher (In press) observation of its tendency to elicit cognitive rather than affective involvement in responses. Indeed Krikorian & Rafales (1982) reported findings which were divergent from Gur & Gur (1975) in the laterality/DMI relationships at high arousal levels. The authors suggested this divergence, "may reflect the fact that the current study included emotion as an additional factor, whereas the emotional content of questions was not controlled in the former." (p. 379) In support of this understanding, is the Moses & Reyher observation that the DMI engages social/interpersonal concerns in responding in that persons in a high stress condition. They would be expected to become more concerned about the impression that they were making on other people by identifying various choices in the DMI. The DMI then, could be subject to similar mechanisms which produce the changes in the laterality measures as a function of stress. The domain of personality functioning and hemispheric functioning may both shift under such conditions.

Overall, the most parsimonious understanding of the positive relationship obtained in this present study, incorporates each of the possible explanations considered. The tachistoscope does produce results which compared to the CLEM are different for the reasons discussed. However, this measure too is influenced by stress. This study appears to be measuring laterality within the low stress condition of the tachistoscopic paradigm, thus finding LHA in persons who rely on INT + REV. The DMI itself may also be malleable to what then may be the underlying independent variable of anxiety which, embedded within either of these measures, would produce a difference in outcome. It would have been contributing to the outcome in an uncontrolled way, in that this particular study did not begin in an effort to hold constant the factor of stress, or anxiety. This variable could be manipulated by the differing demand characteristics of the experimental setting. Indeed, future research must address this in a controlled way. Finally, all of these studies are based on small numbers of subjects and as such could produce spurious findings. Taken together it is believed that these separate explanations each had a part in contributing to the outcome of this study.

In summary, to the extent that one is willing to make the inference that tachistoscopic identification is an index of lateral cerebral functioning, the data contained in this study support the hypothesis that there is a relationship between laterality and defense choice in lateralized persons, under conditions of minimal interpersonal and performance stressors.

Once the variance due to the psycho-social components of the grouping used in the original data base study were partialled out, this correlation emerged as significant. Bi-directional subjects do not appear to produce DMI scores which fit neatly into the laterality/defense choice relationship and should be controlled in future studies of these relationships. Use of the tachistoscopic method is particularly useful in accomplishing this objective. It also proved heuristic in contributing new information to the experimental literature in this area, by permitting an assessment of the relative contribution of the two separate cerebral hemispheres to the laterality/defense choice relationship. The uniquely lateralized population which was objectified in the foundation study helped to differentiate that left hemisphere may be related to defense choice, whereas the performance of right hemisphere in this study, does not.

The implications of this laterality/defense choice relationship suggest that stress may have a complex effect on hemispheric activation as well as on the level of defensive operation. Some of the interpretive difficulties of this study may be a function of the differing demand characteristics of the studies reviewed here. Anxiety brought about by either interpersonal aspects of the test situation, or by intrapsychic conflict generated by emotional question content, can produce a shift in hemispheric activation. The present study observed the laterality/defense choice relationship at the low level of arousal wherein left hemisphere advantage for verbal stimuli is positively related to INT + REV.

Though moving into the realm of speculation, efforts to understand the findings in this area of research lead to thoughts that the interrelationship of interpersonal, intrapsychic and endopsychic sources of anxiety, have a profound effect on the cognitive, emotional and dynamic aspects of personality. These are believed to be manifest in these complex and confusing data. Though they are not easily separable in this area of neuropsychological functioning, earlier models such as Freud's concept of facilitation may be useful in efforts to conceptualize this process.

Future directions of research would likely utilize both the tachistoscopic paradigm and the CLEM in varying levels of arousal, while measuring defense choice both by an instrument which taps the cognitive level of functioning as well as personality measures that tap the system unconscious.

