CHAPTER-I
INTRODUCTION

Language starts at the centre of human affairs, from the most prosaic to the most profound. It is the medium through which the manners, morals and mythology of a society are passed on to the next generation. It is most astonishing of all human abilities. It is considered to be the accomplishment that sets human apart from rest of the animal kingdom (Lenneberg, 1967). It develops increasing adaptive potential (Miller, 1981). A system that combines meaningless elements such as sounds and gestures into structural utterances that convey meaning, allows displacement & productivity (Hockett, 1960). The gift of language only enables us to share the richness of human experience, communication, memory and thought.

Lieberman (1994) discusses the development of voluntary speech and syntax in human as a distinguishing factor from other primates. Human linguistic abilities are considered in their evolutionary perspective. Human language is not seen as a unitary entity; lexical ability appears to involve a different base than speech and syntax.

Spoken language was a great accomplishment but was restricted in terms of time and space. Spoken words could be
preserved only in form of repetition. Thus emerged the written language. Information was now no longer simply a word-of-mouth affair. It could be now noted down. New generations could share the experiences of the past and pass on their information to future generation as well.

The structural components of language are phonemes (basic sounds), morphemes (meaning) and syntax (language rules, grammar), which help to build sentences. Chomsky (1968) proposes the inherent existence of a set of cognitive structures that prepare the child to learn language. Anatomical asymmetry with a larger 'Wernicke's area' on the left side of the brain, which is evident in human fetuses also (Damasio and Geschwind, 1984), is said to be responsible for such learning because language ability resides primarily in the cerebral hemisphere.

Other evidence for Chomsky's theory comes from studies that demonstrate a critical period for optimal language learning, perhaps from birth to about six (Miller, 1981). Even deaf children, deprived of the opportunity for imitation and verbal reinforcement, develop a form of general language (Feldman, Goldin-Meadow and Gleitman, 1978).

The societies of the present day are not the isolated ones. People from all over the country have quite fair chances
of moving from one place to the other because of a job requirement, for the purpose of business or education or other such social reasons. To mix up with others, people have to learn the languages other than the mother tongue. In this way the multilingual societies come in existence. Vast educational network and programme has also played a significant role in language development. Moreover, professionals as translators and interpreters are proficient in more than one languages.

Complex behaviour involves many different areas of the brain. The human brain has three major sub-divisions, namely, hindbrain, midbrain and forebrain. In general, the more reflexive or automatic behavior is, the more likely it is to be controlled by areas in the hindbrain and midbrain. The more complex a behavior, e.g., language the likelier it is to involve the forebrain, e.g., cortex.

The forebrain is covered by a layer of densely packed cells known as the cerebral cortex. In humans, it contains atleast 70% (3/4th) of the neurons in the central nervous system (Nauta & Fairtag, 1979; Schneider & Tarsis, 1986). On the top of the brain, there is a deep canyon that runs the full length of the brain & divides it into two symmetrical hemispheres. These
hemispheres are mirror images of each other (a conventional view) which are connected by a large band of nerve fibres, called, corpus callosum.

Cortex reveals particularly deep fissures or valleys on its convoluted surface and so appears like 'bark'. One of these fissures, called the fissure of Rolando (or the central sulcus), extends from the top of the neocortex down to its side on each hemisphere. Another, called the fissure of Sylvius (or lateral sulcus), extends in roughly an anterior-posterior direction in the lateral regions. A less prominent fissure, called the parietal-occipital fissure, runs in the same direction as the fissure of Rolando but at a more posterior location. The fissures divide the cortex into four distinct lobes. Anterior to the fissure of Rolando is the frontal lobe. Inferior and posterior to the fissure of Sylvius is the temporal lobe. Anterior to the parietal-occipital fissure is the parietal lobe, and posterior to it is the occipital lobe (Figure 1).

Functionally, the human neocortex is organised in specific and nonspecific categories. Control of body movements comes from a strip of cortical surface called motor cortex, located on the frontal lobe immediately anterior to the fissure of Rolando. Reception of somatosensory information occurs in a strip of cortical surface called somatosensory cortex, located
FIGURE 1: THE LOBES OF THE CEREBRAL CORTEX.
in the parietal lobe immediately posterior to the fissure of Rolando. Auditory information is received in a region of the temporal lobe (auditory cortex), & visual information is received in a region of the occipital lobe (visual cortex). The rest of the neocortex is called association cortex presumed to integrate different forms of information received by the neocortex from the external environment & the rest of the brain. There is contralateral projection of body to cortical somatosensory areas as well as contralateral control of body musculature by motor cortical areas.

