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SUBLIMINAL PERCEPTION IN THE CONTEXT OF FUNCTIONAL HEMISPHERIC ASYMMETRIES.

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SUBLIMINAL PERCEPTION IN THE CONTEXT OF FUNCTIONAL HEMISPHERIC ASYMMETRIES

by

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B.Sc. McGill University, 1971

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1979

APPROVED BY:

Chairman

To Timothy,

my dearest friend and husband,

for his inspiration, caring and patience.

ABSTRACT

Perceptual defence and the effects of subliminal stimuli upon subsequent verbal behavior were studied in the context of functional hemispheric asymmetries and hemisphericity of the subjects. It was hypothesized that subjects would demonstrate perceptual defence for words flashed into their left visual field (LVF) by recognizing significantly fewer anxiety words than neutral words. No such effect was predicted for the RVF. The magnitude of perceptual defence was postulated to vary in relation to the hemisphericity of the subjects. It was further hypothesized that the presumably anxiety-arousing verbal stimuli not recognized by the subjects during unilateral tachistoscopic presentations (perceptual defence) would, under some conditions, influence the subject's subsequent interpretation of repetitive ambiguous auditory verbal stimuli.

Twenty right-handed female subjects who showed at least 75% of their lateral eye movements to the right and twenty with lateral eye movements to the left, participated in the experiments. Perceptual defence was demonstrated as predicted, and the right-movers showed less perceptual defence than the left-movers as was indicated by decreased LVF recognition of anxiety-producing words in comparison to neutral words. The results were discussed in the context of current neurophysiological evidence which suggested that the right hemisphere

and the inhibition of neuronal transmission across the cerebral commissures may be involved in the mechanisms underlying perceptual defence, repression and certain unconscious processes.

In order to explore the effects of subliminal stimuli upon the subjects' subsequent interpretation of repetitive ambiguous auditory verbal stimuli, a dichotic verbal transformation task (DVT) was employed before (pretest) and after (post-test) the tachistoscopic procedure. It was found that the subjects' DVT pretest reports differed significantly from their DVT post-test reports as a function of the tachistoscopically presented anxiety-producing stimuli which were not recognized by the subjects during the tachistoscopic experiment.

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CHAPTER I

INTRODUCTION

The human brain has been implicated in certain manifestations of the human psyche since antiquity. In writings which range from those of the early philosophers (e.g. Plato) and anatomists to those of the modern-day neuropsychologists, attempts have been made to associate what has been variously referred to as the human soul, mind, or consciousness to the activities of the human brain.

The first scientific discovery with respect to identifying the human brain with a particular human ability is usually ascribed to Paul Broca (Boring, 1950). He was the first one to propose in 1861 that the ability to verbalize (use expressive language) became disturbed when certain portions of the left hemisphere of the brain were damaged. This finding was soon followed by localization of motor functions in the cerebral cortex by Fritsch and Hitzig (1870). Since about this time it became accepted that not only the physical functions of the human body but also the higher mental activities, such as language, are related to the functioning of the human brain. This view, with some modifications regarding the extent to which certain functions can be specifically ascribed to definite regions of the brain, has persisted to present day.

The upper parts of human brain are divided longitudinally into two

cerebral hemispheres (left and right) connected with one another by several commissures, the largest of these being a thick bundle of fibers called the corpus callossum. The appearance of the two hemispheres to the naked eye is nearly identical yet each has some different, highly specialized functions of its own. Since Broca's important discovery of motor speech centers in the left hemisphere, it has become generally accepted that he two hemispheres of the human brain are functionally asymmetrical. This was further supported by Wernicke's (1874) finding that removal of more posterior areas in the left hemisphere, but not the right, resulted in the inability to understand language. Due to the importance of language in the regulation of human behaviour and in human interactions the hemisphere found to be functionally related to language (speech, reading, writing) began to be referred to as the dominant hemisphere. For almost all right-handed individuals (and most left-handers as well) the left hemisphere is the dominant one and subserves the primary function of language processing and production. Its anatomical connections with the rest of the body are such that it receives sensory input from, and co-ordinates motor activity primarily on the right half of the body. The minor (right) hemisphere receives sensory input from, and primarily regulates the motor activity of the left half of the body. Considerable research has shown that apart from the sensory and motor functions, the minor (right) hemisphere also subserves many psychological processes (e.g., organizing visual-spatial relationships, appreciation of music, ability to recognize faces)

comparable in complexity to the mediation of language by the left hemisphere. A model of dual dominance has therefore been proposed to express the idea that the leading hemisphere for some functions may not be the leading hemisphere for all functions but that each hemisphere is specialized in different ways and complements the other (Bakan, 1971). Current research on hemispheric asymmetry essentially reflects the dual dominance model in that the functions of both hemispheres are being actively studied.

Functional asymmetry of the human brain has been demonstrated in clinical studies with patients suffering from brain damage of various causes as well as in experimental studies with normal subjects. Extensive neuropsychological batteries have been developed to study and diagnose the effects of damage to different portions of the brain (e.g., Halstead, 1947; Reitan, 1959; Milner, 1971). Damage to the left side of the brain is usually followed by loss of language abilities in varying degrees depending upon the severity, etiology and exact loci of injury. Conversely, patients with right-sided cerebral damage experience various degrees of inability to organize visual-spatial relationships in the environment and have difficulty identifying unfamiliar faces or distinguishing musical patterns (Milner, 1968; Kimura, 1973).

Temporary anaesthetization of one hemisphere (the Wada tachnique, Wada & Rasmussen, 1960) used to determine hemispheric dominance for speech prior to surgical removal of epileptic foci, has contributed

further evidence in support of lateralization of cognitive functions. During this procedure, sodium amytal is injected into the left or right carotid artery in the neck, thus producing a temporary anaesthetic effect within the ipsilateral cerebral hemisphere. The patient is awake during this procedure and is asked to respond to different simple verbal and nonverbal tasks. When the left hemisphere is thus anaesthetized the patient becomes temporarily paralyzed over the right side of his body and loses his ability to verbalize and to respond to verbal tasks. Conversely, when the right hemisphere is treated similarly, the temporary paralysis is over the left side of his body and the patient demonstrates difficulties in solving problems involving visual-spatial organizations (Wada & Rasmussen, 1960).

Probably the most dramatic demonstrations of functional asymmetry resulted from studies with split-brain patients. In these patients the fibers of the corpus callossum connecting the left and right hemispheres were surgically severed, which anatomically separated the two cerebral hemispheres from one another. This operation is used in treatment of severe, intractable cases of epilepsy (Sperry, 1964). Following this operation there is a marked decrease in seizure activity and the patients appear quite normal and are able to carry on their everyday activities. It is only under specially designed experimental conditions that the dramatic effects of disconnecting the two hemispheres emerge. Sperry (1968) summarized the picture of such patients as follows:

> The most remarkable effect of sectioning the cerebral

> commissures continues to be the apparent lack of change with respect to ordinary behaviour. (The patients)... exhibit no gross alterations of personality, intellect or overt behaviour two years after operation.... Despite this outward appearance of general normality in ordinary behaviour...specific tests indicate functional disengagement of the right and left hemispheres with respect to nearly all cognitive and other psychic activities. Learning and memory are found to proceed quite independently in each separated hemisphere... and the whole inner realm of gnostic experience of the one is cut off from the corresponding experiences of the other hemisphere....(p. 31).

Experiments with split-brain patients most clearly demonstrated functional specialization of each hemisphere and the ability of either hemisphere to mediate complex psychological processes at least to some extent independently from one another. This independence is evident in the dissociation of perception and verbal response. When patients were blindfolded and then asked to manipulate common objects with their right hand only (i.e., the information was received by the left - verbal hemisphere), they were able to describe them verbally. When they felt the same objects with their left hand only (i.e., right - nonverbal hemisphere) they could not describe them verbally but were able to select them with their left hand from among a group of other objects.

In order to compare the response of either hemisphere to visual stimuli a special way of presentation had to be devised., The visual system in humans is organized in such a way that visual stimuli which reach the temporal half of the retina of each eye are projected to the ipsilateral visual cortex. Stimuli which reach the nasal part of the retina of each eye are projected via fibers which cross at the optic chiasm to the contralateral visual cortex. When a stimulus is presented briefly by a tachistoscope to the left of the central fixation point (left visual field -- LVF), it is received by the right cerebral hemisphere via the right temporal and left nasal halves of the retinae. Conversely, the left cerebral hemisphere receives input which is presented to the right of the central fixation point (right visual field -- RVF) via the left temporal and right nasal halves of the retinae.

When this method of presentation was used with split-brain patients, they were able to verbally report only those stimuli which were flashed tachistoscopically to the RVF because these stimuli became directly available to the left hemisphere for verbal interpretation and report. Similar stimuli presented to the LVF reached the right (nonverbal) hemisphere and were not reported verbally. The subjects were, however, able to select the appropriate object that they saw from an array with their left hand, thus indicating the right hemisphere's knowledge of it. Occasionally, a presentation of a stimulus to the right hemisphere resulted in a complete denial of having seen anything at all. This was the case with one woman who was viewing a series of neutral geometrical

designs presented randomly to her LVF or RVF by a tachistoscope. In this series a picture of a nudé pin-up was included and flashed to the LVF thus reaching the right (nonverbal) hemisphere. Immediatelly upon the presentation the woman blushed and giggled but denied having seen anything at all, though she added: "Oh, Dr. Sperry, you have some machine!"

Another split-brain patient would spontaneously laugh whenever he felt a certain tactile stimulus in his left hand (right hemisphere), although unable to acknowledge what caused his laughter (Gazzaniga, 1970).

Similar observations were made during auditory presentation of stimuli. Milner, Taylor, and Sperry (1968) used a dichotic method to present verbal stimuli to split-brain patients. This method consists of simultaneous presentation of different auditory input to each ear. Following the dichotic presentation of auditory verbal stimuli, the subjects in this experiment expressed their disappointment over not having heard anything in the left ear, despite having expected some input. All these patients, however, were easily able to report digits presented to the left ear when there were no competing digits from the right ear. Milner et al. (1968) concluded that this demonstrated that the ipsilateral pathway (from the left ear to the left hemisphere) was intact and could be utilized, but was inhibited during competition from the stronger contralateral input (from the right ear), as manifested by the complete suppression of verbal input from the left ear under the

dichotic listening conditions. This is in agreement with previously established anatomical findings, that the subcortical contralateral auditory pathways are more numerous than the ipsilateral ones.

The subjects in the Milner et al. experiment were also given two competing instructions, again presented dichotically. During this task they were told, for example, to pick up a brush (left ear) and pick up a key (right ear) with their left hand from among a collection of nine objects screened from their sight. All subjects reached for the object that coincided with the left ear instructions (received by the right hemisphere which controls the left hand). Later when they were asked to recall the objects that they had picked up they verbally described the ones that they were instructed to chose through the right ear (received by the left hemisphere). Furthermore, they reported total non-awareness of the inconsistency in their behaviour.

It has been suggested that, apart from specialization of each hemisphere for tasks with different content (i.e., verbal - nonverbal) there is perhaps an even more important difference between them, and that is the difference between their characteristic styles of information processing (Galin, 1976). The left hemisphere style has been variously described as symbolic, abstract, linear, rational, focal, conceptual, propositional, secondary process, digital, logical, active and analytic. These descriptions express the operations that enable the left hemisphere to mediate complex linguistic skills, mathematical and logical constructions as well as time estimation, any of which may

become disturbed following damage to different parts of the left hemisphere. The right hemisphere style has been described as concrete, diffuse, perceptual, appositional, primary process, analog, passive and holistic. Again, these descriptions are related to the operations of the right hemisphere which enable it to mediate perceptions and manipulations of complex spatial relations (such as in driving a car or constructing an object from a blue-print), appreciation of music or performing a dance. (Dimond & Beaumont, 1974; Kinsbourne & Smith, 1974; Nebes, 1974; Galin, 1976).

