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Relative Hemispheric Involvement During Arousal and Inhibition of Affect

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RELATIVE HEMISPHERIC INVOLVEMENT DURING AROUSAL AND INHIBITION OF AFFECT

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ABSTRACT

The predominant view of hemispheric contributions to emotionality focuses upon the inherent emotionality of the right hemisphere, in contrast to the logical, rational, nonemotional characteristics of the left hemisphere. However, recent research has also implicated contributions of the left hemisphere during affective arousal (d'Elia & Perris, 1973, 1974; Ehrlichman & Wiener, Notes 10, 11; Harman & Ray, 1977; Tucker, Antes, Stenslie & Barnhardt, 1978; Tucker, Roth & Shearer, Note 7). Some reports have implicated the left hemisphere in negative affect (Ehrlichman & Wiener, Notes 10, 11; Harman & Ray, 1977), and the right hemisphere in positive affect (Ehrlichman & Wiener, Notes 10, 11). Others have suggested interactional conceptualizations of hemispheric contributions to emotionality (e.g., Bakan, Note 5; Galin, 1974, 1977; Tucker, Note 12), for which tentative empirical support has been reported (Tucker, Antes, Stenslie & Barnhardt, 1978; Tucker, Roth & Shearer, Note 7). From an interactional viewpoint, a given hemisphere is neither inherently rational or emotional, nor inherently positive or negative: subjective emotion is a result of the interaction between the primitive, spontaneous right hemisphere and the inhibiting, constricting left hemisphere.

The present study sought to lend direction to further theorizing about the role of the cerebral hemispheres in emotionality through varying both the positive vs. negative dimension of the affective state, and the inhibitory vs. facilitative orientation with which the individual approaches affective arousal. Sexual arousal and aversive arousal were chosen as prototypic examples of affective arousal with positive and negative valences, respectively. Prescreened sexual and aversive slides were shown individually to 48 Introductory Psychology students (24 males, 24 females), under instructions to either facilitate or inhibit arousal. During each of the four counterbalanced, within-subjects conditions (i.e., positive-inhibit, positive-facilitate, negative-inhibit, negative-facilitate), relative hemispheric activation was assessed via an index of auditory attentional bias (Kinsbourne, 1970; Tucker, Antes, Stenslie & Barnhardt, 1978).

No direct indication of differential hemispheric involvement, as evidenced by mean attentional bias across conditions, was observed for the grouped data; a slight right bias was evident across conditions. Prediction of attentional bias using subject involvement ratings suggested that both success in generating aversive arousal and lack of success in inhibiting aversive arousal were accompanied by relatively greater right hemisphere involvement. However, greater right hemisphere activation was characterized by less physical arousal, thus emphasizing the heterogeneous nature of aversive arousal. Trait Anxiety Inventory, Sex-Guilt Inventory, and Stroop Color-Word Test scores were not effective predictors of attentional bias.

Under instructions to facilitate arousal, subjects tended to report cognition characterized by imagery, global perception of the slides, and absence of internal verbal dialogue. Under instructions to inhibit arousal, subjects tended to report cognition characterized by internal verbal dialogue, analytic perception of the slides, and absence of imagery. Parallels were drawn between the differential cognitive strategies reported by subjects across the facilitation vs. inhibition dimension, and the differential processing characteristics of the cerebral hemispheres. These categorical data suggest relatively greater right hemisphere involvement during facilitation of arousal and relatively greater left hemisphere involvement during inhibition of arousal, across both positive and negative affect. This result was not corroborated by attentional bias data; possible difficulties with the attentional bias paradigm are discussed.

The attentional bias data do not support earlier reports that the left hemisphere is characterized by negative affect (Ehrlichman & Wiener, Notes 10, 11; Harman & Ray, 1977), while the right hemisphere is characterized by positive affect (Ehrlichman & Wiener, Notes 10, 11). In the present study, the facilitation of aversive arousal was characterized by less left and more right hemispheric involvement, while the results for sexual arousal were insignificant. Categorical analyses of subjects' descriptions of their experience provide tentative support for a model of hemispheric contributions to emotionality which focuses upon the interaction between an inhibiting, constricting left hemisphere and a primitive, spontaneous right hemisphere. Implications for future research, psychopathology, and psychotherapy are discussed.

CHAPTER I

INTRODUCTION AND REVIEW OF THE LITERATURE

Introduction

The search for more adequate understanding of behavior inevitably leads scientists to the study of the nervous system generally, and more specifically in the case of "higher order" human behaviors, to the cerebral cortex. The study of brain function has oscillated from an extreme focus on widespread localization of function espoused by the pseudoscience of phrenology during the early 19th century, to the reactionary extreme focus on unitary brain function proposed by Flourens in the mid-1800's. Current views on localization of cortical function, which fall somewhere between these extremes, as well as current interest in hemispheric lateralization of functions, are both indebted to Broca's discovery of a dominant hemisphere speech center in 1861.

Progress in localizing cortical functions was furthered by the extensive research of Karl Lashley (e.g., 1950) on the effects of brain lesions on problem solving, learning, and perceptual discrimination. Goldstein's (1939) emphasis upon the unitary quality of the organism discouraged interest in localization until Penfield and his colleagues revived and refined methods of electrical stimulation of the brain. Penfield (1958) "mapped" the cerebral cortex's motor, sensory, and association areas according to subjects' verbal reports and motoric behavior in response to weak electrical stimulation applied directly to the cortex.

Taken as a whole, research on cortical localization of behavior yields the generalization that a high degree of localization can be demonstrated for more specific functions such as simple sensory and motor responses. However, less specific or higher order behaviors manifest less apparent localization. The degree and quality of localized brain function in more complex, characteristically human behaviors remains largely a matter of speculation.

During the past decade, interest in the cortical localization of function has focused most intently upon the differential specialization of the brain's cerebral hemispheres. The apparent impetus for recent interest in the possible functional differences between the hemispheres was the work of Sperry, Bogen, Gazzangia and their various colleagues at California Institute of Technology (Gazzangia, 1967; Nebes, 1974). During the 1960's, the Cal Tech group produced an impressive array of studies on commissurotomy patients (i.e., individuals in whom the corpus callosum, and other commissures connecting the halves of the cerebral cortex, were cut in an attempt to manage severe epileptic seizures). From this interesting conglomeration of studies and anecdotes, two startling observations emerged which were to ignite a flurry of interest in hemispheric specialization: (a) the two hemispheres of the human brain are specialized for different cognitive functions--the nondominant hemisphere is not merely an insignificant spare part; and (b) when the cerebral hemispheres are separated by commissurotomy, each hemisphere seems to be capable of maintaining autonomous consciousness as if there were two separate brains in the craniums of such individuals and, by extrapolation, of intact individuals. Although similar ideas had been proposed previously by others (see Galin, 1977), the graphic anecdotes and films produced by the Cal Tech group managed to better capture the attention of scientists and the laity alike.

The developing laterality Zeitgeist was accompanied by a burgeoning mass of research on the lateralization of cognitive and perceptual functions (see reviews by Dimond, 1972; and Harnad, Doty, Goldstein, Jaynes & Krauthamer, 1977). Without reviewing such research in detail, several generalizations seem especially salient in describing hemispheric specialization among right-handed individuals in whom the left hemisphere is dominant for language functions.[1] The left hemisphere is more adept in language and arithmetic operations, supposedly due to its characteristic articulate, analytic, and sequential/linear manner of processing information. In contrast, the right hemisphere is more adept in nonverbal, spatial and musical tasks, supposedly due to its characteristic global, holistic and simultaneous/nonlinear manner of processing information. In the left hemisphere, data are organized according to principles of conceptual similarity, whereas in the right hemisphere data are organized according to their structural similarity. In other words, apples and oranges are alike for the left hemisphere

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[1]All of the material presented in this study refers to right-handed individuals in whom the left hemisphere is dominant for language. Lateralization among left-handed individuals is not characterized by the same consistency, and thus, they are typically omitted from research in this area. For more information on lateralization among left-handers, see Hécaen and Ajuriaguerra (1964).

because they are fruit, but for the right hemisphere they are alike because they are round (Lezak, 1976).