CEREBRAL ASYMMETRY

Cerebral asymmetry refers to the differences (structural and functional) between the two sides, or hemispheres, of the brain. Cerebral dominance, hemispheric specialization, asymmetry or lateralization are some of the interchangeably used terms in neuropsychology. Though the left and right hemisphere seems to be mirror image, but there are in fact many structural differences in the two. According to Geshwind and Levitsky (1968), in the left hemisphere planum temporale is larger than the right. They confirmed through postmortem examinations that out of 100,65 had their left temporal lobe larger than right against the 11 cases of larger right temporal lobe. Damasio and Geshwind (1984) found larger left Wernicke’s areas in human fetuses. Le May and
Culebras (1972) commenting on Sylvian fissure (lateral sulcus) state that left fissure is long and horizontally oriented, whereas, right fissure is short and upwardly oriented. CT scan revealed that the left occipital region was usually wider than right and right frontal region was wider than left.

One of the most significant aspect of hemispheric dominance is primarily related to handedness, i.e., right hand preference and proficiency, therefore, left hemispheric dominance (due to contralateral control). Satz (1979) and his colleagues (Carter, Hohenegger & Satz, 1980), e.g., have reported that 95% of right-handers are left hemispheric specialized whereas 5% are right hemispheric specialized. For left handers, 24% left specialized, 0% right specialized and 76% bilateralized.

Regarding the functions, in general, the left hemisphere is specialized for linguistic, sequential and abstract abilities, whereas, the right hemisphere is specialized for non-linguistic visuospatial functions. There is left hemisphere specialization for positive and the right for negative emotional expression (Lee, Loring, Dahl & Meador, 1993; Ross, 1993). Right hemisphere executes the responsibility for organizing information in its total, Gestalt form (Nebes, 1971). It is also important for perceptual, emotional, expressive, spatial
functions (Graham, 1990; Levinthal, 1990), remembering the
correct sequence of pitches (Shapiro et al, 1981), recognizing
natural noises and various sound qualities (Ardila and Ostrosky-
Solís, 1984), recognizing familiar faces and distinguishing
among people (Corballis, 1983), auditory discrimination (Sidtis
and Gazzaniga, 1981), identification of objects by active touch
(Le Doux, 1979) etc.

In the studies of dichotic listening, a REA (Right Ear
Advantage) has been found for identifying digits, words and
consonant-vowel syllables, and a LEA (Left Ear Advantage) has
been found for reporting musical notes, environmental sounds and
sonar sounds (Chaney and Webster 1966). Thus, the left and the
right hemispheres are specialized for the processing of verbal
and non-verbal stimuli, respectively (Entus, 1977; Geffner and
Milner, 1960). According to Geffen, Bradshaw and Wallace (1971),
there is LVF (Left Visual Field) advantage for visual perception
and faces indicating right hemispheric processing. Tactile
perception of meaningless shapes (Witelson, 1974) and notation
of musical chords (Gordon, 1970) are also represented in the
right hemisphere.

Patients with right anterior temporal lobe lesions found
it difficult to discriminate between different tone qualities,
and patterns but that left temporal lobe lesions produced no such
deficits (Milner, 1975). Right temporal lobe lesions affect
musical and spatial recognition, simple arithmetical operations,
information processing, self recognition and social awareness
(Sperry, Zaidel & Zaidel, 1979). Berry (1990) investigated the
interaction between hemispheric specialization and recognition
memory for colour pictures. Results indicate that the colour
processing was bilocalional, with realistic verbal image
processing being done in the left hemisphere and pure colour
processing being done in the right hemisphere. A cooperation in
face perception by both hemispheres is observed by Sergent
(1985).