Furthermore, it has been suggested that the two hemispheres differ in their perceptions of emotional situations. Dimond, Farrington and Johnson (1976) used special contact lenses which directed visual input to either the left or the right hemisphere of normal subjects. They showed their subjects a film (without sound) and found that films projected to the right hemisphere elicited more unpleasant and "horrific" reactions than films shown to the left hemisphere. They concluded that each hemisphere appeared to add its own emotional dimensions (with the right hemisphere more likely to trigger an unpleasant emotional experience).

This is consistent with earlier observations of emotional reactions in brain damaged patients. Gainotti (1972) concluded on the basis of previous reports and his own observations that patients with left-sided brain damage showed higher incidence of depressive-catastrophic reactions, while patients with right-sided brain damage showed more

euphoric or indifference reactions. Similar observations were reported by Babenkova (1972) and Hecaen (1962).

Such dissociations of emotional reactions were also seen following a temporary anaesthetization of either hemisphere with sodium amytal (Wada technique). The depressive-catastrophic reactions usually followed the inactivation of the left hemisphere, while inactivation of the right hemisphere resulted in the more euphoric-maniacal reactions (Alema, Rosadini & Rossi, 1961; Terzian, 1964; Terzian & Ceccotto, 1959). In these studies the emotional reaction appeared to be triggered by the intact hemisphere with its proposed emotional bias.

Studies of sleep and dreaming suggested to Bakan (1976) yet another important aspect of hemispheric asymmetry. He described research which showed that as the sleeper goes into REM sleep (associated with dream production) there is a relative shift toward greater activity within the right hemisphere. He also mentioned studies with patients who, following damage to their right hemisphere, lost their ability to dream.

Penfield (1975) observed that during mild electrical stimulation of the surface of the right temporal lobe (prior to brain surgery for epilepsy) his patients reported "dreamy states", "visual illusions", "detailed memories" and feelings of "familiarity and strangeness". Stimulation of the same areas of the left hemisphere never produced such effects.

Bakan (1976) on the basis of these studies proposed that it is the right hemisphere which is the "dreamer". He also suggested a parallel

between Freud's dichotomy of primary-process thought (hallucinatory, concrete, illogical, emotional and unconcerned with reality) and secondary-process thought (verbal, abstract, logical, objective and in tune with reality), and the functional dichotomy of the right hemisphere (nonverbal, perceptual, spatial, pictorial and emotional) and the left hemisphere (language related, logical, abstract and analytic). Freud considered dream thinking to be a type of primary-protess thought and called it "a royal road to the unconscious". Bakan (1976) adds: "Since the right hemisphere and dreams share many aspects of primary-process thought, I believe that the royal road to the unconscious leads to the right hemisphere" (p. 66).

It has been observed that in split-brain patients the left hemisphere appears to dominate, with its mode, the patients' actions, and makes decisions most of the time, except when a task is presented in which the right hemisphere clearly excells (Levy, Trevarthen & Sperry, 1972). It has been proposed that a similar but perhaps less clearcut relationship between the two hemispheres exists in normal people as well, and that their two modes of information processing are sometimes complementary and sometimes in conflict: As Galin (1976) put it:

> The analytic and holistic modes are complementary; each provides a dimension which the other lacks. Artists, scientists, matematicians, writing about their own creativity, all report that their work is based on a smooth integration of both modes (p. 40).

As an example of conflict between the two modes Galin (1976) describes his own experience with dancing:

> My difficulties with dancing may be related to my excessive reliance on analytic sequential processes; instead of allowing a smooth synthesis of the separate parts, I have not been able to progress past counting "one...two...THREE ..., one...two...THREE" (p. 41).

The concept of the relative reliance of different people upon one or the other mode associated with the left or right hemisphere is referred to as hemisphericity (Bogen, 1969). It reflects the observations that some people's behaviour, cognitive style and personality are more compatible with the mode of one hemisphere than the other. The extent to which hemisphericity is manifested in different individuals and the implications of it, has been explored most extensively in studies of conjugate lateral eye movements in normal people.

Most people, when facing an experimenter who has presented them with a question which requires some reflection, avert their eyes away from the experimenter in a characteristic direction (Teitelbaum, 1954). Their eyes ~~move~~ predominantly to the left or to the right. These people can be classified as left-movers or right-movers, respectively. A certain small portion of people look in either direction on different occasions and are referred to as bidirectionals. It has been suggested that the direction of conjugate lateral eye movements (CLEMS) typical of different individuals reflects the functional organization of the

brain (Day, 1964). According to Bakan (1969) the direction of CLEMS is related to the amount of activity within the cerebral hemisphere contralateral to the direction of the movement. When the activity in one hemisphere exceeds the amount of activity in the other, the initial minimal bias is converted into a significant increment and the eyes are directed via a mechanism in the frontal eye areas of the cerebral cortex contralateral to the side of the more active hemisphere. Thus, he proposed that the predominant direction of CLEMS could be used as an index of hemispheric cognitive activity characteristic for different individuals.

The relationship between the functional organization of the brain and the direction of CLEMS has been demonstrated in studies in which right-movers (i.e., more active left hemisphere) and left-movers (i.e., more active right hemisphere) were found to differ in a predicted way on numerous cognitive as well as personality measures. Right-movers were found to reflect a mode of functioning consistent with the left hemisphere, i.e., they were more analytic, used more verbal elaborations, scored higher on the Mathematics section of the Scholastic Aptitude Test, were less emotional and utilized psychological defences of projection and outward expression of anger (Weiten & Etaugh, 1973; Gur & Gur, 1974 and 1975). The left-movers were more emotional (Day, 1968), more highly susceptible to hypnosis (Bakan, 1969), reported more day-dreaming (Meskin & Singer, 1974), utilized psychological defences of denial and repression (Gur & Gur, 1974) and were more holistic and nonverbal (Gur &

Gur, 1975), thus reflecting the mode characteristically associated with the right hemisphere (e.g., Benton, 1972; Ornstein, 1972).

As to the mechanism of interhemispheric interaction, several possibilities have been considered (Galin, 1974). One possibility is that the hemisphere which takes charge of a certain situation disconnects the other which remains independently active, as in the case of split-brain patients. Another possibility is that both hemispheres are active and integrated with each other. Bogen and Bogen (1969) suggested that this condition may be a prerequisite for the occurrance of creativity. A third possibility is that the two hemispheres alternate in their domination, depending on the demands of a given situation, with the more active hemisphere inhibiting the other. Another version of this would be that the more active hemisphere inhibits only part of the other hemisphere making selective use of the rest as necessity demands. In this case, the inhibition would be only partial but sufficient to prevent the less active hemisphere from pursuing its own plan of action. This condition of "selective inhibition" has received the most support from experimental studies. For example, when normal subjects were performing verbal tasks (left hemisphere) their EEG over the right hemisphere registered an increase in alpha waves (idling rhythm). Conversely, when they were working on a block design test (right hemisphere) the increase of EEG alpha waves was noted over their left hemisphere (Galin & Ornstein, 1972). This would suggest that some inhibitory process occurred with respect to one hemisphere as a result

of demands placed upon the other.

It was proposed that such inhibition (or sometimes disconnection) may result for two reasons. First, a hemisphere which is better equipped to solve a given problem may reach the output channel faster and gain control over the overt behaviour by inhibiting the activity of the other hemisphere. This has been called "resolution by speed". The above experiment may be an example of this. Second, "resolution by motivation" may occur when one hemisphere has more "interest" in influencing the outcome. Gazzaniga's (1971) experiment with split-brain monkeys may be used as an example of this. Split-brain monkeys were taught opposite solutions to a problem with different amounts of reward for each hemisphere. In a conflict situation when both hemispheres were simultaneously exposed to the same problem (each having learned a different solution to it) the hemisphere which received the most rewards during training dominated the other one, and directed the monkeys' behaviour accordingly.

Galin (1976) suggested that this may be a useful model for explaining the dominance of one hemisphere over the other in normal humans. Specifically, he points out that as the left hemisphere develops language (given its importance in all spheres of human interactions) it attains an advantage over the right hemisphere in obtaining reinforcements and manipulating the environment. This makes the left hemisphere more likely to dominate in "resolution by motivation" in conflict situations. Under normal circumstances both hemispheres

are exposed to the same stimuli which they interpret according to their modes of information processing which in some cases may result in a conflict. For example, when verbal communication and facial expression of the same person convey different messages, where the former constitutes a positive affect and the latter a threatening one, each hemisphere will interpret such input primarily within its own mode (left hemisphere - positive verbal message; right hemisphere - threatening facial expression). Each hemisphere may subsequently be motivated to take the opposite action, i.e., approach (left) or escape (right), respectively, thus a conflict is set up. Usually, it is the left hemisphere which dominates and directs the overt behaviour, while the right hemisphere is either inhibited or disconnected and its memory of the threatening facial expression will remain confined in its storage (Galin, 1976).

Should both hemispheres fail to dominate in this conflict, then the result of their conflicting perceptions (along with their conflicting motivations towards different actions) may be confused behaviour or lack of any response whatsoever. There are ample examples of such outcomes in psychopathology, as in cases of schizophrenia.

Bateson and his associates (1956) have based their theory of schizophrenia on what they called the "double-bind" situation to which the schizophrenic patient has been exposed repeatedly during his upbringing. This is very similar to the example above, where a person is confronted by conflicting messages. While in most cases an individual

(i.e., his left and right hemisphere) can assess the advantages (and rewards) of selecting a definite action, the schizophrenic patient in the "double-bind" situation fails to perceive such advantages because either approach or escape has, in the past, elicited punishment. Thus, he fails to inhibit the unpleasant and threatening input. The subsequent behaviour incorporates the internal conflict and may take a form of a thinking disorder manifested, in part, by a language disorder. Bleuler (1911) emphasized this type of disorder as the main characteristic of schizophrenia and believed that the "abnormality does not lie in the language itself, but rather in its content" (p. 147). The content frequently has a dream-like, primary-process thinking quality (Bakan, 1976). Bakan has speculated that it might reflect those mental processes in the right hemisphere which have gained access to consciousness because their transfer to speech centers in the left hemisphere had not been inhibited. This might occur if the barrier between the two halves of the brain were in some way defective, which is what Bakan proposed. In such case, decisions about which hemisphere will dominate in situations of conflict may be ineffective, and neither hemisphere can inhibit nor disconnect the other. It is as though the contents and intentions of either hemisphere "spill over" from one to the other and interfere with either hemisphere's ability to direct purposeful behaviour. Following a surgical interruption of part of the corpus callossum (which has been implicated in mediating interhemispheric inhibition and information transfer in normal people) schizophrenic

patients have shown a decrease in their hallucinatory activity, less anxiety and less tension (Laitinen, 1972). It is tempting to speculate that this operation may have created an "artificial" barrier between the two hemispheres, thus facilitating the domination of the left hemisphere. It has been mentioned earlier that in split-brain patients the left hemisphere usually dominated overt behaviour, unless the mode of the right hemisphere was explicitly required.

The studies reviewed above document the importance of the hemispheric asymmetry and the interhemispheric transfer of information, in the total psychological functioning of human beings. Verbal expression of our conscious experiences was shown to be mediated by the left hemisphere. On the other hand, a host of complex non-verbal functions were seen to be mediated by the right hemisphere. It has been also demonstrated that information transfer between the two hemispheres is accomplished through the fibres of the corpus callossum and other cerebral commissures. Studies with split-brain patients have indicated that in these patients dissociation can occur between the overt behavior (which is mediated by an in response to information fed into the right hemisphere) and the conscious experience of it (as manifested by verbal report mediated by the left hemisphere). In other words, these patients either could not report what exactly transpired or denied knowledge of anything taking place at all. In these cases, at least, the activity mediated by the right hemisphere did not come into conscious experience of the subjects, presumably because the commissural transfer of information

between the two hemispheres was interrupted. "One may well wonder if this is the case in normal subjects, so that information fed into this (right) hemisphere reaches consciousness only after interhemispheric transfer." (Eccles, 1965, p. 34).