Research on differential processing within the cerebral hemispheres supports a conceptual model of the duality of brain functions in which left hemisphere thinking is characterized by reason, logic, science-mindedness, or no-nonsense attention to details; right hemisphere thinking is characterized by intuition, nonverbal perceptiveness, inspirational hunches, or uncritical imagination (Lezak, 1976). However, more ambitious individuals (e.g., McLuhan, as cited in Goleman, 1977) unencumbered by empiricism, have gone well beyond the data, proclaiming in the popular literature that the long-neglected right hemisphere and its capabilities are somehow the key to our individual and collective futures. Right hemispheric thinking has been touted as a virtue akin to self-actualization, spiritual serenity or nirvana, whereas the logical, analytic left hemisphere has been condemned as the bane of our technological society. At the opposite end of the spectrum, more cynical individuals have declared that much of the hemispheric research is the result of dichotomanic, academic hucksters (e.g., Gardner, 1978; Goleman, 1977).

Theoretical Accounts of Hemispheric Lateralization

As a myriad of investigators sought to delineate the cognitive and perceptual differences between the hemispheres and brain function evangelists sought to take the message to the people, theoreticians sought to account for lateralization in structural, evolutionary, and nature/nurture terms. Semmes (1968) proposed that differences in hemispheric function could be plausibly explained through examination of the neuroanatomical differences between the two halves of the brain. She suggested that the specialization of the left hemisphere for speech and finely articulated sensory-motor function of the contralateral, dominant hand is a result of the convergence of input from lower-level units of a particular function to a discreet location in the left cortex. Conversely, Semmes suggested that the right hemisphere's superior capability in Gestalt/synthetic processing is due to its diffuse neuroanatomical organization which allows input from a variety of modalities. Thus, the left hemisphere sacrifices a "complete picture" for finely modulated control within a single modality while the right hemisphere sacrifices such control for an ability to synthesize all sensory input into an overall impression or gestalt. There have been more recent attempts to delineate structural differences between the hemispheres (Galaburda, LeMay, Kemper, & Geschwind, 1978; Reubens, 1977), but the relationship of structural asymmetries to functional asymmetries remains a matter of conjecture.

Levy (1969) assumed an evolutionary stance in her theorizing about hemispheric specialization. She suggested that specific lateralization of language in the left hemisphere may be a functional adaptation permitting control of the vocal apparatus uncomplicated by competition between the hemispheres for the motor mechanisms of language expression. Similarly, Levy speculates that during human evolution, holistic, gestalt-type processing may have been lateralized to the "mute" right hemisphere as a consequence of antagonism between perceptual and language functions.

Corballis and Morgan (Note 1) emphasize the importance of a maturational left-right gradient which favors earlier or more rapid development on the left. They also suggest that the "leading" side--typically the left--normally exerts an inhibitory influence on the "lagging" side. Thus, as in Levy's thinking, right hemisphere specialization is thought to occur by default since the leading, inhibiting left hemisphere is consumed by speech and complex motor tasks. These authors also discuss possible genetic mechanisms for the inheritance of a maturational gradient in light of environmental influences (Morgan & Corballis, Note 2).

Subcortical versus Hemispheric Contributions to Emotionality

Several lines of research converge in implicating the importance of the limbic system (Papez, 1937) in emotional arousal. For example, removal of the amygdalas and other portions of the limbic systems of rhesus monkeys results in extreme placidity, even towards attacking animals, and hypersexuality (Isaacson, 1974). Electrical stimulation of limbic system structures can produce "sham rage," whereas stimulation applied to apparent inhibitory centers can terminate the rage (Delgado, 1970).

Sham rage can also be observed among decorticate animals in response to very slight frustration or provocation. Such affective behavior is an integrated expression of rage, but lacks the awareness and persistence characteristic of normal emotion. Since such rage reactions are easily released among decorticate animals, it appears that cortical processes must normally inhibit the expression of rage.

However, if the connections between the hypothalmus and the lower neural system are severed, only fragmented, uncoordinated emotional expression is possible. Thus, it seems that the hypothalmus and other portions of the limbic system are essential for the integration and coordination of emotional expression, while the cerebral cortex may inhibit, direct, or color affective expression.

There is also evidence suggesting a subcortical basis for differential qualities of subjective emotions. James Olds and his co-workers have demonstrated that electrical stimulation of the septal area of the limbic system can be a more potent reinforcer for animals than food (e.g., Olds & Milner, 1954). Similarly, humans stimulated in approximately the same subcortical regions report subjective pleasure. In contrast, Neal Miller and his co-workers have demonstrated that more medial electrical stimulation is highly aversive and that animals will learn avoidance responses in order to evade such stimulation (e.g., Miller, 1960). Thus, the data reported by Olds and Miller suggest a neural substrate for pleasant and aversive subjective emotional arousal. This subcortical system has reverberating interconnections with the cerebral cortex (i.e., "circuit of Papez") which enable thought to affect emotional expression and vice versa.

Whereas earlier efforts to understand brain function and emotionality had largely focused upon the division between the "rational" higher neural components and the primitive "emotional" lower neural components, recent efforts have focused upon possible differential hemispheric contributions to emotion. Although the limbic system is of crucial importance to emotion, the present study was focused upon the contributions of the cerebral hemispheres to the expression of emotion. More specifically, the present study was an investigation of possible differential hemispheric involvement during positive and negative affect and during the arousal and inhibition of emotion.

Compared to the abundance of data on asymmetries of cognitive and perceptual functions, there has been a relative dearth of research on hemispheric lateralization and emotionality. Most of the research concerning possible differential contributions of the hemispheres to emotions has been done in the past five years. Results in this novel area tend to be inconsistent, if not blatantly paradoxical, and difficult to replicate. For the present study, the results of research in three general areas relevant to laterality and emotionality will be briefly reviewed: (a) studies of individuals with brain lesions, (b) studies of individuals with functional disorders, and (c) studies of intact individuals.

Studies of Individuals with Brain Lesions

Perhaps the earliest indication that hemispheric laterality was implicated in emotionality was Goldstein's (1939) observation that patients with left hemisphere lesions manifested "depressive-catastrophic reactions" in response to stress. Conversely, Denny-Brown, Meyer and Horenstein (1952) reported a case study in which they described a patient with right hemisphere damage who manifested an "indifference reaction" quite similar to the classic "la belle indifference" often observed in hysteric conversion disorders.

More recent studies have reported replicative yet equivocal results regarding the affective reactions of unilaterally-lesioned patients. Hécaen (1962) reported that specific catastrophic reaction to failure occurred significantly more among left-damaged patients and that an indifference reaction to failure occurred significantly more among right-damaged patients. However, the significantly greater confusional disturbances and gross size of lesion among right-damaged patients confounds interpretation in terms of lateralization.

Gainotti (1969, 1972) also reported significantly higher incidence of catastrophic reaction categories (e.g., anxiety, tears, refusals) among left-damaged patients and significantly higher incidence of indifference reaction categories (e.g., indifference, jokes, minimization or denial of deficit) among right-damaged patients. Depressive categories (e.g., discouragement, declarations of incapacity) did <u>not</u> differentiate the two groups. Gainotti (1972) speculated that the left, verbal hemisphere should be considered more important from the "intellectual" point of view, and the right, nonverbal hemisphere as more important from the "emotional" point of view.

Other studies have reported that right-damaged individuals manifest significantly greater indifference and auditory affective agnosia, i.e., inability to recognize affective tone (Heilman, Scholes & Watson, 1975; Tucker, Watson & Heilman, 1976), inability to produce affectively toned speech (Tucker et al., 1976), and inability to recall affectively toned material (Wechsler, 1973). Psychometric studies have reported significantly greater MMPI elevations on scale <u>D</u> (Gasparrini, Satz, Heilman & Coolidge, Note 3), and scales <u>D</u>, <u>Hs</u>, and <u>Sc</u> (Black, 1975) among nonaphasic individuals with left hemisphere lesions. However, negative or equivocal results have also been reported (Dikman & Reitan, 1974, 1977; Vogel, 1962). Another psychometric study suggests that individuals with left temporal epileptic foci are prone to depressive-catastrophic reaction, whereas those with right temporal lobe foci manifest a propensity for greater denial (Bear & Fedio, 1977).