According to Bryden (1970), the left cerebral
hemisphere's control of language processes and the right
hemisphere's control of non-verbal activities are by relatively
independent mechanisms, and therefore can be dissociated. Other
theorists willing to make the general claim that all or most
language functions are unilaterally represented in the left
hemisphere are De Renzi (1978), Gazzaniga & Le Doux (1978),
Kinsbourne (1978) and Klatzky (1970). Left hemisphere also
contains neural substrates for non-verbal form of communication
(e.g. gesture) and perception of stimuli to be labelled verbally.
Models 1

Studies of hemispheric functional asymmetry suggest a varied pattern of laterality. Allen (1983) describes these patterns into models of laterality (implying different assumptions as well as empirical evidence): Unilateral specialization models and Bilateral models (negative, positive, parallel and allocation). Unilateral specialization models assume a functional lateralization of the task, though both hemispheres are capable of performing the task, but, for one reason or another, only one does. It also implies a real, all-or-none capacity difference between the hemispheres. Cases of such models are in language (Broca, 1865; Dax, 1865; De Renzi, 1978; Lenneberg, 1967), susceptible to individual differences (e.g., Satz, 1979) with some further specification of task in terms of modes of thought (Bogen, 1969, 1973) with propositional mode being lateralized in left. Components of language may be unilaterally represented in different hemispheres (e.g., Molfese, 1978, a,b, 1980; Searlemen, 1977). Visuospatial (Seamon, 1974), manipulospatial (Gazzaniga and Le Doux, 1978), serial-parallel processing (Cohen, 1973) components of tasks are also found to be unilaterally lateralized. Semmes (1968) says that organization of hemispheres into focal (left) or diffused (right) may determine unilateral task representation.
Bilateralization holds that both hemispheres have equal capacity for a given process or task. There may be positive interaction between the hemispheres and that both perform the function simultaneously. The overall performance is some integrated conjoint function of the two hemispheres. It is possible that both hemispheres are doing approximately the same processes (Benton, 1980) or are doing different processes of the same task (Alwitt, 1981), support to co-operative bilateral interaction comes from newer methodologies, e.g., r CBF [regional cerebral blood flow] (Broadbent, 1974; Chiarello, 1980; Sergent and Bindra, 1981).

One interpretation of the degree of lateralization concept is that lateralization may not be an all or nothing phenomenon (unilateral specialization) but instead may be a continuum or dimension along which individuals, and psychological functions, may be ranged. Thus, to give some common examples, it might be hypothesized that left handed individuals are less strongly lateralized than right handed individuals or that verbal functions are more lateralized than visuospatial functions. If this initial interpretation is adopted, then degree of lateralization could be taken simply as a reflection of an underlying bilateralization (both hemispheres capable of the task) with emphasis on the relative contributions made by
the two hemispheres.

Negative interaction model postulates that both hemispheres have the capacity to perform a given function (bilateralization) but that, under normal circumstances, they inhibit or suppress each other’s activity, either through the corpus callosum and the cerebral commissures, or the brain stem, or both. Two types of negative interaction is possible: unidirectional inhibition (i.e. one hemisphere inhibits the other but not vice versa), bidirectional inhibition (i.e. both hemispheres mutually or reciprocally inhibit each other).

The developmental pattern of left lateralization of language from initial equipotentiality and evidences of left as well as right hemisphere language abilities could be explained by unidirectional negative interaction model. An example of bidirectional negative interaction model is Kinsbourne’s model of attention and orientation (1970, 1974 a,b).

There may be parallel bilateral involvement in a task without positive or negative interaction. Both hemispheres may perform exactly the same function or may perform qualitatively different functions or different subcomponents of a superordinate function. Dimond (1972) and Dimond and Beaumont (1974) theorize early stages of perceptual analysis as per
parallel processing.

A task may be allocated to any of the two hemispheres as both hemispheres, have the capacity to perform a given task. It is a non-interactive and non-parallel bilateralization. The allocation of processing to the appropriate hemisphere may once at the beginning (the input model) or at the end (output model) or the processing alternates from one hemisphere to another (switching model). Such processing has been evidenced in attention (Levy, 1974; Moscovitch, 1979)—attention switching in sensory fields. Dimond (1972) also postulates that each hemisphere performs its specialized processing and then transmits the result through an output system of the same or another hemisphere.