In order to address this issue, it would be necessary to show that conscious experience as manifested in verbal report of it, depends on the hemispheric functional asymmetry and on the interhemispheric transfer of information in normal subjects. An experimental design that appears to satisfy these conditions has been proposed by Jean (1974) and Jean and Reynolds (1974 & 1975) in their study of perceptual defence. The experimental method used was a tachistoscopic presentation of neutral and anxiety-producing words flashed at very fast exposure times to either the left or the right visual field (thus reaching the visual cortex of either the right or the left hemisphere). Perceptual defence was said to occur when a subject failed to perceive anxiety-producing words while still able to perceive and report neutral words presented in a similar fashion.

Jean and Reynolds observed that the two hemispheres differed in the extent to which they mediated the perception of the anxiety-producing words and the neutral words. Their subjects were able to report more anxiety-producing words when the latter were presented directly to the left hemisphere than when presented to the right hemisphere. Furthermore, the female subjects in this experiment recognized fewer anxiety than neutral words presented to the LVF but not when these words were

presented to the RVF. Since the right hemisphere has been shown to be unable to mediated expressive language, the verbal report of stimuli presented to it depends on the callossal transfer to the left hemisphere. It has been hypothesized that in perceptual defence the callossal fibers selectively inhibit transfer of information from the right to the left hemisphere thus preventing its verbalization and entry into awareness. This information is presumed to be stored in the right hemisphere. However, in order to presume that the information which was not reported did in fact reach the brain (was processed and stored), it should be possible to demonstrate its impact, perhaps by showing its effect on a subsequent behaviour of the subject. Leibniz (1698) may be considered to have been the first to explicitly comment on a common observation of this effect: "There are also numberless perceptions, little noticed, which are not sufficiently distinguished to be perceived or remembered but which become known through certain consequences." (In Dixon, 1971, p. 7). These consequences may be symbolic images (related by their content to the unrecognized information) which emerge in subsequent dreams as seen in the Poetzl phenomenon (Poetzl, 1917) or they may be experimentally induced changes in subsequent perception of a supraliminally presented stimulus (Smith, Spence and Klein, 1959). Klein et al. (1959) showed tachistoscopically their subjects the words HAPPY and ANGRY at very fast exposure times. The subjects were not aware of these words which were presented subliminally. Each presentation of one subliminal stimulus (HAPPY or

ANGRY) was followed by a supraliminal exposure of a drawing of a neutral face. The subjects could see this neutral stimulus quite clearly. The experimenters observed that their subjects' responses to the supraliminal pictures tended to be influenced by the preceding subliminally presented word (either HAPPY or ANGRY).

Dixon (1971) reviewed a host of studies about the effects of subliminal stimuli upon subsequent overt behavior. In these studies, the subliminal presentation was accomplished by centrally positioned brief tachistoscopic exposures (e.g., Smith et al., 1959; Murch, 1969), low illuminations of the stimulus (e.g., Dixon, 1958 a) or binaural subthreshold presentations of auditory stimuli (e.g., Dixon, 1956). No attempts were made to investigate subliminal perception and perceptual defence in the context of hemispheric asymmetry. Since it has been suggested (Jean & Reynolds, 1974 & 1975) that the phenomenon of perceptual defence may be related to hemispheric asymmetry and interhemispheric transfer of information, the effects of unilateral subliminal stimuli upon subsequent behavior should also be studied in this context. This would necessitate a design in which both the subliminal input and the subsequent overt behaviour were correspondingly lateralized. The lateralization of input was previously achieved by unilateral tachistoscopic presentations of stimuli. It is proposed here that the lateralization of the output may be accomplished by utilizing the technique of dichotic listening.

Dichotic listening refers to a method during which each ear

receives a different but simultaneously presented input. It has been observed that at least in the right handed individuals, verbal input is more reliably reported when it is presented to the right ear. Musical discriminations are more easily made when such input is channelled through the left ear (Kimura, 1973). It has been hypothesized that the contralateral pathways (from the ear to the brain) which are anatomically more numerous may inhibit the lesser ipsilateral pathways. In this way the right ear input would be primarily analyzed by the left hemisphere (verbal) and the left ear input by the right hemisphere (more musically adept). This would reflect the functional asymmetry of the human brain (Milner, 1971).

Recently, Warren and Ackroff (1976) reported the results of their study in which they modified the dichotic listening method to explore the verbal transformation phenomenon in this context. The "verbal transformation phenomenon" is the term used to describe the observation that when a subject is listening to a tape of one repeated word for several minutes, changes and distortions of the repeated word, which are not part of the recording, will be "heard". This produces numerous illusory auditory transformations of the word (Warren & Gregory, 1958; Warren, 1961 a). In their experiment, Warren and Ackroff (1976) had their subjects listen to the same word repeated over and over. The tapes for each ear were constructed in such a way that one tape started with the beginning of the word while the other tape started in the middle of the word and proceeded to its end. When these tapes were played

dichotically, i.e., one to each ear simultaneously, the subjects were at any one point presented with two different stimuli. These stimuli were in fact identical but their presentations were desynchronized. Warren and Ackroff observed that under these conditions, an identical stimulus word in either ear underwent independent and simultaneous change. Furthermore, the transformations from the two ears differed qualitatively. The forms heard in the left ear were simpler and phonetically more closely related to the original stimulus word than the forms reported from the right ear. The authors concluded that this may have reflected independent processing of identical verbal information from the two channels. Would it be possible that the transformations heard under these competitive conditions in the right ear represented verbal processing activity in the left hemisphere and the transformations reported from the left ear represented the verbal processing in the right hemisphere?

Recent investigations of linguistic capacity of the right hemisphere have suggested that the right hemisphere can understand fairly complex language (Zaidel, 1976) and has some capacity for at least simple expressive language (Levy, Nebes and Sperry, 1971). This capacity, however, is interfered with by the domination of the left hemisphere over the output channels. Levy et al. (1971) proposed that: "...the minor (right) hemisphere could probably talk more than it does, were it not for the grip which the major (left) hemisphere maintains over the motor channels for speech" (p. 57). Perhaps under special circumstances

this control of the left hemisphere may be suspended and the right hemisphere may gain access to the speech output. It is proposed here that the dichotic verbal transformation task may be a case of such special circumstances when the right hemisphere can gain access temporarily to the speech output because the left hemisphere is focused on processing of its own input at that time, while the instructions requested report from the left ear only (the right hemisphere).

Up to this point the modified dichotic listening task has been considered primarily for its demonstrated lateralizing properties. However, studies, which explored the verbal transformation phenomenon (defined above) describe another finding relevant to the present study. It has been reported that the verbal transformations can be influenced by visually presented words. Lilly (1972) had his subjects listen to a tape with one repeated word and simultaneously look at cards with a word printed on them (i.e., one word per card). Frequently subjects reported having heard the word printed on the card at which they were looking. When the cards were presented laterally so that only peripheral vision was involved, subjects were not able to consciously read the word, but the visually presented words still programmed up to ninety percent of the transformations that the subjects reported.

It was also observed by this author that people tended to hear repeatedly transformations which were related to their personal preoccupations at the time of the experiment. This resembles a process which occurs during projective testing or free associations. Therefore,

it was hypothesized that the verbal transformations may be a useful tool in trying to elicit verbal reports of information which was available, though not recognized during the tachistoscopic experiment. Specifically, it is proposed that when a subject fails to verbally identify an anxiety-producing word presented tachistoscopically the same subject may be able to subsequently report it as a transformation during the dichotic verbal transformation task. Furthermore, it was proposed that the transformations reported from the right ear would reflect the processing within the left hemisphere and vice versa.

In general, the purpose of the present study was to show that verbal information which was not recognized in an early stage of the experiment could under special conditions influence the subjects' subsequent behaviour.

Specifically, the first part of the experiment was a replication of Jean's (1974) perceptual defence study, which tested the hypothesis that perceptual defence "...involves the storing of threatening information in the nonverbal (right) hemisphere through the selective inhibition of commissure transfer mechanism, so that access to the verbal hemisphere and hence awareness, is denied." (p. 18).

The second part of the experiment tested the hypothesis that the unrecognized threatening information was indeed stored in, and could be released by, the right hemisphere by showing its effect upon verbalizations from the left ear input during a modified dichotic listening task.

The design of the first part of the experiment was similar to that used by Jean (1974) with two modifications. First, different sets of neutral and anxiety-producing words were used. Second, selection of subjects was based on the direction of their conjugate lateral eye movements (CLEMS) rather than their scores on Byrne's Repression-Sensitization Scale. This modification was prompted by the results of Jean's (1974) study in which the Byrne scale failed to correlate with the tachistoscopic indications of repression and vigilance. On the other hand, recent studies of CLEMS (as reviewed earlier) have suggested that in the left-movers the right hemisphere plays a greater role in their total psychological functioning (Bakan, 1971). Furthermore, the left-movers have been found to utilize denial and repression as their preferred psychological defences (Gur & Gur, 1975). Since perceptual defence has been used as an experimental paradigm of repression, it would appear that the directionality of CLEMS would be a more direct and reliable predictor of the tachistoscopically induced perceptual defence than the Byrne Repression-Sensitization Scale.

In the second part of the experiment a dichotically presented verbal transformation task was used to elicit separate verbal responses from the left and right ear input. The transformations which a person hears are frequently phonetically distorted, yet somewhat similar to the original word. For example, a stimulus word "cogitate" used in a pilot study produced the following chain of transformations: "contemplate, computate, agitate, aggregate, etc.,". It was because of this phonetic

effect that the words presented tachistoscopically were modified in order to facilitate their subsequent verbalization.

In order to demonstrate the role of hemispheric asymmetry in the mediation of perceptual defence, the words (both neutral and anxiety-producing) were flashed randomly to the left and right visual fields (LVF, RVF) tachistoscopically. In order to demonstrate the effect of subliminal stimuli on subsequent behaviour in the context of the hemispheric asymmetry, the subjects heard a tape with repeated stimuli presented dichotically. The same tape was presented before and after the tachistoscopic experiment. The subjects were asked to report what they heard from one ear only. Since there is only one output for verbalization, it was hypothesized that the report from one ear under the dichotic listening conditions, may reflect the processing activity of one (the contralateral) hemisphere only. Specifically, it has been expected that the verbal transformations heard in the right ear (left hemisphere) would be modified by those words which have been verbally identified during the tachistoscopic presentation (to either visual field), since these words were part of the left hemisphere's verbal processing. The transformations heard in the left ear (right hemisphere) were expected to be modified by those words which have been verbally identified, because during the tachistoscopic report these words were received auditorily by both hemispheres. Also, the left ear (right hemisphere) verbal transformations should incorporate the unreported anxiety-producing words presented tachistoscopically to the right

hemisphere, because they were presumed to have been stored there and be potentially available for both further processiong and possibly for reporting.

To summarize, asymmetrical specialization of the two cerebral hemispheres has been documented by many researchers. The left hemisphere (with its verbal, analytic, rational etc. mode of information processing) has been identified with the mediation of verbal reports of conscious experience. The functions of the right hemisphere (with its spatial, nonverbal, pictoral and emotional mode of information processing) were hypothesized to have a limited representation in conscious experience via interhemispheric transfer of information to the left hemisphere.

Under normal circumstances the two hemispheres interact and, in most people, one of the hemispheres appears to play a greater role in a person's total psychological functioning. This is referred to as "hemisphericity". It is reflected in a person's inclination toward the mode of information processing subserved primarily by one hemisphere and is indicated by a person's directions of conjugate lateral eye movements (CLEMS). The direction of CLEMS has been shown to correlate with higher activity in the contralateral hemisphere. Left-movers and right-movers reportedly differ in many aspects of their cognitive functioning and personality dimensions. Left-movers appear to be more emotional, more highly susceptible to hypnosis, report more day-dreaming and use

psychological defences of denial and repression. Right-movers appear to be more analytic, use more verbal elaborations, are less emotional and use psychological defences of projection and outward expression of anger.