Interpretation of the various unilateral brain damage studies has typically focused on the "obvious" implication that damage to one of the cerebral hemispheres will diminish the functioning of that hemisphere and, thus, result in a relative dominance of the other hemisphere. In other words, from the depressive-catastrophic reactions of left-lesioned patients, we could infer that the right hemisphere tends toward emotionality or, more specifically, negative affect. However, an often neglected article by Hall, Hall and Lavoie (1968) suggests otherwise. Right- and left-lesioned groups were clearly differentiated using discriminant analysis of eight Rorschach variables. The results suggest that the two groups manifest very different cognitive styles: left-damaged patients were found to be constricted and inhibited in their ideation and very much aware of their deficit, whereas right-damaged patients were found to be expansive and unconstrained in their ideation and either unaware or unconcerned about their deficit ("anosognosia"). Hall, Hall and Lavoie interpreted their findings as indicative of an exaggeration, rather than a decrement, in the damaged hemisphere's normal contribution to the individual's functioning. Such an exaggeration interpretation may be applicable to the results of other brain lesion studies. Since the cognitive style of the Hall et al. left-damaged patients approximates depressive ideation familiar to clinicians, perhaps the depressive-catastrophic reaction often reported following left hemisphere insult may reflect an exaggeration of usual left hemisphere functioning. Such conjecture awaits empirical verification.

Other early data on possible lateralization of emotionality were largely serendipitous results of an innovation called the Wada technique (Wada & Rasmussen, 1960), used to determine lateralization of speech prior to brain surgery. The Wada technique involves the injection of a barbiturate (sodium amytal) into one of the carotid arteries. This procedure produces brief impairment of the ipsalateral hemisphere, and thus, total contralateral hemiplegia--including speech if the intracarotid injection is on the dominant side. Terzian (1964) and Rossi and Rosadini (1967) reported that when the injection was made into the left carotid artery, a depressive-catastrophic reaction followed, whereas a euphoric, sometimes nearly manic, reaction typically occurred following right carotid injections. Thus, observations of patients' behavior during use of the Wada technique tend to support the findings of the brain lesion research. However, caution is necessary in interpreting these results both since Milner (1967) has attributed all the emotional effects of pharmacological inactivation of one hemisphere to personality predisposition, and since patients who undergo this procedure are candidates for brain surgery. There are, of course, certain dangers in all generalizations about lateralization and emotionality which are based on studies of individuals with brain lesions. As Reitan (1964) has noted, the validity of such research and subsequent speculation is always very tenuous since the independent variables were created by "accidents of nature."

Studies of Individuals with Functional Disorders

As with brain-lesioned patients, generalization about brain function from studies of psychiatric patients may necessarily be misleading since a variety of unknown variables may be present among such groups. However, the results of such studies, particularly those focused on depression and conversion disorders, may provide further direction in understanding the contributions of the cerebral hemispheres to subcortical emotionality among intact, "normal" individuals.

d'Elia and Perris (1973, 1974) utilized electroencephalographic (EEG) integration techniques to study relative hemispheric activation among two samples of psychotically depressed patients. Their results suggest greater involvement of the left hemisphere during depression, with left hemisphere involvement roughly proportional to degree of depression. The d'Elia and Perris data also suggest a possible shift toward greater right hemisphere involvement following electroconvulsive therapy (ECT) or Indoklon therapy. Perris (1974) presented EEG evoked response data which also demonstrated left hemisphere involvement during depression and a contralateral shift after administration of antidepressant medications.

The findings reported by d'Elia and Perris have not been corroborated by several other studies. Involvement of the left hemisphere in depression was not supported by a similar EEG study (Marjerrison, James & Reichert, 1975). Flor-Henry (1976) and Yozawitz and Bruder

(Note 4) have reported right hemisphere performance decrements among patients with affective disorders. Other data suggest a left temporal focus in the inhibited and schizoaffective forms of depression and a right temporal lobe focus in agitated depression (Chiofalo, Dorr & Biedermann, 1977). Furthermore, several studies suggest that ECT is more efficacious when applied unilaterally to the right hemisphere (Galin, 1974), but indeed, this finding is also not without exceptions (Reichert, Benjamin, Keegan & Marjerrison, 1976).

Vogel and his colleagues have reported that by depriving depressed individuals of REM sleep, the occurrence of which is accompanied by greater right hemisphere activation (Bakan, Note 5), the symptoms of depression can be reduced (Vogel, Thompson, Thurmond & Rivers, 1973; Vogel, Thurmond, Gibbons, Sloan, Boyd & Walker, 1975). These authors have suggested that the active ingredient of their regimen was "REM pressure," rather than mere deprivation, and that this phenomenon held for endogenous rather than reactive depression. They also noted that a variety of antidepressants disrupt REM sleep. Thus, perhaps coerced activation of right hemisphere activity may reduce depression, possibly accompanying left hemisphere overactivity. Burtle (Note 6) has provided support for this hypothesis by demonstrating that specific imagery training (i.e., coerced right hemisphere activity) was related to reduced depressive symptomatology.

Galin (1974) theorized that some unconscious processes could be mediated by the right hemisphere, independent of the preemptive control of the left hemisphere. Ferenczi (1926) had noted that in his clinical experience, unilateral hysterical conversion symptoms were more common on the left side of the body. Thus, Galin (1974) suggested that perhaps unconscious, right hemisphere processes could be expressed via contralateral somatic disorders. Through retrospective study of case records, Galin, Diamond and Braff (1977) and Stern (1977) both found evidence of a significant preponderance of left-sided symptoms among patients with unilateral conversion disorders, although the Galin et al. results were true only among female patients.

Studies of Intact, "Normal" Individuals

Recent approaches to the study of functional hemispheric asymmetry among intact persons have focused on lateralized input and output modes. Such procedures include dichotic listening tasks and tachistoscopic presentation of visual stimuli to the left and right visual half-fields (Kimura, 1966, 1967; Springer, 1977), conjugate lateral eye movements (Gur & Gur, 1977; Kinsbourne, 1972), recording of EEG activity over the two hemispheres (Galin & Ornstein, 1972) or bilateral recording of EEG evoked potentials (Donchin, Kutas & McCarthy, 1977), and observation of attentional bias (Kinsbourne, 1970; Tucker, Roth & Shearer, Note 7). Despite the idiosyncratic problems inherent to each of these approaches to measuring relative hemispheric activation, they are all attempts to circumvent the tenuous generalizability of brain lesion, split brain, and psychiatric disorder studies and the intrusiveness of the Wada technique. Each of these various approaches has recently been applied to the study of possible asymmetries in emotionality.

Kimura's (1967) introduction of dichotic presentation of auditory stimuli as an approach to studying functional lateralization initiated considerable research interest in this relatively simple technique. Dichotic listening tasks involve the presentation of two spoken messages, via headphones, one to each of the ears. Each ear sends both contralateral and ipsalateral projections to the cortex. However, when ipsalateral and contralateral inputs compete in the auditory neural system, it is thought that contralateral input inhibits or occludes the ipsalateral signals. Thus, right ear superiority for spoken messages is thought to reflect the dominance for language of the left hemisphere.

Applying the dichotic listening paradigm to emotionality, King and Kimura (1972) and Carmon and Nachson (1973) found a left ear, i.e., right hemisphere, advantage for processing of human nonverbal sounds (crying, laughing and coughing) for which an acoustic explanation did not seem applicable. In similar research, right hemisphere superiority was documented for speech contours such as pitch, tempo, inflection and stress (Blumstein & Cooper, 1974), and for correct identification of the emotional tone of a sentence (Haggard & Parkinson, 1976). Safer and Leventhal (1977) used monaural presentations without competing stimulation to support earlier reports of left ear advantage for emotional tone of sentences, and also demonstrated right ear advantage for sentence content. Similarly, Adair (Note 8) found that left ear reception of stimulus words resulted in more archaic free associations than did presentation to the right ear.

In recent years, the most popular method purporting measurement of hemisphericity has been the simple observation and recording of subjects' conjugate lateral eye movements (LEM's) during reflective thinking (Bakan, 1971; Gur, 1975). Shifts to the left are presumed to reflect right hemisphere predominance, whereas shifts to the right are thought to reflect left hemisphere predominance. It has been theorized that activation of the cognitive functioning of one hemisphere will overflow to the frontal orientation center of that hemisphere and cause eye movement contralateral to that hemisphere (Gur, 1975; Kinsbourne, 1972). Despite such attempts to provide a viable theoretical basis for LEM's, the relationship between eye movements and hemisphericity is an equivocal, empirical association, based upon an accumulation of studies.