METHODS TO STUDY LATERALIZATION

Variety of techniques are in use to study asymmetry or lateralization of brain in general and language lateralization, in particular. Broadly speaking, these methods can be grouped into two major categories: invasive techniques and non-invasive techniques or physiological and experimental techniques.

Electrical recording from scalp is known as electroencephalogram (EEG). Averaged evoked potential (AEP) or evoked responses (AER), is an alternative way to study
psychological processes in the electrical activity of the brain. Recording of EEG or AEP from different hemispheres under verbal engagement is used to study language lateralization (Hougdahl & Franzon, 1985; Mills, Coffey, Corina and Neville, 1993; Burgess & Gruzelier, 1993), Schouten, Von Dalen & Klein, 1985).

Similar to EEG, is the technique of MEG (magnetoencephalogram). EEG helps in mapping the surface of the cortex only, but MEG allows mapping deep within the folds of the cortex without surgery (Zimmerman, 1982). However, both of them helps in understanding the organization of complex mental function in the brain. EEG measurement confirms left hemisphere activity as greater while experiencing verbal information and right hemisphere when encoding spatial tasks (Doyle et al, 1974; Galin & Ornstein, 1972).

NMR or MRI (nuclear magnetic resonance imaging) has also been used by Hines, Chiu and others (1992) to relate language lateralization and callosum and by Hinke et al (1993) to relate Broca's area and internal speech word generation.

Another technique, Brain electrical activity mapping (BEAM), has also revealed differences in the brain of disturbed and non-disturbed people. It converts the complex data of an EEG into a colourcoded map of the brain which is easily read and
interpreted (Shiel & Wilson, 1992).

In the Wada test, sodium amytal is injected into the left or right internal carotid artery of the brain to suppress the activity in one half of the brain. Estimates of left hemispheric lateralization in right handers range from 90-99%, using sodium amytal, and estimates of right hemisphere range from 1-10% (Harris and Carlson, 1988) with frequently reported figures being 96 & 4% (Rasmussen & Milner, 1975).

Ingvar (1976), Ingvar & Lassen (1975) and Lassen et al (1978) have used another non-invasive physiological measure to map the active brain, i.e., regional cerebral blood flow technique (rCBF) while reading silently, reading loudly and doing motor activity. Another technique to study active brain is PET (position emission tomography), in which radioactivated glucose uptake is indicated in the image at the time of engaging in a task, e.g., in linguistic task (Damasio & Damasio, 1993).

Transcranial Doppler Ultrasonography also indicate the blood flow through a given artery, e.g. middle cerebral artery (supplying language areas) has been used by Markus & Roland (1992) to study language lateralization.

Thus, with the technological advances newer techniques are coming into use which provide reliable information regarding
the working brain with reference to the locus of activity be it blood flow, glucose uptake, electric and magnetic field, etc. Fortunately, all these methods are non-invasive and in near future newer facts regarding brain’s functional asymmetry as well as language lateralization may emerge.

Clinical method implies study of special groups, e.g., split brain patients, aphasics, language disables, trauma patients (intra cerebral bleeding) (Naeser and Chan, 1980) and pathological groups, e.g., hemiplegia (Demuruise et al, 1986).


In the aphasis subjects, tracing of the neurological damage allows the localization of language function (Gloning and Quatember, 1966; Hacaen, De Agostini & Monzon-Montes, 1981; Hacaen & Sauget, 1971; Newcomb and Ratcliff, 1973; Satz, 1979;
Segalowitz and Bryden, 1983). With the advent and use of imaging and scanning techniques, it is now easier and reliable to locate the damage and its extent.

Some of the techniques can be grouped as experimental techniques, firstly, hemivisual field tachistoscopic presentation and its recognition allows visual projection to one of the hemisphere. Right visual field advantage indicates left hemispheric dominance and vice versa for the task. For verbal task this technique has been quite frequently used and modal finding is RVF advantage (Abernethy and Conen, 1993; Beaumont, 1982 b; Carmon, Nachshon and Starinsky, 1976; Faust, Kravetz and Babkoff, 1993; Vaid and Corina, 1989; Walters and Zattore, 1978).