The interaction between the two hemispheres was seen to occur through the commissural fibers the largest of which is the corpus callossum. In a conflict situation the left hemisphere has been reported to dominate, while the transfer of information from the right hemisphere is inhibited. Threatening information perceived by the right hemisphere may represent a conflict and the transfer of this information through the commissural fibers may be inhibited. This was hypothesized to occur in perceptual defence. Anxiety-producing words, which were flashed at very fast exposure times to the right hemisphere, may not be available for verbal report because their transfer to the left hemisphere may have been inhibited at the level of the commissural fibers. This information, if it does not enter the left hemisphere and hence is not available to verbal expression and conscious experience, may be retained in the right hemisphere and remain unverbalized.

The present study has attempted to demonstrate experimentally the effects of stimuli which have been unrecognized during the early part of the experiment. In order to accomplish this the dichotically presented verbal transformation task (DVT) was employed in the role of word association test. During the DVT procedure it was hypothesized that the verbalizations of input into one ear would reflect the verbal processing activity of the contralateral hemisphere, while the other

hemisphere was occupied with the processing of input to the other ear. Specifically, the verbalizations generated by input to the right ear were expected to include words previously presented tachistoscopically to the left hemisphere as well as words presented to the right hemisphere which were reported by the subjects, since these words entered the left hemisphere via commissural fibers. The verbalizations during input to the left ear were expected to again include words tachistoscopically presented to both hemispheres which were recognized then by the subjects (because of the bilateral auditory feedback during the tachistoscopic verbal report), in addition to the unrecognized words, presented to the right hemisphere, since they were supposedly retained within the right hemisphere.

The selection of experimental subjects played a special role in the present study. Since it was important to first demonstrate perceptual defence in order to study the effects of subliminal stimuli, those individuals who were most likely to demonstrate perceptual defence were recruited as subjects for the experiment. Jean (1974) found that the females in her experiment exhibited perceptual defence to a greater extent than males, regardless of their scores on Byrne's Repression-Sensitization Scale. Therefore, only females were asked to participate in this present experiment.

Furthermore, the direction of the subjects' CLEMS was used here as a moderating variable to obtain an indication of preferred defence style (Bakan, 1969; Gur & Gur, 1975). It has been observed that left-

movers utilize more denial and repression than the right-movers, while bidirectionals are inconsistent in this respect. Therefore, only the left-movers and the right-movers were compared in the course of this study.

Since functional asymmetry and hemisphericity have been reported to be related to handedness (Gur & Gur, 1974) and these relationships are more consistent and better understood in the right-handed people, only right-handers were selected to be subjects in this experiment.

The specific hypotheses were as follows:

1. It was hypothesized that subjects would demonstrate perceptual defence for words flashed into their left visual field (LVF) by recognizing significantly fewer anxiety than neutral words. No such effect was predicted for the RVF.
2. The two groups of subjects, the right-movers and the left-movers were expected to differ in the extent to which they would manifest perceptual defence. Specifically, the right-movers were expected to demonstrate less perceptual defence than the left-movers as indicated by a lesser decrement of their recognition of anxiety words in their LVF in comparison to neutral words recognition.
3. It was hypothesized that the subjects' verbal transformations reported before (DVT pretest) and after (DVT post-test) the tachistoscopic experiment would be different, and that this difference would be due to the subjects' exposure to the

experimental words presented tachistoscopically. The following specific predictions were made:

a) The tachistoscopic experimental words were not expected to be reported on the DVT pretest because they were selected on the basis of their low frequency of occurrence in the reports of subjects who listened to a similar tape prior to this experiment.

b) It was predicted that any of the tachistoscopic experimental words that were recognized from either visual field may be subsequently heard as verbal transformations from either ear because these words acquired a bilateral representation following the subjects' verbalization of these words.

c) The left-ear report only was expected to reflect the unrecognized tachistoscopic experimental words presented to the LVF.

d) It was predicted that the right-movers and the left-movers would differ in their report of unrecognized anxiety words on the DVT post-test to the extent that they differed in their manifestation of perceptual defence.

CHAPTER II

METHOD

Subjects

Fifty six reportedly right-handed female students from various Intersession and Summer Session Psychology courses volunteered to be subjects in this study. Forty subjects whose first language was English and who satisfied the criteria of right-handedness (on the basis of Humphrey's, 1951 questionnaire) and also demonstrated clear left or right direction of conjugate lateral eye movements were selected to participate in the tachistoscopic and dichotic listening experiments.

Of the 16 students not included in the experiments, three were ambidextrous according to the handedness questionnaire, 12 showed bidirectionality during the assessment of their lateral eye movements, one reported partial deafness in her left ear and one had an uncorrected visual deficit.

Materials

Handedness questionnaire adapted from Part A of Humphrey's (1951) questionnaire (which assesses the consistency of hand usage for different tasks) was used to evaluate the subject's degree of right-handedness.

A set of 12 proverbs (Bakan & Strayer, 1973) was used during the assessment of the direction of the subjects' lateral eye movements.

For the dichotic verbal transformation task (DVT), the original Lilly (1973) tape was used. This tape consisted of the word "cogitate" repeated over and over by one person in the foreground, and a phrase "go with it" repeated by another person in the background. In earlier pilot studies and in the report by Lilly (1973), this tape was observed to produce a large number of various transformations, some phonetically similar (e.g., "agitate"), others phonetically distorted (e.g., "has a tape") with respect to the original stimuli.

An asynchronous two-track recording was made of this tape. One track started with the beginning of the word "cogitate", the other track started with the middle of the same word. (The background phrase "go with it" automatically underwent a similar division because of its fixed position with respect to the word "cogitate" on the original tape).

The two tracks were played through stereophonic headphones (on two track stereo taperecorder Sony TC-270) and their onset was simultaneous. One of the tracks was heard only in the left ear and the other one only in the right ear by the subjects, in a following manner:

track "L" (left ear) c o g i t a t e c o g i t a t e . . .

track "R" (right ear) t a t e c o g i t a t e c o g i . . .

This produced a dichotic type of verbal transformations; the subjects heard the same word changing into different forms independently but simultaneously in each ear (Warren & Ackroff, 1976).

The presentations of the track "L" and "R" to the left and right ear, respectively were randomized among the subjects.

For the tachistoscopic presentation, 20 neutral and 15 potentially anxiety-arousing words were selected from the reports of 80 subjects who participated in earlier verbal transformation pilot studies. These 35 words which were heard by less than 5% of the subjects in the pilot studies, were subsequently rated for their anxiety-producing effect by another group of 30 students. The ten most threatening words were matched with one of the neutral words each, on the basis of their frequency (Kucera and Francis, 1967), length and first letter. These words were referred to as the "experimental words" and were used in the assessment of perceptual defence effect. (See Appendix A for the list of the experimental words).

Twenty additional neutral words, matched with the experimental words on word length and frequency were used as "pretest words" prior to the experiment itself, in order to determine each subject's 50% recognition threshold for unilateral tachistoscopic presentation to the left or right visual field (LVF, RVF). Beyond this, the pretest words were not part of any subsequent data analyses.

All stimulus words were printed in black on 8" x 11" white cards with Letraset, 16 pt. Futura Bold and were presented in a Gerbrands' Harvard Mirror Tachistoscope.

Procedure

Each subject was tested individually. The experimental session consisted of 1) handedness evaluation (approximately 5 min), 2) lateral eye movement evaluation (approximately 15 min), 3) DVT pretest (approximately 5 min), 4) tachistoscopic pretest (approximately 15 min), 5) tachistoscopic experiment (approximately 10 min) and 6) DVT post-test (approximately 5 min). A five minute break was incorporated between the tachistoscopic pretest and the tachistoscopic experiment. At the end of each session every subject was informed about the purpose of the experiment and was asked not to discuss it with any of the other participants. Subjects known to be acquainted with one another were tested in immediate succession, so as to minimize the possibility of disclosure of the purpose of the experiment.

Handedness evaluation. Each subject first answered 20 questions of the handedness questionnaire. The criterion for being included in the study was 15 out of 20 questions answered in the right-handed direction.

Assessment of the conjugate lateral eye movements. Each subject was tested individually in a testing room which provided uniform and symmetrical surroundings, with the experimenter facing the subject. The experimenter first read the following instructions, then turned on the video taperecorder and then read the 12 proverbs to the subject.

Instructions:

"In this next part of the experiment I will ask you to interpret a number of different proverbs. While doing that I will be observing your face and videotape the expression on your face. I will explain the purpose of this procedure to you as soon as we finish the session. Meanwhile, I would like you to find a comfortable position and remain that way throughout this session. Look at me until I have finished saying the proverb and then go ahead and answer. Try to give some interpretation to every proverb. I will not be scorring the correctness of your answers. Listen until I finish while looking at me, think it over, then answer."

The videotaperecorder (Sony AV-3600) and the camera (Sony Video Camera 8 VC-3260S) were situated in another room connected with the testing room by a two-way mirror. The camera was behind the experimenter, behind the two-way mirror, which was covered with drapes in order to minimize the subject's distraction.

The subject's first lateral eye movement immediately following each question was recorded by the experimenter and the videotape. The two records were subsequently compared. The criterion for a subject to be included in the study was 75% of the lateral eye movements in one direction. Twenty subjects with lateral eye movements to the right

(right-movers) and 20 subjects with lateral eye movements to the left (left-movers) participated in the tachistoscopic and DVT experiments.

DVT pretest. The 40 subjects who satisfied the above requirements were further divided into four subgroups. Ten right-movers and ten left-movers were asked to give reports of what they heard during the DVT experiment from their right ear only and ten right-movers and ten left-movers were asked to report what they heard from the left ear only. The instructions were as follows:

> "Next, I would like you to listen to a tape. Make yourself comfortable and try to pay attention to what you hear in your left (right) ear only. As you begin to recognize some of the words, say them aloud. Every time you hear a change in the word say the word that you hear. Remember to say only the words that you hear in your left (right) ear, and report every change that you hear."

All subjects listened to the DVT tape for five minutes. Their responses were written down by the experimenter and recorded on a cassette recorder (Superscope C-104). The records were subsequently compared and their accuracy was verified by the subjects.

Tachistoscopic pretest. During this procedure each subject's 50% recognition threshold for the right and left visual field (RVF, LVF)

was determined. Each subject was asked to look through the tachistoscope viewer and focus on a dot in the middle of the screen. This dot was then replaced by a digit flashed at a very fast exposure time (20 msec), and the subject was requested to report what she saw. The exposure times were gradually increased with each new presentation until the subject could give five consecutive correct responses. From then on each digit was accompanied by one pretest word either to the left or to the right of the digit. The subject was encouraged to always focus on the digit in order to be able to report it accurately and then to give her impression of the word. Feedback regarding correct responses was given for the digits but not for the words. This procedure was used in order to ensure that the subject was always fixating at the central point. Since the exposure times were too brief to allow scanning to the left or right, the words could only be perceived by the peripheral vision, i.e., the left or right visual fields and thus be directed to only one hemisphere at a time.

Of the 20 pretest words, five pairs were assigned to the LVF and five to the RVF. The words were flashed randomly to the RVF or LVF, increasing the exposure time by 10 msec until 50% recognition threshold for each visual field was obtained.

Tachistoscopic experiment. After a short break (5 min), each subject participated in the tachistoscopic testing session during which the 20 experimental words were presented at the previously determined

50% recognition threshold. Each visual field was assigned five pairs of experimental words, i.e., ten words appeared to the left of the fixation point, five of these were neutral and five anxiety-producing words. The other ten words appeared to the right of the fixation point. Randomizing the order in which a word appeared in the LVF or RVF presumably decreased the subjects' chances of correctly predicting where the word would be and therefore encouraged them to focus at the fixation point in order to report the centrally situated digit correctly.

The subjects' responses were recorded by the experimenter and subsequently analyzed to see which and how many words were correctly reported for each visual field presentation.

DVT post-test. Following the unilateral tachistoscopic presentation of neutral and anxiety words, all subjects heard again the same DVT tape as during the pretest for another five minutes. The procedure was the same as for the DVT pretest.