Gur (1975) demonstrated that when the experimenter recorded LEM's from behind the subject, the nature of the cognitive task seemed to be the determinant of eye movements during reflective thinking (i.e., verbal--right, spatial--left). However, when LEM's were monitored face-to-face, subjects evidenced stereotypic LEM's--usually to the left--regardless of the cognitive demands of the question. Gur suggested that perhaps anxiety disrupted the brain's usual task-oriented processing and thus resulted in LEM stereotypy unrelated to the task. Hiscock (1977) could not find evidence supporting such an override caused by anxiety, but left looking stereotypy has been demonstrated in response to emotional questions (Schwartz, Davidson & Maer, 1975; Schwartz, Davidson, Maer & Bromfield, 1974), and during induced stress (Tucker, Roth, Arneson & Buckingham, 1977).

The attraction of a right-looker/left-looker typology has generated research on possible stable personality correlates of LEM stereotypy. Left-lookers have been reported to score higher on scales of repression and denial (Gur & Gur, 1975) and responsiveness and expressiveness (Woods, 1977), whereas right-lookers have scored higher on scales of projection and "turning against others" (Gur & Gur, 1975).

In general, research on LEM stereotypy supports the popular conceptualization of the lateralization of emotion which depicts the right hemisphere as a storehouse of unelaborated, primary process, primitive emotions with which the individual copes via denial á la Gainotti (1969). However, recent reviewers have emphasized that LEM results are very tenuous and that theory building based on the LEM literature is premature (Ehrlichman & Weinberger, Note 9).

The supposed "emotionality" of the right hemisphere has not been unequivocally supported by recent EEG studies. Davidson and Schwartz (1976) did report greater desynchrony, i.e., activation, of the right hemisphere during affective imagination relative to non-affective imaginal material. However, other EEG studies suggest that the cerebral hemispheres are differentially involved in positive and negative affect. Ehrlichman and Wiener (Notes 10, 11) report greater EEG desynchrony over the right hemisphere during recall of positive affect and over the left hemisphere during recall of negative affect. Similarly, Harman and Ray (1977) observed increased amplitude of left hemisphere EEG recordings during positive affect and decreased amplitude during negative affect, i.e., greater left hemisphere activity during negative affect. Harman and Ray suggest that their findings parallel those of d'Elia and Perris (1974) in demonstrating that the left hemisphere, rather than the right, reflects changes in emotionality. The authors speculate that perhaps negative affect is viewed more analytically by the individual or sustained by internal verbal dialogue, both supposedly functions of the left hemisphere.

Other research on lateralization of emotions has capitalized upon the neuroanatomical crossing of visual neural pathways via the optic chiasm. Thus, with a tachistoscope, if presentations are rapid so as to prevent saccadic eye movements, all of the field to the left of a fixation point excites the visual cortex in the right hemisphere while stimuli from the right visual field excite the left visual cortex. Using this method, in combination with assessment of LEM's and auditory attentional bias, Tucker, Antes, Stenslie and Barnhardt (1978) reported evidence of hemispheric interaction during affective arousal. Subjects who reported high state anxiety in response to contrived anxiety induction manifested a right visual field, i.e., left hemisphere, performance decrement on both verbal and spatial tasks. The authors suggest that anxiety imposes a processing load specifically on the left hemisphere, and that this should be accompanied by relative left hemispheric activation. Tucker et al. present other data which support their contention: high trait anxious subjects exhibited significant right ear attentional bias and decreased frequency of left eye movements. Tucker et al. interpret their results as suggestive of relative left hemisphere activation accompanied by concomitant left hemisphere performance decrement and suppression of right hemisphere activity during anxiety. (Similarly, Gur, 1978, has presented data suggesting left hemisphere dysfunction and left hemisphere overactivation among schizophrenics.)

Dimond, Farrington and Johnson (1976) devised an innovative technique for studying lateralization of emotions which, like tachistoscopic research, depends upon crossing of visual pathways between the eyes and the visual cortex. These authors developed special contact lenses which, in effect, allow presentation of visual stimuli to a specific hemisphere. Dimond et al. showed various films in this manner to each hemisphere individually. Films shown to the right hemisphere were judged by the subjects as being more unpleasant than were films shown to the left. According to Dimond et al., left hemisphere perception tends to dominate overall perception and typically suppresses right hemisphere perception which is characterized as more unpleasant and horrific than that of the left hemisphere.

Further support of hemispheric interaction, rather than mere dichotic processing, in affective arousal has been reported by Tucker, Roth and Shearer (Note 7). Using hypnotically induced mood states of depression and euphoria, these authors found a significant right ear attentional bias, i.e., presumably left hemisphere activation, during the depressive mood state. The right ear attentional bias was accompanied by significantly impaired imagery ability, yet no decrement in arithmetic performance. Thus, in accord with the Tucker et al. (1978) observation regarding apparent hemispheric interaction during anxiety, the authors interpret their results as indicative of left hemisphere overactivity and concomitant right hemisphere impairment during depressive affect. They also suggest that impaired right hemisphere functioning may be a result of active suppression of the right hemisphere by the overactive left hemisphere.

Summary and Implications for Theory Building

The predominant view of hemispheric contributions to emotionality localizes emotion as a right hemisphere characteristic, in contrast to the logical, rational, nonemotional characteristics of the left hemisphere. Although a considerable volume of research corroborates such a conceptualization (e.g., Davidson & Schwartz, 1976; Gainotti, 1972; Schwartz, Davidson & Maer, 1975; Schwartz, Davidson, Maer & Bromfield, 1974; Tucker, Roth, Arneson & Buckingham, 1977), other recent research implicates the left hemisphere's involvement in emotionality (e.g., d'Elia & Perris, 1973, 1974; Ehrlichman & Wiener, Notes 10, 11; Harman & Ray, 1977; Tucker, Antes, Stenslie & Barnhardt, 1978; Tucker, Roth & Shearer, Note 7).

Although the research on lateralization of emotionality may well seem confusing and paradoxical, perhaps this very nature of the literature suggests that a new direction in theorizing is imminent. Clearly, both the right and left hemispheres appear to make important contributions to the elaboration and expression of subcortical arousal into phenomenologically perceived emotions. This observation points to the naiveté of continued reliance upon the popular model of brain function in which "emotion" resides in the right hemisphere, and "reason" in the left. Furthermore, the literature suggests that mere dichotomous attribution of specific emotions (e.g., anxiety, depression) to one hemisphere or the other, will be an inefficient tack for furthering understanding of cerebral contributions to emotionality. Recent evidence (e.g., Galin, 1977; Tucker et al., 1978; Tucker et al., Note 7) suggests that a more fruitful approach to understanding brain function in emotion may involve changing our focus from lateralization of the cerebral hemispheres per se, to a model which emphasizes the interaction or integration of the cerebral hemispheres in emotionality. However, the specifics of such a model await further conceptual elaboration and empirical corroboration.

Several theoreticians have proposed tentative models for explaining cerebral contributions to emotionality via interactional principles. Prior to the flurry of activity of recent years, Bogen (1969) hypothesized that certain kinds of left hemisphere activity may directly suppress certain kinds of right hemisphere activity. He also suggested that some left hemisphere activity may block the access to that hemisphere of certain products of right hemisphere activity, presumably by blocking commissural transfer.

Galin (1974) suggests that such inhibition of neural transmission across the cerebral commissures may represent a neurophysiological mechanism for some instances of repression, as well as an anatomical locus for unconscious mental contents, i.e., the right hemisphere (cf. Galin, Diamond & Braff, 1977; Stern, 1977). Galin (1974, 1977) and Bakan (Note 5) have compared right hemisphere processing to what psychoanalysts call primary process thinking, e.g., holistic, nonverbal/imaginal representation, nonlinear association, and little involvement with perception of time or sequence. According to Bakan, such primary process, right hemisphere mentation is typically suppressed by the inhibitory influence of the left hemisphere. He cites research supporting a "spill over" model of schizophrenia which suggests that a breakdown of left hemisphere inhibitory functioning allows primary process, right hemisphere contents to "flow" from their usual REM sleep expression channels into waking, secondary process mentation and overt behavior (cf. Rosenthal & Bigelow, 1972). Thus, for optimal functioning a moderate level of inhibitory activity by the left hemisphere is presumably necessary.[2]

Tucker (Note 12) has suggested that the hemispheres are not merely differentially specialized, but rather that they are inherent opposites which interact in dialectical fashion. Thus, optimal brain function is dependent upon a higher order, synergic level of integration rather than either dichotomous usage of the "best" hemisphere for a given function or an additive hemispheric configuration. The dialectical flavor of Tucker's model distinguishes it from other conceptualizations of hemispheric interaction. Thus, whereas many researchers in the field speak of opposition or interference between the cerebral hemispheres as a limiting or disruptive phenomenon, Tucker proposes that synergic interaction of hemispheric processing is a direct product of such opposition between the halves of the brain. According to a dialectical model, therefore, differentiated emotionality is a product of the synthesis between the controlling, dominating and inhibiting left

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[2]Bakan (Note 5) actually uses the terms "left hemisphere system" and "right hemisphere system" to emphasize his recognition of the subcortical and biochemical components of brain function which are inseparable from hemispheric processing. Such a gesture is certainly laudable in this area of research. Too often, research and speculation in the area of laterality speaks only of hemispheric processing with no overt recognition that this is an artificial separation, a hemispherectomy so to speak, which does injustice to the integrative, systemic nature of the human nervous system.

hemisphere, and its opposite, the spontaneous, primitive and syncretic right hemisphere.