Secondly, dichotic listening technique has been the most popular technique to study language lateralization. Right ear advantage indicates left hemispheric dominance and vice versa. REA for verbal stimuli has been repeatedly obtained via response latency and accuracy (e.g. Carlsson et al, 1992; Cohen et al, 1991; Demeurisse et al; 1986; Entus, 1977; Fabbro, Gran & Gran, 1991; Gordon, 1980; Grimshaw et al, 1994; Haggerty and Stahl, 1978; Jancke, 1992; Kershner and Morton, 1990; Kimura and D'Amico, 1989; Mc Keever, Hunt, Wells and Yazzie, 1989; Rosenblum and Stephens, 1981; Sommers and Starkey, 1977; etc.)
Thirdly, concurrent activity paradigm is also frequently used experimental method of lateralization. It is also known as time sharing technique, popularized by Kinsbourne and Hicks. The basic idea of this paradigm is that when two activities are to be processed simultaneously by the same hemisphere, the interference is more as compared to the single activity or two activities are processed by separate hemispheres, for example, in motor-verbal dual task, the verbal task is represented in the left hemisphere and the motor task by the right hand is also in the left hemisphere, the subjects when asked to perform both these tasks (e.g. reading and tapping) at the same time, the greater interference is exhibited in right hand performance than left hand performance. It indicates left hemispheric language involvement. Kinsbourne and Cook (1971) introduced a vocal-manual interference paradigm which was capable of revealing the lateralization of verbal output control in normal individuals. Work was replicated and extended by Hicks et al (1975, 1978). According to this method when subjects perform two unrelated tasks simultaneously, they do better if tasks are governed by different hemispheres than by the same. This is a prediction of the functional cerebral distance principal (Kinsbourne & Hicks, 1978a, 1978b). Pashler & O'Brien (1993) claims that dual task interference is reduced when the two cerebral hemispheres can carry out the two tasks independently.
Towell, Burton and Burton (1994) highlighted the nature of task as an important variable for interference. Jancke (1993) reports that the direction of movement in motor task may affect the interference. In an experiment, Wiegersma and Wijnmaalen (1991) examined interference between verbal production and left and right hand tapping in 112 right handed men. They found that controlled rather than automatic verbal production caused interference with right hand performance.

Significant disruption in right hand performance in motor-verbal concurrent tasks, i.e., left language lateralization has been reported by many (e.g., Fabbro et al, 1990; Furtado and Webster, 1993; Green, 1986; Hassler, 1990; Simon and Sussman, 1987). Certain methodological issues have been dealt, e.g., by Parcet, Avila and Janque (1990); Sergent, Hellige and Cherry (1993); and Sussman (1989).

**LANGUAGE LATERALIZATION**

Early work on language claimed that speech is localized in the frontal lobe of the left hemisphere (ventral part of premotor area). Wieling & Pallie (1973) have shown from postmortem examination that the language-mediating area of the superior temporal lobe surface of the brain tends to be physically larger on the left than on the right, both in neonates
and in adults. This asymmetry appears to be functional as well as anatomical. In the year 1865, Paul Broca (1824-1880) identified a section of the left frontal lobe that seemed to relate the expressive language. This was known as Broca’s area. Damage to cells in this region produces a condition known as expressive aphasia, wherein the patient has difficulty in speaking. The selective action of specific brain regions become even more apparent when an area in the left temporal-parietal cortex known as ‘Wernicke’s area’ was discovered in 1874 to be the centre for understanding the language which consists of planum temporal and posterior end of temporal gyrus. Lesions in this part of the brain produces a disorder known as receptive aphasia (inability to grasp the meaning of words). Broca and Wernicke’s areas are connected by a fibre bundle known as arcuate fasciculus, the damage of which results in conduction aphasia. Another area in parietal lobe, angular gyrus connects visual function and language, as in reading and writing. Figure-2 shows major language areas in the cortex.

In the process of reading and speaking/writing, the visual projection system carries information from the eyes to visual areas (Occipital cortex). From here the information moves into the angular gyrus where the words are perceived through reading and then the meaning is added to the information in the
FISSURE OF ROLANDO ARCUATE FASCICULUS ~

WRITING BROCA'S AREA

ANGULAR GYRUS

READING VISUAL CORTEX

LATERAL FISSURE NAMING WERNICKE'S AREA

FIGURE-2: THE MAJOR LANGUAGE AREAS OF THE CORTEX
Wernicke's area. Now, if the information is to be spoken, it moves to the Broca's and other motor areas of speech, but if it is to be written, it comes directly to the frontal motor areas controlling hand from Wernicke's area.