CHAPTER III

RESULTS

The present study was designed to explore two phenomena. First, an attempt was made to demonstrate a perceptual defence and its relationship to lateral hemispheric differences. This was a partial replication of previous research by Jean and Reynolds (1974 & 1975). Specifically, fewer anxiety words were expected to be recognized in the left visual field of the female subjects who participated in this experiment. Second, a modified dichotic listening version of the verbal transformation task was used as a word association test to observe responses of subjects before and after the perceptual defence procedure (tachistoscopic presentation of anxiety and neutral words to the left or right visual fields at a 50% recognition threshold). The subjects in this study were divided into two groups on the basis of the direction of their lateral eye movements (right, left). This measure has been used in recent research as an index of hemisphericity, the implications of which have been discussed in the Introduction. The specific hypotheses and relevant findings pertaining to the two issues outlined above were as follows:

A. Perceptual defence (Tachistoscopic experiment)

It was hypothesized that subjects will demonstrate perceptual defence for words flashed into their left visual field (LVF) by recognizing significantly fewer anxiety than neutral words flashed to the LVF. No such effect was predicted for the RVF.

Furthermore, the two groups of subjects, the left-movers and the right-movers were expected to differ in the extent to which they would manifest perceptual defence. Specifically, the right-movers were expected to demonstrate less perceptual defence than the left-movers as indicated by a lesser decrement of their recognition of anxiety words in their LVF in comparison to neutral words recognition.

Table 1 shows the mean number of neutral and anxiety words recognized in the RVF and LVF by the right-movers and the left-movers.

TABLE 1

Simple inspection of Table 1 reveals that the largest differences between mean number of neutral and anxiety words recognized occurred in the LVF of the left-movers. The right-movers also recognized fewer anxiety than neutral words in their LVF but this difference is smaller than for the left-movers.

The statistical significance of the relationship between the direction of lateral eye movements, visual field and type of word was

TABLE 1

Mean Number of Tachistoscopic Experimental Words Recognized

Visual Field	Right		Left	
Type of Word	Neutral	Anxiety	Neutral	Anxiety
Group				
Right-movers	2.85	2.55	2.40	1.95
Left-movers	2.55	2.25	2.45	1.40

determined in a following way: subjects' responses in terms of anxiety and neutral words recognized in each visual field were subjected to 2 x 2 x 2 (eye movements x visual field x type of word) analysis of variance with repeated measures on the last two factors (Winer, 1971). The results of this analysis of variance are presented in Table 2.

TABLE 2

Significant results were obtained for all three main effects. The main effect for lateral eye movements was significant at .05 level and the main effects for visual fields and for anxiety versus neutral words were highly significant at .001 level each. A significant interaction for visual fields x type of words was obtained at .05 level.

The significant main effect for lateral eye movements means that the right-movers and the left-movers differed in their recognition of all words (i.e., both anxiety and neutral) when the scores for both visual fields (RVF and LVF) were combined. This relationship as illustrated in Table 3 shows that the right-movers tended to recognize more words than the left-movers.

TABLE 3

TABLE 2

Summary of Analysis of Variance

Source	df	MS	F
Between Subjects	39		
Eye-movers (M)	1	3.03	4.52*
Subj. w. Groups	38	0.67	
Within Subjects	120		
Visual fields (V)	1	8.00	16.00**
Type of Words (W)	1	11.03	24.51**
M x V	1	0.02	0.04
M x W	1	0.89	1.98
V x W	1	2.02	5.78*
M x V x W	1	0.91	2.60
V x Subj. w. Groups	38	0.50	
W x Subj. w. Groups	38	0.45	
VW x Subj. w. Groups	38	0.35	

* $p < .05$
** $p < .001$

TABLE 3

Total (Mean) Numbers of Words

Recognized in Both Visual Fields

Type of Word	Neutral		Anxiety		Total	
Group						
Right-movers	105	(2.63)	90	(2.25)	195	(2.44)
Left-movers	100	(2.50)	73	(1.83)	173	(2.17)
Total	205	(2.56)	163	(2.04)	368	

The significant main effect for visual fields means that the two visual fields differed in terms of numbers of words (both anxiety and neutral) recognized in the RVF and LVF when the scores for left-movers and right-movers were combined. Specifically, the RVF presentation yielded a higher number of all recognized words than the LVF. This finding is shown in Table 4.

TABLE 4

The significant main effect for anxiety and neutral words means that more neutral than anxiety words were recognized in both fields combined when the scores for the right-movers and the left-movers were combined. This can be seen also from Table 4.

The significant interaction between visual fields and type of words means that there was a difference in recognition of anxiety and neutral words related to which visual field was employed at that time. Table 4 shows this in general, and Figure 1 is a graphic representation of this relationship.

FIGURE 1

Four *t*-tests on simple effects were performed, in order to determine

TABLE 4

Total (Mean) Numbers of Words

Recognized by Both Groups of Subjects

Type of Word	Neutral	Anxiety	Total
Visual Field			
Right	108 (2.70)	96 (2.40)	204 (2.55)
Left	97 (2.43)	67 (1.68)	164 (2.05)
Total	205 (2.56)	163 (2.03)	368

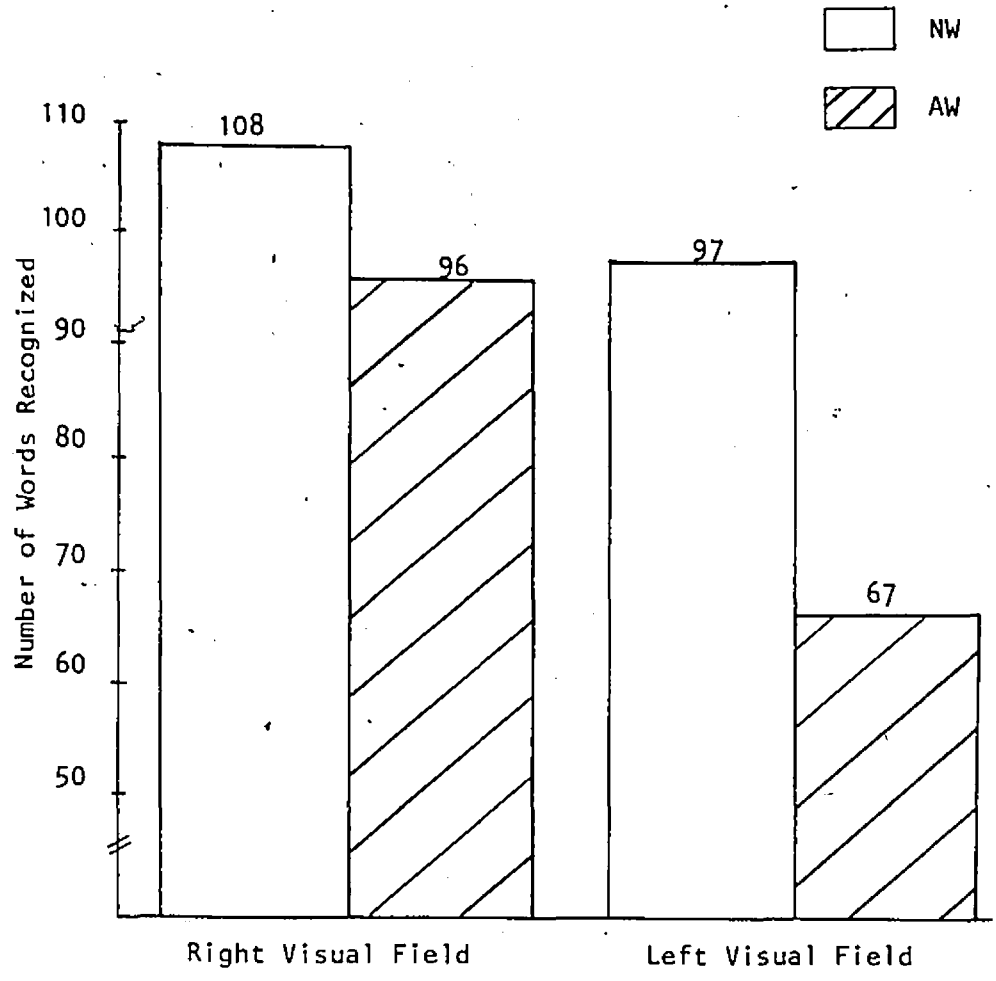

Figure 1. Total numbers of neutral (NW) and anxiety words (AW) recognized in the right and the left visual field with scores for the right-movers and the left-movers combined.

which of the comparisons contributed to the overall significant interaction effect. The following comparisons with scores for the left-movers and right-movers combined, were made:

1) LVF was compared with RVF for recognition of neutral words. $t = 1.33$ (n.s.)

2) LVF was compared with RVF for recognition of anxiety words. $t = 3.52$, significant at .001 level.

3) Neutral words and anxiety words were compared within the RVF. $t = 1.45$ (n.s.)

4) Neutral words and anxiety words were compared within the LVF. $t = 4.96$, significant at .001 level.

Therefore, the significant interaction effect between the visual fields and type of words can be attributed to these two observations: 1) the LVF presentation yielded significantly fewer recognitions of the anxiety words than the RVF, and 2) the LVF also yielded significantly fewer recognitions of anxiety than neutral words. This finding supports the main hypothesis of the tachistoscopic experiment as outlined above. Specifically, perceptual defence has been demonstrated for the anxiety words presented to the LVF.

The second hypothesis concerned the differences between the two groups of subjects, right-movers and left-movers, in their manifestation of perceptual defence. Figure 2 is a graphical representation of the findings. It can be seen that both groups showed a decrease in their recognition of anxiety words in their LVF, and that the left-movers

showed a greater decrease than the right-movers. This difference in recognition of anxiety and neutral words in the LVF was statistically significant only for the left-movers (t = 3.71, significant at .001 level). The comparison for the right-movers yielded a t = 1.59, which was not statistically significant.

FIGURE 2

In summary, the most important findings from the tachistoscopic experiment were that 1) the differential recognition of anxiety and neutral words is mediated by presentation to the LVF. Fewer anxiety than neutral words were recognized from LVF than from the RVF and fewer anxiety than neutral words were recognized from the LVF but not from the RVF. This supports the hypothesis that perceptual defence may in some way be related to the functions of the right hemisphere (LVF). 2) It was shown that while both the right-movers and the left-movers tend to recognize fewer anxiety than neutral words in their LVF, this difference was statistically significant only for the left-movers, indicating that they show perceptual defence to significantly greater degree than the right-movers. This then supports the second hypothesis of the tachistoscopic experiment.