The views expressed by Bogen, Galin, Bakan and Tucker all emphasize the interaction of the cerebral hemispheres, generally, and the inhibiting qualities of the left hemisphere, specifically. According to these theoreticians, it is insufficient to continue the simple delineation of the specific capacities of each hemisphere in isolation. One hemisphere's contribution to a particular affective state is at least partially dependent upon the concomitant influence of the other hemisphere. However, several recent EEG studies appear to conflict with such interactive conceptualizations of hemispheric emotionality: left hemisphere EEG data suggest a predominance of negative affect (Ehrlichman & Wiener, Notes 10, 11; Harman & Ray, 1977), whereas the right hemisphere is characterized by positive affect (Ehrlichman & Wiener, Notes 10, 11). However, the findings of Dimond et al. (1976) suggesting the predominance of horrific affect in the right hemisphere are difficult to reconcile with such a model. As an alternative, from an interactive stance, either hemisphere could be characterized by positive or negative affect depending upon the concomitant influence of the other hemisphere. For example, Tucker, Roth and Shearer (Note 7) have suggested that "a variety of primitive, syncretic and spontaneous emotional responses with primary elaboration in the right hemisphere could be quite aversive to the individual; the inhibition, and potentially the differentiation, of such primary affective arousal by the left hemisphere could result in an affective state which is more positive (p. 11)."

Thus, it is unclear whether the differential contributions of the cerebral hemispheres to emotionality are a result of the inherent affective tone or cognitive processing predilections of the individual hemispheres, i.e., perhaps the left hemisphere is primarily "negative" or negative arousal is primarily verbal, whereas the right hemisphere is primarily "positive" or positive arousal is primarily nonverbal, or vice versa. Alternatively, perhaps it is unnecessary to posit such differences in favor of an interactional model which emphasizes the constricting, inhibiting influence of the left hemisphere upon the primitive, spontaneous right hemisphere in determining the quality of subjective emotionality. Tentative empirical support has been reported for both the former (Ehrlichman & Wiener, Notes 10, 11; Harman & Ray, 1977) and the latter approaches (Tucker, Antes, Stenslie & Barnhardt, 1978; Tucker, Roth & Shearer, Note 7); however, a direct comparison of the models has not been reported.

The Present Study

The present study was designed to provide further data on the equivocal issue of hemispheric contributions to emotionality through varying both the positive vs. negative quality of the affective state, and the inhibitory vs. facilitative orientation with which the individual approaches affective arousal. Comparison of these two dimensions of affective arousal according to an attentional bias measure of relative hemispheric activation should yield results relevant to a theoretical understanding of lateral cerebral function in emotion. In order to operationalize such a comparison, aversive and sexual slides were shown to subjects under instructions to either facilitate or inhibit arousal, with concurrent measurement of auditory attentional bias as an index of relative hemispheric activation. Previous research showing the importance of the right hemisphere to emotion (e.g., Davidson & Schwartz, 1976; Schwartz et al., 1974; Schwartz et al., 1975; Tucker et al., 1977) generally, and to horrific affect (Dimond et al., 1976) and sexual arousal (Cohen, Rosen & Goldstein, 1976; Goldstein, Sugerman, Marjerrison & Stoltzfus, Note 13), in particular, would suggest that the facilitation of such arousal would result in relatively greater right hemisphere activation. Evidence of left hemisphere involvement in negative affect (Ehrlichman & Wiener, Notes 10, 11; Harman & Ray, 1977) would suggest differential hemispheric function during positive and negative affective arousal. Interactional views (e.g., Galin, 1974, 1977; Bakan, Note 5; Tucker, Note 12) would suggest that primary elaboration or facilitation of both positive and negative affect would be associated with relatively greater right hemisphere activation, and the inhibition of both positive and negative affect with relatively greater left hemisphere activation. The present study was expected to lend direction to the further elaboration of theoretical models and, thus, contribute to a better understanding of hemispheric contributions to emotionality within and across various subjective emotions and perhaps within and across various individuals.

CHAPTER II

METHOD

Selection of Affective Visual Stimuli

Prior to the recruitment of subjects, two slide pools were created to serve as stimuli for affective arousal. A pool of 54 sexually-oriented color slides was created using photographs from "soft core" pornography magazines (e.g., Playboy, Playgirl), depicting individuals and heterosexual couples in situations ranging from seductive poses with some exposure of genitalia to apparent intercourse. A pool of 24 aversive or repulsive color slides was created using photographs from periodicals, textbooks, and those supplied by a cooperating forensic pathologist. These slides depicted various unpleasant scenes such as morgue corpses, child abuse victims, starvation victims, snakes, rats, etc. The combined pool of 78 slides was shown to a group of 52 undergraduates in Abnormal Psychology. They were told about the proposed study, and asked to rate the suitability of each picture for inclusion in the study via a five point "arousal value" scale. The fourteen sexually-oriented slides which were ranked as most arousing by each sex were randomly assigned to two slide sets of seven slides each; i.e., two seven-slide sets for each sex. Since no sex differences were evident on ratings of the aversive slides, the fourteen slides ranked as most arousing were randomly assigned to two slide sets of seven each to be shown to both sexes. Use of these visual stimuli was based on two assumptions: (a) college students should be able to use the slides as suggestive stimuli which facilitate access to their sexual or horrific imagination, thus approximating positive and negative affective states; (b) for a majority of the population, the heterosexual slides chosen should have a "positive" valence, whereas the aversive slides chosen should have a "negative" valence.

Subjects

Forty-eight undergraduate psychology students (24 females and 24 males) were recruited from undergraduate psychology courses and given course credit for their participation. All subjects were right-handed and reported no known differential hearing loss. All subjects read a brief description of the study and completed a consent form prior to their participation in the study (see Appendix A). A brief phone interview with each subject was intended to screen individuals who might be upset by the nature of the research. The phone contact verified that subjects had read and understood the consent form, and were willing to cooperate with the demands of the research project.

Attentional Bias Task

Relative hemispheric activation was assessed via an auditory attentional bias paradigm (Tucker, Antes, Stenslie & Barnhardt, 1978; Tucker, Roth & Shearer, Note 7). This technique is based, first, upon Kinsbourne's (1970) observation that there is a contralateral shift in attention during relative dominance of one hemisphere, and, second, upon the contralateral/ipsalateral input competition in the auditory neural system as described above in regard to both dichotic listening (Kimura, 1966, 1967) and monaural listening (Safer & Leventhal, 1977).

In the present study, the attentional bias task consisted of the periodic presentation of a 400 hertz tone of approximately .5 seconds duration to both ears of a set of headphones. The auditory signal to each side of the headphones was of equal intensity, but in order to minimize the effects of possible systematic bias in the audio equipment, the headphones were reversed on alternate subjects. The subjects' task was to quickly judge in which ear the tone sounded the loudest and respond via the buttons mounted in the arms of their chair. Since the auditory input to each ear was identical, the subjects' responses should reflect either random responding, a response bias, or an attentional bias. As in Kinsbourne's (1970) research and the dichotic/monaural listening literature, directional bias is presumably indicative of contralateral hemispheric dominance, i.e., a left ear bias reflects relatively greater right hemisphere activation, whereas a right ear bias reflects relatively greater left hemisphere activation.