In the same manner, in the process of hearing and speaking the information coming through the primary auditory projection area situated in the Heschl's gyrus at the floor of lateral fissure (input), turns toward planum temporale, superior frontal gyrus, located at the lower border of the lateral fissure (Wernicke's area), where the speech sound is translated into word meanings, i.e., the information is comprehended and then through arcuate fasciculus it reaches Broca's area and other motor areas of speech in frontal lobe, that finally converts the language information into motor programs that will produce speech completing the process of listening and speaking.

The increased local blood flow accompanies task engagement allows objective visualization of the process. The blood flows to the front of a person's brain when he is engaged in an abstract problem and then flow to speech centres in the left hemisphere as the person begins to talk about it (Ingvar and Lassen, 1975).
To extend, a step further, the blood flow recording of the subjects while reading silently shows that it activates the language area of the frontal lobe, an association area at the posterior tip of the lateral fissure (angular gyrus), the frontal eye fields of the frontal lobe (premotor area) just anterior to the central fissure, and a supplementary motor area (M2) on the superior surface of the frontal lobe. In case of reading aloud, several motor zones become active because the function of speech is added to the performance, e.g., the mouth area of the primary motor cortex just forward of the central fissure (M1) is added together with the mouth area of the somatosensory cortex just posterior to the central fissure (S1), and a large area of auditory cortex in the upper temporal lobe (Wernicke’s area). These three zones are active because reading aloud involves moving the mouth muscles, sensing those movements and hearing what one is saying (Lassen et al, 1978). Similar findings have been reported while counting silently or loudly to 20 by Lassen.

Shiel and Wilson (1992) reported that patients with left hemispheric diseases are more likely to fail the language oriented subtests. Left hemisphere is responsible for phonology, syntax and semantics (Springer and Deutsch, 1989). Ashton, Roderick and McFarland (1991) found that right hand performance decreased while reciting meaningful words as compared to non
meaningful. Left hand performance was essentially unaffected.

Even, the retrieval of lower level morphological representation of language is a specialization of left hemisphere (Burgess, Curt and Skodis, Jennifer, 1993). Mills et al (1993) reported that lexical representations are activated faster in left hemisphere than right hemisphere.

It is generally agreed that left cerebral hemisphere contains the balance of the brain's language network. Some theorists claim unilaterality in the well-specified subcomponents of language rather than language as a whole. Bogen (1969, 1973), e.g., has argued for two modes of thought, propositional and appositional. The term propositional is capable of formulating propositions. It is this particular productive aspect of language that Bogen believed might be lateralized, in the majority of people, to the left hemisphere. There have also been claims for unilateral specialization in the perception and comprehension aspects of language, as well. With respect to speech perception, Molfese (1978a, 1978b, 1980) has argued that a number of specific components of the speech signal (e.g., voice onset time) may be unilaterally processed. Other researches suggest that the left hemisphere may be unilaterally specialized for verbal coding processes (Seamon, 1974; Seamon

In a review of right-hemisphere linguistic ability, Searlman (1977) noted that the case for unilateral specialization of linguistic functions seem much more frequently made for the production aspects of language rather than for the comprehension aspects. The right hemisphere, however, does make some contribution to language (Miller and Whitaker, 1983). In fact, there is evidence that severe deprivation of auditory and verbal experience can shift language control from the left to the right hemisphere (Kolb and Whishaw, 1985), however, deprivation of visual information, e.g., congenitally blind subjects exhibit normal pattern of left hemispheric dominance for speech. Demaerelisse et al (1986) have also reported that left hemispheric hemiplegic patients show right hemispheric dominance for language. Carlsson et al (1992) also reported that right hemispheric congenital hemiplegic children showed left language laterality whereas left hemispheric hemiplegics showed right language laterality. The right hemisphere produces the information and emotion in the speaker's voice and comprehends the same in the speech of others (Springer and Deutsch, 1989). Studies of commissurotomy subjects have shown that the right
hemisphere has considerable linguistic capability (e.g., Zaidel, 1976), more than is typically recognized. Kimura (1973) showed that right-handed subjects who were left brained for language tend to make many more free hand movements with their right hands while speaking than with their left. Self-touching movements in these subjects were greater in the left hand. Moscovitch (1980) asserts that Kimura's findings are true only for non-emotional material but in case of emotional subject-matters (when facial expressions reflects the feelings), there is no contralateral hand preference for activity.