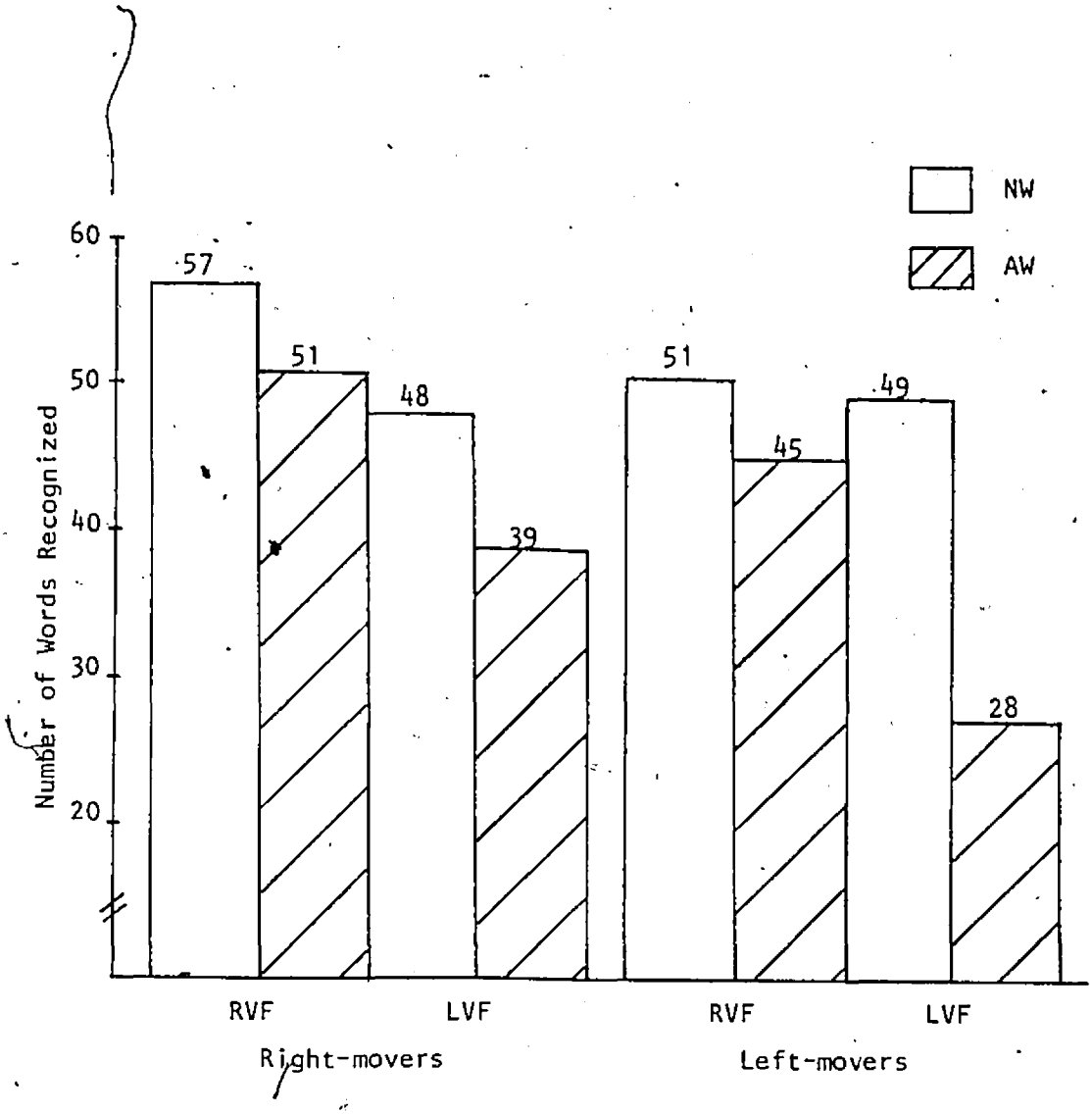

Figure 2. Total numbers of neutral (NW) and anxiety (AW) words recognized by the right-movers and the left-movers in their right (RVF) and left (LVF) visual fields.

B. Word association test (Dichotic listening experiment)

The main hypothesis in this part of the project was that the subjects' perception (report) of the verbal transformations in the dichotic listening experiment would undergo a change as a result of their exposure to the tachistoscopic procedure. In this context several predictions were made:

1) The tachistoscopic experimental words were not expected to be reported on the DVT pretest (i.e., prior to the tachistoscopic presentation) because they were selected on the basis of their low frequency of occurrence (less than 5%) in the reports of subjects who listened to a similar tape prior to this experiment.

Table 5 summarizes the total number of tachistoscopic experimental words that were heard before and after the tachistoscopic experiment by the two groups of subjects.

TABLE 5

Only two different words occurred in the reports of five subjects prior to the tachistoscopic experiment. Four subjects reported the word "trouble" and one subject reported the word "hazardous" on the DVT pretest.

2) It was predicted that any of the tachistoscopic experimental words that were recognized from either visual field would influence

TABLE 5

Total Number of Tachistoscopic Experimental Words Reported on the DVT Pretest and Post-test

Group	Right-movers	Left-movers	Total
Pretest	3	2	5
Post-test	15	10	25

the subsequent verbal transformations from either ear because these words acquired a bilateral representation following the subjects' verbalization of these words.

This did not occur. None of the experimental tachistoscopic words recognized and reported during the tachistoscopic experiment were subsequently reported on the DVT post-test. In fact, only the unrecognized anxiety words were reported by any subject. Table 6 shows a list of all tachistoscopic experimental (anxiety) words and their frequencies based on the subjects' DVT post-test report.

TABLE 6

This finding shows a significant difference in the DVT report on the post-test. Table 7 shows the number of subjects who reported tachistoscopic experimental words on DVT pretest and DVT post-test in the right-mover group and Table 8 shows the same data for the left-mover group.

TABLES 7 & 8

The respective chi-square values are 6.144 ($p < .02$) for the right-movers and 8.64 ($p < .01$) for the left-movers. These results lend support

TABLE 6

Tachistoscopic Anxiety Words and Number of Subjects Who Reported them on DVT Post-test

Tachistoscopic Words	Number of Subjects
AMPUTEE	8
TRAGIC	7
COWARD	3
TROUBLE	2
HATEFUL	1
CANCER	1
MURDER	1
TORMENT	1
HAZARD	1
ARREST	0

TABLE 7

Number of Right-movers Reporting Tachistoscopic Anxiety Words on DVT Pretest and Post-test

	Pretest	Post-test	Total
Yes	2	9	11
No	18	11	29
Total	20	20	40

Note. chi-square = 6.14; $p < .02$

TABLE 8

Number of Left-movers Reporting Tachistoscopic Anxiety Words on DVT Pretest and Post-test

	Pretest	Post-test	Total
Yes	3	12	15
No	17	8	25
Total	20	20	40

Note. chi-square = 8.64; $p < .01$

to the main hypothesis, namely, that the DVT report will undergo a change as a result of the subjects' exposure to the tachistoscopic experiment.

3) Predictions were made regarding the DVT post-test report such that this report was expected to be different for the left ear and the right ear as a function of lack of recognition of words presented to either the LVF or RVF. This did not materialize. The results summarized in Table 9 indicate that there appeared to be no obvious relationship between these two variables as they were studied here.

TABLE 9

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4) It was predicted that the right-movers and the left-movers would differ in their report of unrecognized anxiety words on the DVT post-test. A chi-square for the relevant data was .902 (n.s.). This means that the number of subjects reporting anxiety words on the DVT post-test was not significantly different in the two groups. However, a point biserial correlation testing the association of DVT post-test anxiety words and the tendency to recognize more neutral than anxiety words in the tachistoscopic experiment (difference scores were used here: n - a / n + a) differentiated the right- and left-movers to some extent. The t-test on the point biserial correlations for the right-movers approached significance at .05 level while it was significant at the .05

TABLE 9

Number of Tachistoscopic Anxiety Words Unrecognized in the LVF and RVF Subsequently Heard in the Left or Right Ear

Visual Field	Left	Right	Total
Ear			
Left	6	5	11
Right	8	4	12
Total	14	9	23

Note. chi-square = .35 (n.s.)

level for the left-movers. (t = 2.079 and t = 2.198, respectively).

In summary, the most important finding from the dichotic listening experiment was that there was a significant difference in the DVT report before and after the tachistoscopic experiment, which was directly related to the subjects' exposure to the tachistoscopic experiment, as was hypothesized.

C) Incidental findings

This section deals with findings which were not part of the experimental hypotheses but have certain relevance to some of the concepts dealt with in this project.

It was found that the right-movers and the left-movers differed in their report of verbal transformations on the DVT both before and after the tachistoscopic procedure in the following manner:

1) The right-movers reported in both instances a larger number of simple transformations (changes) than the left-movers. This difference was statistically significant (t = 2.416, $p < .02$) only for the right-ear report.

2) The right-movers reported in both instances a larger number of different forms than the left-movers. This difference was statistically significant also (t = 3.42, $p < .01$).

3) The right-ear report from the right-movers yielded a larger number of different forms than the left-ear report. (t = 2.98, $p < .01$). Similar effect was not found for the left-movers.

These findings are summarized in Table 10 and their implications will be considered in the Discussion.

TABLE 10

TABLE 10

Mean Numbers of All DVT Transformations Reported by the Right-movers and the Left-movers in their Right or Left Ear

I.	Simple Changes			
Group	Right-movers		Left-movers	
Ear-report	Right	Left	Right	Left
Pretest	31.80	26.50	23.20	21.00
Post-test	35.20	39.50	26.40	25.30
Total	33.50	28.50	24.80	23.15
II.	Different Forms			
Pretest	20.60	13.90	12.90	11.90
Post-test	22.80	14.80	13.50	12.70
Total	21.70	14.35	13.20	12.30

CHAPTER IV

DISCUSSION

In the present study, the phenomena of subliminal perception and perceptual defence were explored in the context of functional hemispheric asymmetry. The findings concerning the tachistoscopic experiment and the dichotic verbal transformation task will be discussed in turn.

The tachistoscopic experiment

The results obtained in this part of the study demonstrated a relationship between the type of words presented, the visual field which was employed and hemisphericity of the subjects. It was shown that the words flashed into the right visual field (RVF) were more easily recognized than the words flashed into the left visual field (LVF). This was predicted from and is consistent with findings from other tachistoscopic studies. (e.g., Mishkin & Forgays, 1952; McKeever, 1974). The rationale usually offered is as follows. The visual input (printed word) from the RVF is transmitted along direct anatomical pathways to the contralateral left hemisphere. In most right-handed individuals (and a majority of left-handers as well) the left hemisphere normally subserves all language related functions. Thus, it can directly process the visually presented words from the RVF and provide

the verbal output, which is the subjects' report of their recognition of the words. The visually presented words from the LVF, on the other hand, are transmitted directly to the right hemisphere. Although, number of recent studies (e.g., Levy & Trevarthen 1977) indicated that the right hemisphere might be capable of processing linguistic input, they have also pointed out that under normal circumstances, expressive language is subserved exclusively by the left hemisphere. Therefore, after the right hemisphere has processed some linguistic material, the outcome of this processing has to be transferred through the cerebral commissures to the left hemisphere if it is to be verbally expressed. It has been suggested that some information loss occurring during interhemispheric transfer is probably due to the interpolation of multiple synaptic connections and that this may account for the less efficient language performance when the verbal stimuli were presented to the right hemisphere (LVF). (Fudin & Masterson, 1976). This may become manifested in the subjects' usually requiring longer exposure times for words flashed to the LVF (than to the RVF) and in their recognizing fewer words from the LVF (than from the RVF).

The subjects' hemisphericity (i.e., their preferential reliance on the left or right hemisphere as indicated by the right or left direction of their lateral eye movements, respectively) was also observed to be related to their word recognition. The right-movers recognized significantly more words than the left-movers. This finding is consistent with studies of lateral eye movements reviewed

earlier, which showed that the right-movers tended to perform better than the left-movers on a variety of verbal tasks. This is supposedly related to the right-movers' greater reliance on the activity of the left (verbal) hemisphere in their problem-solving, while the left-movers utilize preferentially the right ('nonverbal') hemisphere's functions.

Perhaps the most interesting finding in the tachistoscopic experiment was that neutral words were recognized more easily than anxiety words presented in the same manner. This effect has been referred to as perceptual defence. It consists of subliminal discrimination of meaning of the neutral and anxiety words and a subsequent inhibition (as in the present study) or sensitization (e.g., Dixon, 1958 a) of recognition of the anxiety-producing stimuli.

Dixon (1971), in his extensive evaluation of studies pertaining to subliminal perception, proposed that physiological mechanisms exist that may underlie the phenomena of subliminal perception and perceptual defence. Based on his review he contended: "1) That the brain can make complex discriminations of incoming information even in states where awareness of the stimulus is precluded. 2) That, far from being a static limen, the awareness threshold is a variable function of complex physiological processes that are themselves determined by stimuli which may never achieve phenomenal representation. 3) That the neural system which mediates receipt of information may be anatomically and physiologically distinguished from that which provides for awareness of

incoming sense data, and that the former may continue to function, even when the latter fails to make its special contribution." (pp. 284-285). He concluded that "discrimination (by brain) without awareness (by the person)" is not only possible but would be predicted on the basis of contemporary neurophysiological data. Similar conclusion has been drawn more recently by Foster and Govier (1978) on the basis of their observations that unattended message in dichotic listening experiment was "processed to a level at which semantic information was extracted without the subject's reported awareness." (p. 289).