Prior to the onset of the experiment proper, sample tones were administered to insure that the subject understood the instructions. Subjects were informally instructed that the tones would be of different intensities in each ear, sometimes blatantly different and sometimes barely distinguishable, in order to establish the apparent integrity of the task. This deception was apparently effective since only a few subjects questioned the veracity of the tone presentations, and these skeptics offered only vaguely articulated suspicions about the "real purpose" of the tones.

Procedure

Each subject was seated in a comfortable, semi-reclining chair in a small, private room. A translucent screen, which allowed projection of the slides from behind, was placed in front of the subject at a distance of about four feet. A projector was housed in an alley adjacent to the subject's room such that slides could be projected through a partially-draped, one-way mirror onto the screen in front of the subject. Having the projector in a separate room diminished projector noise and allowed more privacy for subjects during the experiment.

The procedures were discussed informally with each subject in an attempt to enlist their cooperation as co-investigators who were helping to "create emotions" in the laboratory, rather than as mere subjects of scientific scrutiny. The experimenter emphasized that the slides were probably not so blatantly arousing that they would automatically induce the particular affective state, but that the slides did have enough arousal value so that it would be "only natural" to experience some arousal. Thus, the subject's creative imagination in "turning on and turning off" affective arousal was described informally as the critical variable in the research. Subjects were also told that the tone loudness judgement was a "secondary task" in which they should "go with first impressions" and not be overly concerned with whether they were right or wrong. This was done to reduce evaluative anxiety regarding tone judgements, and to increase the probability that subjects would focus their attention on the concurrent primary task of involving themselves in the affect conditions.

Every effort was made to insure subjects' anonymity and to communicate this fact to the subjects. Only identifying numbers were used on questionnaires, and each subject sealed all of his/her data in an envelope prior to leaving the laboratory. Subjects' informal comments after the experiment suggested that they had generally felt very free to respond affectively during the slide presentations, and free to respond frankly on the self-report questionnaires.

The experiment utilized a 2 x 2, within-subjects design (i.e., positive vs. negative affect x inhibition vs. facilitation). The four treatment conditions were counterbalanced with the exception that the two positive affect conditions and the two negative affect conditions were paired temporally to provide more continuity for the subject. All slide sets were counterbalanced within those conditions. Although considerable informal instruction occurred with each subject, as described above, each subject also listened to the following taped instructions immediately prior to the onset of each of the four treatment conditions.

Inhibition of Positive (Sexual) Arousal

In just a moment, you will be seeing some color slides on the screen in front of you which have been judged by other students to be sexually-arousing. Most of us have learned to limit our sexual arousal to appropriate times, and it is typically a very private, individualized experience. In the next few minutes, as you look at these slides, it is only natural that you will experience some sexual thoughts and feelings. We cannot tell what you are thinking, so it will be a very private experience. All we ask is that you do everything that you can to suppress sexual thoughts and feelings as you look at the slides. Exaggerate your usual inhibitions and allow them to control the nature of your thinking and feeling so that sexual thoughts and feelings can be blocked out of your experience. Please continue to judge the loudness of the tones presented through the headphones, as you have done, while you are viewing the slides and inhibiting your sexual thoughts and feelings. We will begin in just a moment.

Facilitation of Positive (Sexual) Arousal

In just a moment, you will be seeing some color slides on the screen in front of you which have been judged by other students to be sexually-arousing. Most of us have learned to limit our sexual arousal to appropriate times, and it is typically a very private, individualized experience. In the next few minutes, however, we would like you to set aside your inhibitions and allow yourself to experience as much mental and physical sexual arousal as you can while viewing these slides. We realize that the slides alone are probably not sufficient to make you really aroused. However, if you are willing to cooperate, you can use each slide as a stimulus to get into your own sexual thoughts and feelings. Feel free to associate to your own sexual experiences as you watch these suggestive slides. We cannot tell what you are thinking, so it will be a very private experience. All we ask is your cooperation in setting aside your inhibitions and letting yourself really experience your own creative sexual thoughts and feelings while you view the slides. Please continue to judge the loudness of the tones presented through the headphones, as you have done, while you are viewing the slides and allowing yourself to go with your sexual thoughts and feelings. We will begin in just a moment.

Inhibition of Negative (Aversive) Arousal

In just a moment, you will be seeing some color slides on the screen in front of you which have been judged by other students to have some repulsive or frightening content. Most of us have learned some automatic coping mechanisms which enable us to limit the effect that repulsive or frightening stimuli have on our emotions. In other words, we learn how to keep ourselves from becoming overly frightened or repulsed when we are in such situations. In the next few minutes, as you look at these slides, we would like you to stop yourself from experiencing fright, revulsion, or any other negative arousal. Although these slides are certainly not so aversive that they will overwhelm you, it will be natural for you to experience some repulsive or frightened thoughts and feelings. However, we ask that you do everything that you can to suppress such arousal as you look at the slides. For example, you may use the same coping mechanisms you would use if you came upon a car accident and you had to control your scared or repulsed feelings in order to aid the victims. We cannot tell what you are thinking, so it will be a very private experience. All we ask is your cooperation in inhibiting or suppressing whatever repulsive or frightening thoughts and feelings may be aroused while you are viewing these slides. Please continue to judge the loudness of the tones presented through the headphones, as you have done, while you are viewing the slides and blocking out your negative arousal. We will begin in just a moment.

Facilitation of Negative (Aversive) Arousal

In just a moment, you will be seeing some color slides on the screen in front of you which have been judged by other students to have some repulsive or frightening content. Most of us have learned some automatic coping mechanisms which enable us to limit the effect that repulsive or frightening stimuli have on our emotions. In other words, we learn how to keep ourselves from becoming overly frightened or repulsed when we are in such situations. In the next few minutes, however, we would like you to set aside your usual ways of coping with repulsive or frightening situations as you view these slides. We realize that the slides alone are probably not sufficient to make you really scared or repulsed. However, if you are willing to cooperate, you can use each slide as a stimulus to get into your own frightened or repulsed thoughts and feelings. Feel free to associate to your own experiences as you watch these suggestive slides. We cannot tell what you are thinking, so it will be a very private experience. All we ask is your cooperation in setting aside your usual inhibitions and coping mechanisms, and letting yourself really experience your own scared or repulsed thoughts and feelings while you view these slides. Please continue to judge the loudness of the tones presented through the headphones, as you have done, while you are viewing the slides and allowing yourself to go with your repulsed or scared thoughts and feelings. We will begin in just a moment.

Inspection of the preceding passages will verify that instructions as to how subjects were expected to achieve the suggested affective state were intentionally vague. Instructions which might imply the use of either verbal or imaginal mediation strategies were purposely avoided since, from what is known about differential processing in the cerebral hemispheres, this would plausibly result in unnecessary biasing of the data. In other words, inhibitive or facilitative processes, or even negative or positive affective states could differentially involve verbal or imaginal mediation strategies.

Seven slides were presented during each condition for a duration of 45 seconds each, with tone presentations occurring at the 5, 20 and 35 second points during each slide presentation. Thus, a total of 21 tone loudness judgements were required in each of the four treatment conditions. The subjects' responses were recorded by an experimenter who monitored response indicator lights in the alley which were connected to the buttons on the arms of the chair.

Other Measures

Following each of the four treatment conditions, subjects were given questionnaires which requested ratings on a five point scale of success in approximating the affective state suggested in the instructions, degree of psychological arousal experienced, and degree of physical arousal experienced (i.e., 1--not at all to 5--very much). Subjects were also asked to write a brief description of the nature of the inhibitive tactics they had employed or of the nature of the affective arousal they experienced, in the inhibition and facilitation conditions respectively (see Appendix A). The time spent in completing the questionnaires was also intended to minimize affective "carry over" across conditions.

Each subject completed the Trait Anxiety Inventory (TAI) (Spielberger, Gorsuch & Lushene, 1970), and the Forced-Choice Sex Guilt Inventory (SGI) (Mosher, Note 14). The TAI was included because of the apparent relevance of trait anxiety to differential hemispheric functioning (Tucker et al., 1978), and to approximate an indicator of general affective arousal. The SGI was included to approximate an indicator of general inhibitive functioning, as well as to distinguish which students, if any, for whom sexual arousal was clearly not "positive" arousal. Assuming that the TAI and SGI are indeed indicative of general affective arousal and inhibitive functioning respectively, they should be useful predictors of differential hemispheric activation during conditions of arousal and inhibition of arousal.