APPENDICES

Appendix A

Socio-Linguistic Developmental Factors Associated Cognitive Development of Deaf Persons

In thinking of deafness we assume the absence of sound. Yet total absence of sound is rare; hearing impairment, with varying degrees of residual sound is not. The hearing mechanism is extremely complex and a continuum or range of hearing exists. Audiologists measure hearing loss in decibel ranges for each ear and at different frequencies (pitch). Assessment of Profound (97-110db), Severe (65-96db), Moderate (40-64db), Mild (25-40db), Slight (15-24db), and Normal (0-15db) ranges of hearing loss are made. Speech sounds fall approximately between 15 and 65 decibels, rendering some persons in the Moderate range and all in the Severe and Profound ranges, incapable of using auditory input for linguistic purposes (Holm, 1978). But only the most profoundly deaf have NO sound. The degree of impairment then becomes central to any generalizations and assumptions made about its effect on individual functioning and should be reported in relevant studies. Deafness for our purposes would best be defined by Furth (1973) description, "a functional hearing loss of sufficient severity to prevent aural comprehension of speech even with hearing aids."

The residual hearing function in an individual with a hearing loss can be aided by mechanical amplification. Early intervention in infancy is believed to potentiate the use of this residual hearing. "In contrast, the later use of the hearing aid encounters what amounts to an atrophy of the unused residual hearing capacity and hence fails." (Furth, 1973). Report of the use of a hearing aid and the age at which it was first used should be given for deaf subjects described in relevant research.

Age of onset is the twin important component with degree of hearing loss, in defining the population of the deaf for research purposes. For persons deafened after the acquisition of language, even as early as age 2 or 3, the problems are not the same as for those deafened pre-lingually. If a person has developed a language it is "practically impossible for him to forget it or not to use it, although speech may deteriorate." (Furth, 1973). For such persons expressive and receptive SPEECH is the main problem. The later in life the loss is incurred, the less the impact on speech. For persons pre-lingually deafened the issues are quite different.

For the pre-lingually deaf, the impact of the handicap is profound. Lunde (1956) illustrates the impact on the infant's normal associations with the hearing world by comparison to the hearing infant who by the end of 16 weeks seems to identify sounds and by 28 weeks is at Esper's stage of sound imitation, vocalizing vowels and consonants which will become words. Toward the end of the first year the stage of verbal understanding begins; by 2 1/2 years the use of spoken language is understood and by 3 a hearing child embarks on the logical arrangement of words in sentences and becomes aware of "self" via expression of ideas.

Four years of age brings the "why" questions and 5 the ability to discuss remote and difficult concepts. By the time the average hearing child begins school s/he has the ability to express self with a vocabulary of 1,000+ words.

By contrast, the deaf infant hears no speech sounds, phonemes, words, verbal cadences, vowels or consonants to imitate. Nor does s/he hear the sound of his own voice by which to shape its performance. The deaf child does not receive information via spoken language. If a deaf infant is born to hearing parents a problem may not be suspected until 12 to 18 months of age, when the child should begin to show the development of speech. Given the effects of parental denial, professional dismissal of parental anxiety and time spent in various searches for cause, the diagnosis is often not made until three years of age. (Furth 1966) Thus, vital years are spent without language. The child is not afforded communication or the medium by which his inner world can understand, organize and be linked to, the external world. If the parents rely on spoken language, the child has neither appreciation to motivate, nor opportunity to experience, verbal communication via sound. The major communication problem for these deaf people is the absence of a language frame of reference when they are learning to speak, write or read. Such a child begins school with a vocabulary of 4 to 20 words, the first learning task being the understanding that objects have names. For persons prelingually deafened, LANGUAGE, not speech, is the problem. Age of onset should be reported in any study of the cognitive functioning of deaf persons.

If the child's parents are also deaf, as exists in 10% of the cases, however, the situation is different in a quite profound way. Though they do not speak their language, such parents have a language - a mode of communication; a language of sign. Possibly by way of the same early life experiences conveyed in a visual mode, by gesturing parents, these deaf children respond early to parental gestures and sequentially imitate subparts of these. Deaf infants begin to use communication by way of signs, an 8 month old forming the hand shape of the sign for milk when hungry (author's personal observation). Studies of the acquisition of ASL (McIntire, 1977; Bellugi & Klima, 1972) indicate that chldren learning ASL pass through developmental stages similar to those reported for children learning spoken languages. However, it appears that a deaf child's progress through these stages emerges two to three months earlier than the hearing child learning spoken language. (Wilbur & Jones, 1974). Deaf children of deaf parents are not totally deprived of language and its development during the early years of language acquisiiton. Though clearly a minority of the deaf population these deaf persons are the advantaged. Parental hearing status should be reported in all relevant studies.