Among right-handed women, Volf, Senkova, Danilenko and Putilov (1993) found the difference between SAD (seasonal affective disorder) depressed Ss and controls in performance, measures of laterality, suggesting that winter depression is associated with a shift of laterality from the left to the right. Corbera, Grau and Vendrell (1993), using verbal and spatial hemifield tachistoscopic task found separate oscillatory control of the circadian rhythms of the left and right hemisphere activity.

To complicate the matter further, the extent of linguistic representation in the right hemisphere differs among individuals (Myers, 1984), and the extent of right hemispheric involvement in a task varies depending upon its perceptual, motor
and cognitive demands (Henninger, 1989). Moreover, interhemispheric collaboration or bilateralism is an integral part of cognitive processing, evidenced by larger callosum in non-right handers (Witelson, 1989) and right hemispheric representation of language in left handers (Naeser and Borch, 1986). Even 50-70% of the left-handers have their language functions localized in the left hemisphere (Humphrey and Zangwill, 1952). Therefore linguistic abilities may be bilaterally represented in the brains of many left handers.

MRI study by Hines et al (1992) obtained negative correlation between laterality and callosal activity implying exchange of information across hemispheres. Strongly lateralized Ss exchange less information between hemispheres, whereas poorly lateralized subjects exchange more information between hemispheres.

Apparently, the right hemisphere can follow verbal instructions and this fact implies some sort of language abilities. It is found that when children lose their left hemisphere early in life, they still can develop language abilities that appear quite normal unless special tests are applied. They have adequate comprehension of written and spoken language, but inferior speech and syntax (Zaidel, 1983),
Zaidel (1994) suggests the presence of right and left hemispheric meaning systems that can operate separately and simultaneously. Concrete nouns were easier for right hemisphere than abstract nouns. Gazzaniga claims that only a handful of patients have ever shown only sign of right hemispheric language (Gazzaniga, 1983), e.g., 3 out of 28 patients only, and it was much inferior to left hemisphere (Gazzaniga et al, 1984).

Levy, disagrees with Gazzaniga that the right hemisphere has no ability at all to recognize words, visually and in spoken form (Levy, 1983). She argues that words can be treated as simple visual stimuli apart from their semantic meaning and be associated with other stimuli in a nonlinguistic fashion.

Due to consistent early findings of left hemispheric dominance for language, deviation from it has been taken something anomalous or reverse for normal language processing (Cohen et al, 1991) and development (Molfese and Molfese, 1985) and even for normal cognitive development (Stellern, Collins and Bayne, 1987). Sommers and Starkey (1977) did not find right ear advantage (left language laterality) among mentally retarded Ss. Learning disabled Ss were found to have weak laterality and poor language (Haggerty and Raffa, 1978). Syntactic deficiency in reading test correlated negatively with left language laterality (Rosenblum and Stephens, 1981). On the other hand Piccirilli et
al. (1991) found no relationship between mental retardation and specific pattern of cerebral lateralization. Progressive language lateralization hypothesis was also not supported in a study by Kuroda and Kobayashi (1986). Learning disabled Ss show left language lateralization (Obrzut, Conrad, Bryden and Boliek, 1988). Therefore the evidence of ill effects of right hemispheric language lateralization is not very consistent. It cannot always be said that mental retardation, learning disability, poor language development and other linguistic deficiencies are associated with right hemispheric dominance for language, as even among normals it is found.

The degree of laterality or absolute laterality may be determined by number of factors, e.g., handedness, sex, age, mode of language processing, linguality, profession, etc. A brief survey of handedness, sex and mode of processing would be provided in the next few pages. Whereas, the linguality and related variables including development of laterality would be provided in the next chapter.