Two trials of the Stroop Color-Word Test (SCWT) (Stroop, 1935) were administered before and after the experiment via the 45-second, total number read method of administration. Only the second trial was used in the analyses because of the reported practice effect on this measure (Jensen, 1965). The raw SCWT data were converted into interference scores (C and CW difference score) and conceptual vs. perceptual dominance scores (W and C ratio) (see review by Jensen & Rohwer, 1966). Low-interference individuals have been characterized as flexible, tending not to suppress feeling and other internal cues, and exhibiting a greater proportion of primary process thought, most of which is more blatant, drive-related primary process thinking rather than the toned-down, derivative variety; high-interference individuals have been characterized as constricted, tending toward counteractive measures to overcome intrusive cues, and manifesting more overt tension and apparent discomfort in dealing with primary process thought (Gardner, Holzman, Klein, Linton & Spence, 1959; Holt, 1960). Thus, it seemed plausible that SCWT interference scores, either separately or in combination with conceptual vs. perceptual dominance scores, may serve as effective predictors of hemispheric functioning, i.e., attentional bias, during the treatment conditions.

CHAPTER III

RESULTS

Psychological Arousal and Physical Arousal across Treatment Conditions

Means of subjects' ratings of their psychological arousal and physical arousal across the four conditions were compared in order to assure that the various treatment conditions actually did produce differential affective responding. Self-rated arousal was thus compared between the inhibition and facilitation conditions for both positive and negative affective arousal via t tests.

Self-rated psychological arousal in the positive affect-inhibition condition was significantly lower than such arousal in the positive affect-facilitation condition, $t(47) = 6.27$, $p < .001$. Self-rated physical arousal in the positive affect-inhibition condition was significantly lower than such arousal in the positive affect-facilitation condition, $t(47) = 8.17$, $p < .001$.

Self-rated psychological arousal in the negative affect-inhibition condition was significantly lower than such arousal in the negative affect-facilitation condition, $t(47) = 3.92$, $p < .001$. Self-rated physical arousal in the negative affect-inhibition condition was significantly lower than such arousal in the negative affect-facilitation condition, $t(47) = 4.32$, $p < .001$. Thus it is apparently a safe assumption that subjects were, in fact, responding differentially across the four affect conditions, or at least reporting differentially.

Attentional Bias Difference Score Means

The attentional bias tone judgement data for each subject were converted into different scores, i.e., left minus right. Thus, negative difference scores presumably reflect relatively greater left hemisphere activation, whereas positive difference scores presumably reflect relatively greater right hemisphere activation. Disregarding subject variables, the mean difference scores for the four treatment conditions were as follows: positive affect-inhibition, $M = -2.58$; positive affect-facilitation, $M = -4.00$; negative affect-inhibition, $M = -4.83$; negative affect-facilitation, $M = -3.62$. A Hotelling's T^2 test revealed no significant differences among the means, $T^2 = .071$, $F(3, 45) = .02$, $p > .5$, and no significant deviation from zero, $T^2 = .232$, $F(4, 44) = .05$, $p > .5$. Thus, the attentional bias data suggest a slight, nonsignificant right bias, i.e., left hemispheric predominance, across all treatment conditions. However, it should be noted that there were marked individual differences in attentional bias which were not directly attributable to the treatment conditions. For example, some subjects made almost all "left" responses, and some subjects made almost all "right" responses, regardless of treatment condition and regardless of which channel was presented to which ear.

Prediction of Attentional Bias Using Subject Variables

Since considerable individual variation was evident in the attentional bias data, and since the entire study was based upon subjects' ability to recreate affective states in the laboratory, examinations of subject involvement variables in relation to attentional bias were the crucial analyses. Utilizing a multiple regression approach (Kerlinger & Pedhazur, 1973), the following self-rated subject variables were utilized to predict subjects' difference scores on the attentional bias task in each condition: (a) success in approximating the suggested affective state; (b) success in approximating the affective state opposite to the state suggested; (c) psychological arousal during the suggested affective state; (d) physical arousal during the suggested affective state. In other words, for example, attentional bias difference scores in the positive-inhibition condition were predicted using the subjects' ratings of success in inhibiting sexual arousal in the positive-inhibition condition, success in facilitating sexual arousal in the positive affect-facilitation condition, degree of psychological sexual arousal experienced in the positive affect-inhibition condition, and degree of physical sexual arousal experienced in the positive affect-inhibition condition. Prediction of attentional bias difference scores in the other three treatment conditions proceeded in a parallel manner. The summary tables for the multiple regression predictions of attentional bias using such predictors in each of the four treatment conditions are presented in Tables 1 - 4.

Table 1

Multiple Regression: Positive-Inhibition Attentional Bias X Subjects' Self-Ratings

Source	beta	SS	df	F	p
Pos.-Facil. Success	+.027	3.0	1	.03	>.5
Pos.-Inhib. Success	-.112	27.5	1	.27	>.5
Psychological Arousal	-.060	8.2	1	.08	>.5
Physical Arousal	-.210	128.1	1	1.27	.27
Total Regression		171.8	4	.42	>.5
Within		4403.9	43		
TOTAL		4575.7	47		

Table 2

Multiple Regression: Positive-Facilitation Attentional Bias X Subjects' Self-Ratings

Source	beta	SS	df	F	p
Pos.-Inhib. Success	-.013	.5	1	.007	>.5
Pos.-Facil. Success	+.210	91.8	1	.83	.36
Psychological Arousal	+.014	.2	1	.003	>.5
Physical Arousal	-.178	101.0	1	.89	.35
Total Regression		211.9	4	.47	>.5
Within		4890.1	43		
TOTAL		5102.0	47		

Table 3

Multiple Regression: Negative-Inhibition Attentional Bias X Subjects' Self-Ratings

Source	beta	SS	df	F	p
Neg.-Facil. Success	+.201	184.2	1	1.50	.23
Neg.-Inhib. Success	-.043	5.6	1	.06	>.5
Psychological Arousal	-.160	78.1	1	.65	.42
Physical Arousal	+.124	55.8	1	.47	>.5
Total Regression		269.0	4	.54	>.5
Within		5311.6	43		
TOTAL		5580.7	47		

Table 4

Multiple Regression: Negative-Facilitation Attentional Bias X Subjects' Self-Ratings

Source	beta	SS	df	F	p
Neg.-Inhib. Success	-.273	302.8	1	3.73	.06
Neg.-Facil. Success	+.364	214.9	1	2.64	.11
Psychological Arousal	-.051	4.9	1	.06	>.5
Physical Arousal	-.335	454.1	1	5.62	.02
Total Regression		1372.6	4	4.20	.006
Within		3510.6	43		
TOTAL		4883.2	47		

As shown in Tables 1 - 4, subjects' ratings of their subjective state were not effective predictors of attentional bias except in the negative affect-facilitation condition. Utilizing the four subject variables described above, a significant proportion of the variance (28.1%) of attentional bias difference scores could be predicted, $F(4, 43) = 4.20$, $p = .006$. As noted above, there was a slight right bias across all conditions; thus, prediction of attentional bias in the negative affect-facilitation condition is directed toward relative left-right differences rather than specific left bias or right bias per se. Examination of the directional status of the beta weights indicates that *less* success in inhibiting aversive arousal in the negative affect-inhibition condition, *greater* success in facilitating aversive arousal in the negative affect-facilitation condition, and *less* physical arousal in the negative affect-facilitation condition, are predictive of relatively greater left attentional bias, i.e., relatively greater right hemisphere activation, during facilitation of aversive arousal.

As mentioned above, it was also hypothesized that subjects' Trait Anxiety Inventory scores, Sex-Guilt Inventory scores, and Stroop Color-Word Test interference scores and conceptual vs. perceptual dominance scores would predict subjects' attentional bias in the various treatment conditions. Multiple regression analyses using these four variables as predictors of attentional bias difference scores indicated no support for these hypotheses (see Appendix B).

Selected Correlational Results

Although Trait Anxiety Inventory (TAI) scores and Sex-Guilt Inventory (SGI) scores were not effective predictors of attentional bias, they were clearly related to many of the subjects' ratings of subjective states during the various affect conditions. As shown in Table 5, higher trait anxiety was associated with less success in inhibiting arousal, and with greater affective arousal despite instructions to inhibit such arousal. As shown in Table 6, higher SGI scores were associated with less success in facilitating sexual arousal and less success in inhibiting aversive arousal.