Studies comparing Deaf children of Deaf parents with Deaf children of hearing parents indicate that Deaf children of Deaf (DoD) score significantly higher on achievement tests even when matched for IQ's and etiology of deafness with their counterparts who have hearing parents (Meadow, 1975). Tomlinson-Keasey & Kelly (1978) interpret these differences as due to the earlier ex

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exposure and therefore clearer symbolic world to which these Deaf children are exposed. They appear to have normal psychological, cognitive, linguistic and familial develoment (Schlesinger Meadow, 1972: Moores, 1977). In fact, they are four times more likely to continue their studies into a college program (Stevenson, 1974). For these children acquisition of the English language would mark a second language subsequent to the total foundation of a first language. Hearing status of natural parents should be reported in any research of the psychological, cognitive, social functioning of Deaf persons.

Some hearing parents who give birth to a deaf child are able to attain a diagnosis early in the infant's life and learn sign language, instituting it in the family communication milieu. This is more likely to be the case in younger deaf children than older deaf persons, dependent as these circumstances are on the recent changing trends in diagnostic technique and parental education. In such a case, the infants' experience would be much closer to that of the deaf child born to deaf signing parents described above. Communication mode of the parents, used with the child during early developmental years should be reported and considered in all relevant studies.

Another mitigating factor in the early linguistic environment of the pre-lingually Deaf child is the hearing status of older siblings. If they are Deaf AND have learned a system of sign language they may have an influence on the child's language acquisition. They will have a language to introduce to the child.

There are cases of hearing loss in which the condition causing this loss is either directly related to a neurological disorder or has also produced residual brain damage. Examples of such etiologies would be maternal rubella, Usher's Syndrome, premature birth, meningitis, etc. (Vernon, 1969). Because one would naturally expect some cognitive manifestation of an accompanying chronic brain syndrome in the performance of Deaf persons who have this double condition, the etiology of Deafness should be reported and considered in decremental performance observed in Deaf persons participating in research bearing on related areas of functioning.

These multiple factors of etiology, age of onset, degree of usable speech sound, early communication milieu, parental hearing status, education, etc. combine to effect preferred modes of communication, self perception, cognitive functioning, and dependence and command of spoken language. This data must be included as relevant history and used to shape a valid understanding of the cognitive functioning of this population.

Appendix B

Communication Modes Available to Deaf Persons

The major handicap of deafness is the barrier to communication; being cut off from the normal means of acquiring and transmitting language. Though volumes have been written on the subject, the intimate link between language and thought is not fully understood. Levine (1977) states that the forms of language include "all mutually understood codifications used by individuals in effecting communicative relations with others." Any approach to researching cognitive functions of Deaf persons must include therefore, an examination of the communication mode used by the subjects investigated. Considered here are the basic communication modes available to Deaf persons: Speech, Speechreading, Writing, Fingerspelling, the Language of Signs (ASL) and Total Communication. One major distinction can be made among them in their reliance on spoken, or phonetic language.

SPEECH - is dependent on English

When we as hearing persons attempt to learn to speak a foreign language we become aware of how difficult it is. Yet unlike a Deaf person, trying to learn to speak, we can hear the sound we are trying to imitate as well as our own efforts to articulate and pronounce the new language correctly. If however, we did not have a structural linguistic frame of reference, or an understanding of why people's mouths moved and what meaning they derived from it, the task would seem impossible; perhaps meaningless. For a Deaf person without language, learning to speak English is a confusing, tedious and largely rote exercise with little apparent value.

SPEECHREADING - is dependent on English.

Once verbal language is learned it may be "read" from visual scan of the speaker's lips. The studies conducted by the Tracy Clinic (Lowell, 1957; 1958) demonstrate how difficult it is for the Deaf person. They found that non-Deaf college sophmores who were inexperienced in speechreading were better at it than Deaf persons who had studied it all of their academic lives. This is attributed to the fact that the hearing person has a solid language base of syntax and vocabulary to fill in gaps of what they missed visually. Forty to 60% of English is homorphemous; looking like other sounds on the lips. A person who is unequipped to fill in these gaps understands little. These studies also indicated that the best lipreaders in a one-to-one situation understand only 20% of what is said.

WRITTEN LANGUAGE - is dependent on English.