Jean and Reynolds (1974 & 1975) were the first to suggest a specific neurophysiological model as a basis for one specific instance of "discrimination without awareness". Using the example of perceptual defence for anxiety-producing words (as a case of "discrimination without awareness") they proposed that this effect may be related to functional hemispheric asymmetry and interhemispheric transfer of information. They hypothesized that for words flashed into the LVF, "the affective quality of the meaning would determine whether the word would be transferred across the corpus callossum (from the right, nonverbal hemisphere) to the dominant verbal hemisphere. If the word is non-threatening the transcallossal transference would occur, but if the word is threatening, this would be inhibited. Words flashed to the right visual field would have direct access to the language centers of the brain and could be verbalized immediately." (pp. 19-20). They also suggested that prior to the verbalization of words received

directly by the left hemisphere, there may be a sharing of information between the two hemispheres. This could trigger a process that may inhibit the verbalization of anxiety-arousing words presented directly to the left hemisphere. However, since this effect would have to be indirect (mediated through the right hemisphere) and would probalby be weakened or delayed (by the transcallosal transfers) the stronger tendency was expected to be for the word to be verbalized when it was presented to the RVF. The opposite tendency was expected to occur for words flashed to the LVF, since the inhibitory processes would be more direct than the process of verbalization which had to be facilitated by transcallosal transfer.

The results of their study (Jean & Reynolds, 1974), at least in the case of their female subjects, were consistent with their hypothesis. The tachistoscopic experiment of the present study was designed to replicate their findings, using a different set of stimuli and a different procedure in selecting subjects, as was explained earlier. It was found that not only were the neutral words more easily recognized than the anxiety words, but also that this effect was largely due to the fewer anxiety words recognized during the LVF (right hemisphere) presentation. This finding was similar to that reported by Jean and Reynolds. Thus, it lends further support to their hypothesis that at least in this case, perceptual defence as an example of "discrimination without awareness" may be an outcome of the interaction of factors involved in functional hemispheric asymmetries and interhemispheric

transfer of information.

Furthermore, it was also found that, altough both, the right-movers and the left-movers demonstrated some degree of perceptual defence, this effect was significant only for the left-movers. This finding is consistent with other studies which suggested that 1) the right hemisphere is more involved in processing of negative affect within the information than the left hemisphere (Davidson, Schwartz and Weinberger, 1977) and 2) the left-movers tended to utilize their right hemisphere more than the left hemisphere in their total psychological functioning. This was evidenced by their superior performance (when compared to the right-movers) on tasks which were related specifically to the right hemisphere functions, e.g., evaluation of spatial patterns (Tucker and Suib, 1978). Their right hemisphere was hypothesized to be generally more active. This higher level of activity may have produced a more efficient evaluation of affective meaning of the verbal stimuli presented directly to the right hemisphere (through LVF). Subsequently, more of the anxiety-arousing stimuli could be prevented from reaching the expressive language centers of the left hemisphere, because of greater degree of transcallosal inhibition generated by the right hemisphere.

Thus far, the results of the tachistoscopic experiment have been considered in the context of the current research on the neurophysiological substrates of behaviour. However, one important aspect of the experiment has been ignored. This was the aspect of the functional

significance of perceptual defence in a larger context of psychological functioning. In other words, what may be the purpose, if any, of perceptual defence?

As the term implies, perceptual defence was presumed to provide defence against the perception of something, e.g., threatening stimuli in the form of anxiety-producing words. The origins of the notion of defence against something threatening in the individual's envrionment lie in Freud's psychoanalytic theory, with its hypothetical processes of the unconscious. Freud believed that certain stimuli which were threatening to the conscious ego were not permitted to enter consciousness and instead were repressed and became part of the unconscious processes. Freud hypothesized that by a process which he called repression, the conscious processes were kept separate from the unconscious ones. He also suggested that the unconscious processes could influence the individual's conscious behaviour without his/her conscious awareness of them. There is a rather striking similarity between the hypothetical processes of the unconscious and repression as they were postulated by Freud and the phenomenon of perceptual defence ("discrimination without awareness" in the presence of threatening verbal stimuli). Both repression and the perceptual defence serve to protect the organism against threatening stimuli. It should be pointed out, however, that the process of repression had a much wider scope in Freud's psychoanalytic theory and was conceptualized as the basis of all psychological defences. Perhaps, perceptual defence can be viewed

as one specific instance of the more general process of repression. The conceptual proximity between perceptual defence and repression is paralleled by common observations in psychopathology, for example, in hysterical amnesias (forgetting of specific threatening events) or conversion reactions (bodily symptoms which symbolically express an unconscious conflict). These pathological states have one thing in common, namely, they are the outcome of defensive reactions to threatening stimuli of which the individual is not aware, because these stimuli have been repressed. Perceptual defence was also seen to be a "reaction" to threatening stimuli of which the individual was not aware.

Implicit in our discussion of perceptual defence and at least some forms of repression are the issues of language and the role it plays in our conscious experience. What is meant by "discrimination without awareness"? In the present tachistoscopic experiment, "discrimination without awareness" referred to the observation that the selective inhibition of recognition of anxiety-producing words occurred concomitantly with the subjects' lack of awareness of the meaning of these words as evidenced by their inability to report those words verbally. Therefore, it would appear, that at least in this particular case, the absence of the ability to verbalize knowledge of a stimulus was associated with the absence of conscious experience concerning such a stimulus. Similar findings were obtained in the studies (reviewed earlier) with split-brain patients, which showed that the inability to

verbalize a certain experience was associated with the apparent lack of awareness of such an experience.

The issues concerning the meaning of the concept of consciousness have been pondered by vast numbers of thinkers, including philosophers, anthropologists, and linguists as well as psychologists. Thus far, there is no definition of this concept that would be acceptable to all or even a majority of those who choose to ponder it. With this in mind, it is nevertheless, proposed that the findings of the present experiment along with the evidence from other similar studies, suggest that one plausible definition of conscious experience is the ability to verbalize knowledge about such an experience. Furthermore, when such verbalization is not possible, the individual appears to be essentially unaware (unconscious) of the particular experience.

This definition of consciousness as a function of language is not the invention of the present author. It has a long history in the writings of scholars and researchers. Perhaps, the most recent and explicit statement comes from Jaynes (1977), who proposed that "consciousness" originated as a metaphor or a verbal analog of our actual behaviour. It is not a "thing", a "repository" or a "function", it is an operation. Jaynes suggested that this operation was a by-product of language development and he placed its emergence in the history of humanity toward the end of the second millenium B.C. Consciousness viewed as an outcome of language development would therefore be imminently dependent upon language for its manifestation.

Since language functions have been shown to be subserved predominantly by the left hemisphere (in the great majority of individuals) it would seem that consciousness, manifested through language, would also be mediated by the left hemisphere. On the other hand, it has been recently suggested, that the right hemisphere, with its indirect access to expressive language output, may be the anatomical analog of the unconscious processes. (Galin, 1974; Bakan, 1976). Furthermore, it was proposed that the neuronal transmission across the cerebral commissures may play an important role in the facilitation and/or inhibition of thus isolated conscious and unconscious processes, as may be the case in some types of repression and perceptual defence. (Jean & Reynolds, 1974). In other words, the right hemisphere appears to be more adept in discriminating emotional aspects of stimuli and less adept at mediating expressive language than the left hemisphere. If consciousness is more a function of language, then the right hemisphere's nonverbal evaluation of affect may correspond to some hypothesized unconscious processes. When the right hemisphere evaluates a given input as potentially threatening, the commissural transfer of this input may be inhibited and prevented from reaching the expressive language centers of the left hemisphere. Such information will remain unverbalized, "stored" in the right hemisphere and will not reach the individual's conscious awareness. Nevertheless, it may indirectly influence the individual's overt behaviour.

A recent study illustrates the effects of these hypothesized

processes. Galin, Dimond and Braff (1977) noted that physical symptoms of the hysterical conversion reaction were reported to occur more frequently on the left side of the body than on the right (Ferenczi, 1926; Engel, 1970). Galin et al. confirmed the observations on their own sample of patients and hypothesized that this could be due to the right hemisphere's more direct control over the motor and sensory functions of the left side of the body as well as the right hemisphere's involvement in mediating unconscious processes.

Szasz (1974) referred to bodily symptoms as a "protolanguage" (primitive language) which served to carry nonverbal communications about conflicts which could not be expressed verbally (i.e., on the conscious level) because of their potentially threatening content. It is possible that the nonverbal "protolanguage" was mediated by the right hemisphere, and was used in conflict situations to indirectly obtain rewards (e.g., attention).

A similar concept in relation to schizophrenic states was developed by Sullivan (1962), who postulated three "modes" of experience (the prototaxic, the parataxic and the syntaxic modes) in the ontogenesis of personality. The prototaxic mode is the earlies and the most primitive mode, "which is ordinarily incapable of any formulation, and therefore of any discussion" (p. 87). In the parataxic mode, experience is differentiated into various unconnected aspects, while logical, symbolic organization of experience is achieved only in the syntaxic mode. Anything that an individual can communicate or talk about is either in

the parataxic or the syntaxic mode of experience. Sullivan (1962) suggested that severe anxieties experienced in childhood because of confusing interpersonal family relations led in some individuals to regression to the prototaxic mode which he claimed was most marked in schizophrenic states (cf. also Bateson et al., 1956, reviewed on p. 16).

It may be hypothesized, in the context of functional hemispheric asymmetries, that the ontogenetically earlier, nonverbal prototaxic mode could be associated with the functions of the right hemisphere, while the ontogenetically latter parataxic and syntaxic modes could be mediated by the left hemisphere. Perhaps, the regression to the nonverbal, primitive mode of experience is another manifestation of abnormal activity of the right hemisphere (Jaynes, 1977) and/or some abnormality in the interhemispheric transmission of neuronal impulses in the schizophrenic patients as has been proposed by Rosenthal and Bigelow (1972).

In summary, it has been suggested that the findings from the tachistoscopic experiment can be explained on the basis of current neurophysiological theories. There appear to be similarities between perceptual defence, its underlying neurophysiological processes and certain psychoanalytic concepts. It has been proposed that the perceptual defence may be an example of one form of repression, mediated by the inhibition of commissural transfer of verbal information from the right to the left hemisphere. The unrecognized

anxiety words flashed into the LVF could be said to have been "repressed"; their fate will be considered next.

The dichotic verbal transformation task

The results obtained in this part of the study demonstrated that subliminal stimuli (i.e., stimuli which were presented to but unrecognized by the subject) could influence the subject's subsequent behaviour. In a significant number of cases (21 out of 40) the verbal transformations reported by a subject after the tachistoscopic experiment (DVT post-test) were different from the verbal transformations reported by the same subject before the tachistoscopic experiment (DVT pretest). The DVT post-test reports incorporated only those tachistoscopically presented anxiety-producing words which the particular subject did not recognized during the tachistoscopic presentation. This finding is similar to the so-called Poetzl effect (Poetzl, 1917). In studying the effects of subliminal stimuli upon subsequent dream experiences, he observed "that non-consciously perceived stimuli became 'released' into consciousness only at some period subsequent to their presentation" (Dixon, 1971; p. 105). A large number of studies since Poetzl's original research have succeeded in replicating his observations and extending them to include a wider range of stimulus and report conditions. (e.g., Shevrin and Fisher, 1967; Shevrin and Luborsky, 1958; Silverman and Silverman, 1964).