**HANDEDNESS AND LANGUAGE LATERALIZATION**

Human beings are overwhelmingly right handed with approximately 90% of the population using the right hand for
Writing and other unimanual skilled activities. Right handedness is slightly greater in women, with the margin of difference in various surveys ranging from 1% to 4% (Harris & Carlson, 1988).

Annett (1972, 1974) presented a genetic model of handedness, according to which, about 80% of all individuals have the right-shift factor that disposed them to be right handed. About 20% of the others lack this factor and the chances toward left or right hemisphere is 50-50. Annett’s (1985) model of the genetics of handedness is one of the most widely accepted model (Mc Manus & Bryden, 1992). She argues for a balanced polymorphism with a heterozygote advantage. Annett (1993), while studying the relationship between handedness and educational achievement found a natural variation for laterality and ability as expected for a genetic balanced polymorphism with heterozygote advantage.

Abram Blau (1946) preferred laterality to be not an inherited trait but rather culturally transmitted. Collins (1970) seems to prefer the similar position mainly on the grounds that it would permit greater plasticity of adaptation.

Kinsbourne and Lempert (1979) have hypothesized that left language lateralization arise from right biased orientation. Dellatolas (1987) also offered probabilistic models of language lateralization based on handedness. Springer and Deutsch (1985)
reported that about 70% of the left-handers have representation of language in the left hemisphere, 15% in the right hemisphere and remaining 15% in both hemispheres. There is found to be an increased prevalence of left handedness among subjects with language deficits (Lucas, Rosenstein and Rigler, 1989).

Right-handed people rarely have bilateral speech representation (Milner, Branch and Rasmussen, 1964), and on the contrary there is a greater tendency (15%) to bilateral language dominance in left-handers (Hecaen and Sauguet, 1971; Markus & Boland, 1972; Milner et al, 1966; Satz et al, 1967; Springer & Deutsch, 1985).

Rich & McKiever (1990) found left handers as less lateralized on language. Kimura & D'Amico (1989) reported an interactive effect of handedness and choice of subject, e.g., science and non-science. They found that adextral (left-handed) science subjects and dextral (right handed) science subjects were less lateralized equally for language, whereas adextral non-science subjects were less lateralized.

Analysing the effects of gender and handedness using visual half-field incongruent colour - words paradigm, Franzin and Hugdahl (1986), observed significantly more errors, in male dextrals when stimuli were presented in right VHF. Same was the
case with sinistral males. No differences between VHF's were observed for females. Nieto et al. (1990) found RVF advantages for semantic and verbal categorization task only in males. Hassler (1990) found that female left-handers had severe language lateralization but male left handers did not. According to Knox and Kimura (1970), boys have a greater right hemispheric specialization for non-linguistic stimuli than girls do. Their results, however, revealed no significant sex x ear interaction. In case of 5-9 yr. old girls cerebral dominance for language establishes sooner (as they grow older) than boys (Bakker et al., 1976; Buffery, 1976).

MODE OF PROCESSING

In a study conducted by Melamed & Zaidel (1993), behavioural laterality effects in naming and lexical decision in Farsi and English were used to evaluate theories of cross-linguistic differences. The cerebral dominance hypothesis predicts a consistent right visual hemifield advantage (RVFA) in both languages. The scanning hypothesis predicts a smaller RVFA in Farsi in both tasks. Results support the right hemisphere hypothesis, showing greater right hemisphere contribution to orthographic addressing in Farsi than in English.
Assessing language lateralization, using a dichotic consonant-vowel task, some researchers did not find results consistent with the view that Native Americans are more right hemisphere dominant as a function of an appositional (Vaid, 1983) mode of language and thought (Mckie Jer, Hunt, Wells and Yazzie, 1989). Hilgard (1977) reports that when a right-handed person utters the words to a song without singing, he uses his left (verbal) hemisphere whereas when he hums the music without the words, he uses the right hemisphere. Handedness and writing style also significantly influences the processing of language in the cerebral hemisphere. The left handed inverted writers seems to have left hemisphere dominant in language processing. Right handed inverted writers had right hemisphere dominant. While right handed non-inverted writer had left hemisphere dominant in language processing and finally left handed non-inverted writer had right hemisphere dominant in the processing of language (Levy & Reid, 1978).