No universally accepted lexical system of signed language currently exists. Therefore, the only language which can be written and read by the Deaf is the spoken one. Vernon (1969) cites evidence that 30% of Deaf adolescents are functionally illiterate. The average reading level of the Deaf adult is below the fourth grade level. It is important to note that literacy is a measure of the use of spoken language. It is dependent therefore on the acquisition of a spoken language. It should not be interpreted therefore as a measure of linguistic competence, rather as an index of the ability to read, what to a congenitally Deaf person is, their second language.

<u>FINGERSPELLING (also called Dactylology) - is dependent on English.</u>

In this mode different finger positions in hand signs are assigned to each of the 26 letters of the alphabet. The dominant hand of the signer is used alone. (one hand configuration = one letter.) Communication is thus spelled out manually, letter by letter, requiring a knowledge of the signed alphabet, a command of the verbal language used, its spelling and ATALENTFORGUESSINGWHERETHESPACESGO. The hazards of speechreading do not exist in this mode and expressive speech articulation problems are also avoided. Because this mode is acquired for communication purposes not simply as a way to spell English, it is imprecise in its practical use. It should not be used as a measure of spelling, or other English based competency skills. Hoemann (1978) reports error rates in spelling when subjects switched from written spelling to fingerspelling. Important to neuropsychological studies is the fact that, though spelling English words, fingerspelling is read from right to left NOT in the traditional Western mode of Left to Right.

MANUAL ENGLISH - is dependent on English.

In this mode a different single, bimanual static or moving hand configuration is used to represent English words. It uses fingerspelling, often uses standard root signs which are embellished by different letters and literally substitutes these standard (one sign = one word) signs for each English word; retaining sentence structure, grammar and syntax of English. Both hands are used.

SIGLISH - is largely dependent on English.

It incorporates fingerspelling, uses one sign to equal one concept, is heavily though not purely based on English and shifts between English and American Sign Language idiom. Both hands are used.

AMERICAN SIGN LANGUAGE (ASL) - is NOT dependent on English.

It is a manual-visual language that uses standard signs to represent CONCEPTS (one sign = one concept) has a unique grammar and syntax, and only occasionally uses fingerspelling (for some proper nouns, names, etc.). Both hands are used.

There are several misconceptions regarding this autonomous language. It is often described as a universal language whose grammar is poor compared to spoken languages; vocabulary concrete and iconic, and consists of qestures accompanied by facial expressions. Markowitz (1980) shows that these descriptions are not supported by linguistic analysis.

It is not universal. Danish Sign Language, Japanese Sign Language, British Sign Language, etc., are as different from each other as are their spoken languages. To the unseasoned observer of cross-cultural Deaf communication, however, the easier transition made by these persons (for whom pantomime comes easily) out of their native sign languages and into pantomime will not be recognized, as such. That is however, how such communication is accomplished.

ASL has been criticized as being "conceptual" rather than "word-based". Markowitz points out that "the principal function of language is to convey concepts. However, in a sign language, concepts are represented by signs rather than words." Put another way by Turk (1976), himself a Deaf person, "Oral communication is only an aural form of sign language with arbitrary sounds standing for ideas."

Sign is not ungrammatical. Transliteration or word-for-word translations will produce ungrammatical or meaningless sentences due to the different word order and sentence structure of various languages. "Throw Mama from the train a kiss." is not an indication that the original language was ungrammatical rather that translitation has occurred. ASL is an independent structured language with its own grammar and syntax.

When considering the iconicity of signs there are several points to keep in mind:

1. Signs for the same concept are different in different sign languages.
2. If sign language were iconic it would be quite easy for the novice to understand sign. It is not.
3. Iconicity does not play a major role in the acquisition of sign language. A child learning the sign for "milk" has probably never (and need not have) seen either a cow, or the hand action used to milk one which constitutes the sign.

Though many signs are visual representations of the concepts they symbolize, there are many more which are as arbitrary as are words in their representation. Though ASL can express concrete, imaqoic, concepts, it is not restricted in its ability to deal with abstract ideas and includes signs for abstract thoughts such as LOVE, FAITH, BELIEF, TRUST, PRIDE, etc.

It is then, not merely universal, ungrammatical, concrete, iconic or gestural. It is a language independent from all spoken languages. According to Stokoe (1965) there are three parameters of sign which are of central importance to lexical, synthetic and grammatic components of ASL: handshape, motion and location.