The initial stage of the Poetzl phenomenon is essentially "discrimination without awareness". Therefore, the same neurophysiological mechanisms could be postulated as those outlined earlier. The subsequent stage, that of recovery, requires a new assumption, namely, that there be some mechanisms through which the unrecognized information could persist over time to produce subsequent effects on behaviour. Several studies have provided evidence that it is highly probable that such a mechanism does exist. For example, Doerries and Harcum (1967) studied the effects of repeated subliminal presentations of the same tachistoscopic material on the recognition threshold. They found that the recognition threshold decreased as a function of the number of prior subliminal presentations of the same stimulus. On the basis of their findings they hypothesized that "such a mechanism might be a network of reverberatory circuits activated by the initial presentation of a stimulus, still continuing in the organism at the time of the second presentation. Perhaps cell assemblies are still being subliminally activated by an after discharge which facilitates recognition of the word on the second presentation". (p. 33). Such network of reverberatory circuits of cell assemblies may be the mechanism which would allow the subliminally presented information to be stored in some short-term memory process and retained there for subsequent processing.

In traditional studies of the Poetzl effect, the dependent variable has been a dream report or free-associations. Under such

conditions the effects found were always in the form of symbolic elaborations of the meaning of the original stimulus, accompanied by gross distortions of its structural characteristics. These distortions and symbolic elaborations were expected from and consistent with the psychoanalytic interpretation of the Poetzl effect and were specifically related to Freud's theory of dreams. Within this framework, the potentially disturbing stimuli are subject to symbolic transformation before emerging in the subsequent dream, in order to prevent their threatening aspects from entering consciousness. Recently, Bakan (1978) pointed out certain similarities between dream and right hemisphere mentation. He contended that evidence from various researches on dreaming, REM sleep, the effects of brain damage, epilepsy (originating from the right hemisphere) and certain aspects of schizophrenia would appear to support "a hypothesized relationship between REM/dream sleep and functional activation of the right hemisphere system". (p. 286). It is plausible that the elaborations and distortions obtained in the dream studies of the Poetzl effect were mediated by the activity of the right hemisphere.

In the present study, however, the basic structural characteristics of the original stimulus word were preserved in the absence of symbolic elaborations. This could be probably attributed to the different type of dependent measure used. While, in the previous studies, the dependent measure was an unstructured dream report or free-associations, in the present experiment, the dichotic verbal

transformation task was used to elicit the response. The DVT has some characteristics of free-associations, in that it tends to elicit some rather idiosyncratic responses. On the other hand, it does have a built-in phonetic structure, which imposes some limits on the formal aspects of the reported words. As has been pointed out earlier, the tachistoscopic experimental words were deliberately selected from a large number of words previously reported by subjects who listened to a similar DVT tape in a pilot study. This was done to facilitate the recovery of the unrecognized tachistoscopically presented words during the DVT post-test. Although, these words occurred very infrequently in the reports of subjects in the pilot study (less than 5%) and were also reported only by four out of 40 subjects during the DVT pretest in the present experiment, their emergence on the DVT post-test did seem to be facilitated by their structural proximity with the repeated stimulus word used on the DVT tape. This would seem to suggest that perhaps the DVT may be a direct measure of the effects of subliminal stimuli on subsequent behaviour. As has been suggested by Warren (1961), the potential of the verbal transformation task as a projective technique is yet to be explored experimentally. He noted that his "subjects seem to feel that they are not revealing anything within themselves by their responses, but simply reporting the sometimes foolish things the voice is saying. The individual responses sometimes exhibit a rather violent sexuality with close associations in meaning and considerable distortion in speech sounds." (p. 256).

Earlier, Skinner (1936) developed a device which he called the "tautophone" or "verbal summator". This consisted of a phonograph recording of series of vowel sounds heard indistinctly and repeated over and over. When subjects listened to the recordings they were able to organize the vague sounds into speech. Skinner (1936) used this method to study latent speech. Subsequently, Shakow and Rosenzweig (1940) attempted to use the tautophone as an auditory apperceptive test for the study of personality. However, this method limited the scope of possible responses, because the recording was stopped as soon as the subject formulated the first speech sound.

It has been proposed initially that the effects of the subliminal stimuli would be studied in the context of hemispheric asymmetry. For that purpose, a dichotic listening task was selected because of its lateralizing characteristics described in many studies, reviewed previously. It was expected that such a procedure might elicit verbal output to match the lateralized visual inputs. The results, however, did not allow any generalizations concerning such complex cross-modal lateralizations. In other words, the verbal transformations reported from the left ear and the right ear reflected previously unrecognized words tachistoscopically presented to either the RVF or the LVF. It may be that in normal subjects such complex cross-modal lateralizations cannot be studied by the present method simply because the auditory pathways are not as completely lateralized as is the case with the visual pathways. Therefore, the lateralization within the auditory

system my be reflected in certain ear advantages for specific inputs, but such ear advantages may not be sufficiently sensitive to the strict lateralization demands postulated in the present experiment.

That this may be the case is also suggested by some additional results obtained from the DVT experiment. Specifically, it was observed that there were differences in the numbers of verbal transformations (irrelevant by content to the tachistoscopic experiment) both on the DVT pretest and the post-test that were related to the ear of report and the hemisphericity of the subject. Two types of scores were looked at. One was the number of simple changes, that is, the number of times that a change in the stimulus was observed. The other was the number of different new forms reported. Figure 3 summarizes these results for the DVT pretest and post-test scores combined.

FIGURE 3

The right-movers reported the largest number of different forms heard in their right ear. This number was significantly higher than the number of forms reported by the right-movers from the left ear, as well as the number of forms reported by the left-movers from either ear. The highest number of simple changes was again reported by the right-movers from the right ear but it was significantly different only from the reports of the left-movers from either ear. These findings

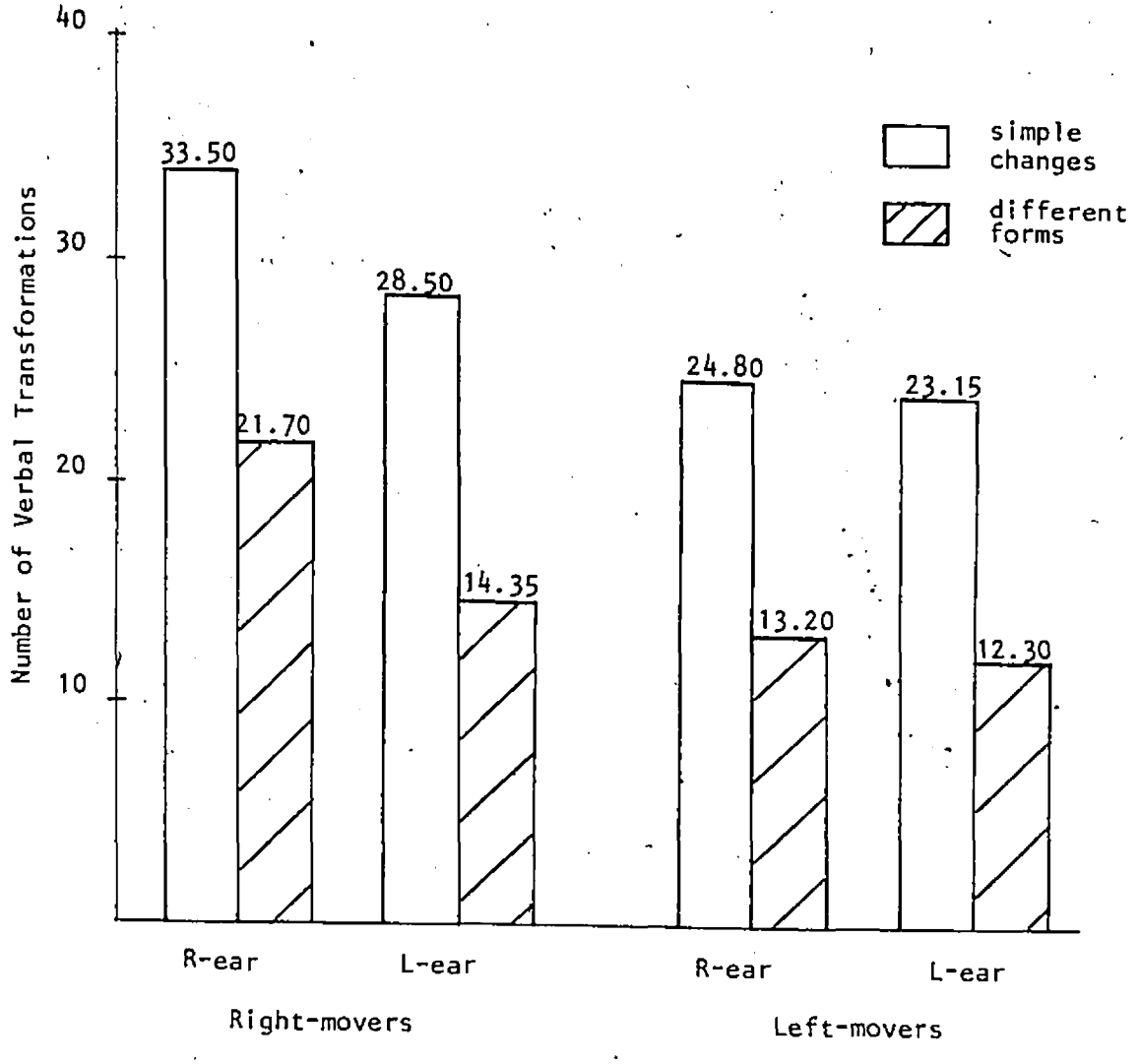

Figure 3. Mean numbers of dichotic verbal transformations (simple changes and different forms) heard by the right-movers and the left-movers from the right and left ear inputs.

suggest that the dichotic listening task used here did reflect simple ear advantages for verbal stimuli, as would be predicted from other dichotic listening studies, but this effect was observed only for the right-movers. As can be seen from Figure 3, the differences were largely due to the higher number of changes and forms reported by the right-movers from their right-ear input. This is consistent with the results of a recent study by Nielsen and Sørensen (1976). Thus it would appear that the right-ear advantage for verbal input was primarily due to the presumed higher activity of the left hemisphere in the right-movers. It may also mean that in the left-movers (with the right hemisphere usually more active) the higher neural activity of the left hemisphere induced by this verbal task did not reach quite the level needed to produce the ear-advantage effect. This may be also another reason why in the present design there was no lateralized effect obtained on the DVT post-test report of the anxiety-producing stimuli from the left and right ear comparable to the lateralized tachistoscopic input effect. This former effect depended greatly on the reports of the left-movers who recognized the fewest anxiety words flashed to their LVF (right hemisphere). Since they demonstrated virtually no ear-advantage for verbal input, the lateralizing value of the dichotic procedure as it was used here is rather questionable. The right-movers, on the other hand, did not demonstrate a significant difference in their recognition of anxiety words tachistoscopically presented to the RVF

and LVF. Therefore, no lateralized report on the DVT post-test of the previously unrecognized words would have been expected, in spite of their (the right-movers') demonstrated right-ear advantage for verbal stimuli.

In summary, the issues concerning perceptual defence and the effects of subliminal stimuli on subsequent behaviour were discussed in the context of functional hemispheric asymmetries, interhemispheric transfer and hemisphericity. It was suggested that the findings of the present study were consistent with and can be explained by current neurophysiological theories. The implications of the findings for the hypothetical processes of repression and the unconscious were also considered.

APPENDIX A

List of Tachistoscopic Experimental Words

NEUTRAL	ANXIETY
Apricot	Amputee
Assign	Arrest
Castle	Coward
Colony	Cancer
Handbag	Hateful
Hidden	Hazard
Memory	Murder
Talking	Trouble
Talent	Tragic
Trilogy	Torment

APPENDIX B

A List of Proverbs for the Assessment of Lateral Eye Movement[1]

1. A rolling stone gathers no moss.
2. The hardest work is to idle.
3. In the mirror, everyone sees his best friend.
4. A watched pot never boils.
5. Better a good enemy than a bad friend.
6. If you can't bite don't show your teeth.
7. Poor worker blames his tools.
8. He that lies on the ground cannot fall.
9. Better a bad peace than a good war.
10. What saddens a wise man gladdens a fool.
11. They that are mute want to talk the most.
12. Words should be weighed and not counted.

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[1] from Bakan and Strayer; 1973.

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