GESTEMIC - is totally INdependent of English.

It is comprised of natural gestures, pantomime and local gestures (one gesture = one concept) and is often called natural sign & international sign. Both hands are used.

TOTAL COMMUNICATION - is partially dependent on verbal language.

Also known as Simultaneous Communication this mode is based on a philosophy of using any and all communication methods available simultaneously. It uses both speech, lipreading and sign options at once, affording maximal information to the receiver from each of these modes.

Any study of Deaf persons must include a description of the communication skills and competence of the experimenter and the subject; the mode used in testing and, in studies of language processing, an account of the contributions of English language.

In summary, all modes of communication available to Deaf persons except American Sign Language and Gestemic (or natural sign), are dependent for successful expression and reception of information, on knowledge and use of verbal language: English. To adequately evaluate language processing in Deaf persons, one must consider the dependence of the communication mode used on English.

Appendix C

Good Day:

This letter is a request for your help by participation in a project designed to increase our understanding of how the human brain processes information in hearing and Deaf persons.

While previous studies have suggested that deaf persons seem to process information in a unique and somewhat different way from hearing persons, there is still little known about why this is true. For that matter, a major obstacle in diagnosis and rehabilitation of deaf persons who have suffered a stroke or other injury to their head, is the inability of psychologists and neurologists to use the wealth of information which currently exists for hearing persons, with deaf persons who need their services.

As a person who uses sign language, you are unique in that you are hearing. By studying the effect of the use of sign language on the way hearing persons process information, we may better be able to understand the effects this unique language may have on the information processing strategies of deaf persons. Because Stroke hits hardest at communication, something our deaf friends and relatives hold dear, it is important that we learn as much as possible to provide a realistic rehabilitation insulation against anything that would threaten it.

I have designed this study, a portion of my graduate research, as a way of exploring the effects of sign language use on information processing strategies for this purpose.

You can help gather valuable information if you are over age 18 and:

__________ are the hearing child of Deaf parents whose first language was ASL, or
__________ learned ASL after the age of 10,

by the time commitment of approximately an hour and a half during which you will watch a film, identify information symbols and complete a short questionnaire. Should you agree to make this voluntary contribution please contact me:

Ms. Rita Rogan Hull
Department of Psychology
Michigan State University
East Lansing, Michigan

Phone: 517 355-9564

It is understood that your participation is totally voluntary and there will be complete freedom to withdraw at any time.

Thank you for your time and interest,

Sincerely,

Rita Rogan Hull
Graduate Student

Appendix D

Subject Information Questionnaire

Subject Number

Sex ______________
Age ______________ Birthdate ________________

Handedness Information
Self: ____________ Mother: ________________
Writing _________ Grandmother: _____________
Throwing _________ Grandfather: _____________
Father:
Grandmother: _____________
Grandfather: _____________

Hearing Status:
Mother ____________
Father ____________

Birth Order: __________

First Language _________________
How learned _________________
Second Language _________________
Age learned __________________ Method learned ____________
Competency Achieved _____________________________________

Education:
Highest grade completed ______________________
Grade point average __________________________
Other specialized training ____________________

Occupation: ____________________________________

Employment Status:
Employed, Full-Time __________
Employed, Part-Time __________
Unemployed __________
Never Employed __________

Vision:
Do you wear glasses? __________
Vision when corrected __________
Do you have a restriction on your Driver's License for vision? __________

Have you ever had problems learning to:
Read ____________ If yes, describe ______________________________
Write ____________ If yes, describe ______________________________
Do Math ____________ If yes, describe ______________________________

Do you sometimes not understand the things you read? ________

Has a doctor ever told you that you had Epilepsy? ___________

Have you ever had blackouts? _______________________________

Appendix E

Experiment I - Words

	Word	Visual Field			Word	Visual Field	
1.	PAN	R		21.	LEG	R	
2.	RAY	R		22.	PUT	L	(?)
3.	PAN	L	(?)	23.	LEG	L	
4.	ROW	R		24.	SKY	L	
5.	WHO	L		25.	WAY	R	
6.	SUM	R		26.	TEN	L	
7.	LOW	L	(?)	27.	MAP	R	
8.	WAY	L		28.	ACT	R	(?)
9.	NOD	R		29.	JOY	R	
10.	BOW	L	(?)	30.	ACT	L	
11.	RAY	L		31.	MAP	L	
12.	SKY	R		32.	ALL	L	
13.	ALL	R		33.	TEA	R	(?)
14.	CRY	L		34.	CRY	R	
15.	NOD	L		35.	SUM	L	
16.	TEA	L	(?)	36.	OUT	R	
17.	LOW	R		37.	ROW	L	(?)
18.	JOY	L		38.	OUT	L	
19.	TEN	R	(?)	39.	WHO	R	
20.	PUT	R	(?)	40.	BOW	R	

INFORMED CONSENT FORM

I freely consent to take part in a scientific study entitled, "Hemispheric Specialization as a Function of Unique Bi-Language Acquisition: The laterality patterns of the hearing offspring of deaf parents whose first naturally acquired language was American Sign Language.".

This study is being conducted by Ms. Rita Rogan (Hull) of the Psychology Department of Michigan State University. I agree that the following statements are true:

1) I understand that I am free to discontinue my participation in this experiment at any time, without recrimination.
2) I understand that all results will be treated with strict confidence. Should the results be published the subjects will remain anonymous.
3) I understand that if I so desire I will be given a summary of the results of this experiment upon its conclusion.
4) I am aware that the experiment may not produce results which are to my direct benefit.
5) The experiment has been explained to me, I understand what my participation entails, and that a full explanation of expectation of outcome will be made to me upon completion of my performance.

____

Signature of Subject

____

Date

Appendix G

DATA

GROUP 1					GROUP 2					GROUP3				
ID	LC	DMI	LT	RT	ID	LC	DMI	LT	RT	ID	LC	DMI	LT	RT
11	-80	2	13	12	21	-69	9	6	5	31	74	51	6	7
12	-87	-27	12	11	22	308	-7	5	9	32	-333	-12	10	6
13	-182	9	12	10	23	-286	2	16	12	33	-345	13	8	3
14	-286	-53	8	4	24	-286	-32	16	12	34	-267	-12	7	3
15	240	-14	11	14	25	0	-34	11	9	35	-80	39	8	7
16	-80	-8	13	12	26	-154	-27	14	12	36	0	48	11	11
17	0	-17	17	17	27	-154	-8	14	12	37	-74	-23	14	13
18	0	3	9	9	28	-240	-48	9	6	38	0	-3	11	11
19	87	-16	8	9	29	0	3	13	15	39	-286	-36	11	8
10	80	19	7	8						30	0	-40	12	8

Appendix H

PEARSON CORRELATION COEFFICIENTS

	WORD	DMI	LEFT	RIGHT	D1	D2	GRP
WORD	1.0000	.2698	-.2454	.3684	.2483	-.0484	-.2573
	p = ***	p = .078	p = .100	p = .025	p = .097	p = .402	p = .089
DMI	.2698	1.000	-.2892	-.0245	-.0753	-.2163	.2067
	p = .078	p = ****	p = .064	p = .450	p = .349	p = .130	p = .141
LEFT	-.2454	-.2892	1.000	.7723	.0554	.1693	-.1578
	P = .100	P = .064	P = ****	P = .001	P = .388	P = .190	P = .207
RIGHT	.3684	-.0245	.7723	1.000	.2356	.1442	-.3500
	P = .025	P = .450	P = .001	P = ****	P = .109	P = .228	P = .031
D1	.2483	-.0753	.0554	.2356	1.000	-.4867	-.8736
	P = .097	P = .349	P = .388	P = .109	P = ****	P = .004	P = .001
D2	-.0484	-.2163	.1693	.1442	-.4867	1.000	0
	P = .402	P = .130	P = .190	P = .228	P = .004	P = ****	P = .500
GRP	-.2573	.2067	-.1578	-.3500	-.8736	0	1.00
	p = .089	p = .141	p = .207	p = .031	p = .001	p = .500	p = ***

ANALYSIS OF VARIANCE
One Way Word by Group

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F PROB
Bet Grps	2	52081.3697	26040.6849	.956	.3974
With Grps	26	707859.3889	27225.3611		
Tot	28	759940.7586			

ANALYSIS OF VARIANCE
One Way DMI by Group

Bet. Grps	2	1689.5169	844.7584	1.278	.2956
With Grps	26	17191.6556	661.2175		
Tot	28	18881.1724			

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