Table 5

Correlations between Trait Anxiety Inventory Scores and Subjects' Self-Ratings

Rating	r	p
Pos.-Inhib. Success	-.14	.17
Pos.-Inhib. Psychological Arousal	+.17	.12
Pos.-Inhib. Physical Arousal	+.33	.01
Neg.-Inhib. Success	-.24	.05
Neg.-Inhib. Psychological Arousal	+.30	.02
Neg.-Inhib. Physical Arousal	+.26	.04
Pos.-Facil. Success	-.11	.23
Pos.-Facil. Psychological Arousal	-.06	.35
Pos.-Facil. Physical Arousal	+.18	.11
Neg.-Facil. Success	-.12	.21
Neg.-Facil. Psychological Arousal	-.20	.08
Neg.-Facil. Physical Arousal	+.16	.15

Table 6

Correlations between Sex-Guilt Inventory
Scores and Subjects' Self-Ratings

Rating	r	p
Pos.-Inhib. Success	+.10	.25
Pos.-Inhib. Psychological Arousal	-.05	.36
Pos.-Inhib. Physical Arousal	-.03	.42
Neg.-Inhib. Success	-.16	.14
Neg.-Inhib. Psychological Arousal	+.26	.04
Neg.-Inhib. Physical Arousal	+.16	.14
Pos.-Facil. Success	-.38	.004
Pos.-Facil. Psychological Arousal	-.23	.05
Pos.-Facil. Physical Arousal	-.18	.11
Neg.-Facil. Success	+.20	.09
Neg.-Facil. Psychological Arousal	+.21	.08
Neg.-Facil. Physical Arousal	-.09	.27

Categorization of Subjects' Descriptions of Subjective States

Immediately following each affect condition, subjects were asked to write a brief description of the nature of the arousal which they experienced in the two facilitation conditions, and the nature of the inhibition strategies which they employed in the two inhibition conditions. Examination of these subjective reports regarding thought processes across conditions suggested that differential cognitive approaches were employed across the inhibition and facilitation conditions. As illustrated by the selected, representative comments presented below, descriptions of arousal in the facilitation conditions suggest that subjects tended toward imaginal/global cognition:

Positive Affect

Females: could picture the sexual act briefly; muscle contractions in vaginal area; I imagined my man and me doing that stuff; made me dream about men in my future and some in my past; mental remembering of sexual experiences; I kept seeing and thinking about intimate times with my mate; heart beating faster; breathing deeper; it felt like I was being physically stimulated and I imagined I was.

Males: fantasizing being there and doing what they're doing--put myself in the picture; mostly sexual fantasy, slight genital tingling, increased heart rate, etc.; slight erection, mentally simulating tactual sensations; mental images of past experiences and fantasies; could very vividly picture myself engaging in sexual activity with the women.

Negative Affect

Females: I kept seeing myself there and it scared me; sick to my stomach, felt like crying; could feel the snakes crawling all over me--yuk!; some slides made me shudder mostly if I thought of those things happening to me or someone close; felt kind of sick feeling in my gut; felt angry and guilty; put myself in their situation and experienced pain myself as if I was actually there; felt anger toward those who caused cuts, burns, starvation, etc.; felt like gagging; I was scared--I felt snakes crawling on me--they were gruesome.

Males: I fantasized that the bat was clutching my chest and chewing on my face; I could feel and smell the colostomy; envisioned the snakes crawling all over my arm; imagined that I was put into a closed environment with the subject; associated the worst possible image; could feel my heartbeat, was sweating some.

In contrast, self-reports about inhibition strategies which were employed suggest that subjects tended toward verbal/analytic cognitive processing, as illustrated by the selected, representative comments presented below:

Positive Affect

Females: I picked objects to focus on; assumed scientific, anatomical viewpoint; by counting other objects in the pictures; told myself that they had clothes on; planned things I have to get done today; by telling myself "he's taken" or "he wouldn't care for me"; told myself I wasn't part of it; I saw the whole picture and then concentrated on the faces; kept telling myself it was an awful act.

Males: by telling myself I wasn't interested; by concentrating on another subject; by picking out faults or negative aspects of people in the pictures; thought of unpleasant sexual situations; picked out parts of the slides that were not arousing and concentrated on them; concentrated on the buzz sound and shut the slides off in my mind.

Negative Affect

Females: assumed a scientific point of view; picked out the positive aspects of each slide; asked myself what I could do to help; tried to figure out the causes of the wounds and how to treat them; I said they can't hurt you--they're just pictures; worked on rationalizing what I saw or explaining to myself; tried to analyze the physical disorder; kept telling myself "it's natural'; kept telling myself these things were fake; thought of an appropriate reason for the slide; snakes bothered me the worst, so I tried counting them; by thinking it will never happen to me.

Males: by explaining to myself that I was removed from the place; by explaining each in known terms; tried to reason what could be done; tried to think of an alternative to the situation; would contemplate the social problems connected to the situation; I told myself that I have seen many things a lot worse; I asked myself "Okay, what needs to be done here to help this person? Things aren't as bad as they look--let's get him to a hospital--he'll be okay."

Such apparent use of differential cognitive strategies across the inhibition vs. facilitation dimension was certainly not an all-inclusive phenomenon, and there were some interesting exceptions. For example, in the positive affect-inhibition condition, one student responded with, "thought of how they would look with a bucket of ice cold water thrown over them," and in the negative affect-inhibition condition, one subject responded with, "put the slide in my mind as an inanimate object--a person as a tree, animal as a rock, etc."

These observations prompted an attempt to quantify this apparent relationship. Subjects' descriptions of their arousal and inhibition strategies were categorized by the experimenter as to whether they involved predominantly verbal/analytic or predominantly imaginal/global processing.[3] Such categorization was accomplished by scanning subjects'

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[3]This was done in a non-blind manner due to the nature of the questions (see Appendix A).

immediate, retrospective reports for key words, phrases, and themes thought to reflect ongoing cognitive activity during the treatment conditions. Relative verbal/analytic predominance was assumed when subjects reported internal verbal dialogue, reasoning, rationalizations, and/or focused, concentrated, analytic perception of the slides, in the absence of imaginal/global content. Relative imaginal/global predominance was assumed when subjects reported imagery, fantasies, and/or global, diffuse perception of the slides, in the absence of verbal/analytic content. With four ratings from each of the 48 subjects, 192 responses were examined, 94 (49%) of which were categorizable as "left" or "right." Responses which did not report categorizable experience according to the criteria above, and those which reported both verbal/analytic and imaginal/global content in the same report, were left uncategorized and omitted from further analyses. The categorized, nominal data were collapsed across the positive/negative dimension and analyzed via a McNemar Test of Change for related samples. In order to use this statistical technique, only those subjects who were classifiable on both the inhibition and the facilitation category could be considered. The data from the McNemar Test of Change for related samples is presented in Table 7. For this subset of subjects, such a categorization of verbal/analytic and imaginal/global processing on the inhibition/facilitation dimension was significant, $\chi^2(1) = 14.06$, $p = .0002$. Thus, subjects who reported experience classifiable as verbal/analytic in the inhibition condition reported experience classifiable as imaginal/global in the facilitation condition, and vice versa.

Table 7

McNemar Test of Change: Classifiable Reports of Arousal and Inhibition Strategies

		Facilitation Verbal/ Analytic	Facilitation Imaginal/ Global	Unclassified	Total
Inhibition	Imaginal/Global	0	4	7	11
	Verbal/Analytic	3	16	31	50
	Unclassified	0	10		
	Total	3	30		94

$\chi^2(1) = 14.06$, $p = .0002$

In order to ascertain whether subjects were favoring such differential cognitive processing within the positive and negative affect conditions, separate McNemar Test of Change Statistics were computed. As presented in Tables 8 and 9, the verbal/analytic versus imaginal/global processing categorization was significant for the positive affect conditions, ($\chi^2(1) = 9.09$, $p = .0026$), and approached significance for the negative affect conditions, ($\chi^2(1) = 3.2$, $p = .074$). In other words, during both positive and negative affect, subjects who reported verbal/analytic processing during the inhibition of arousal tended to report imaginal/global processing during the facilitation of arousal. However, subjects' reports were not corroborated by their attentional bias difference scores (see Appendix B).

Table 8

McNemar Test of Change: Classifiable Reports of Arousal and Inhibition Strategies During Positive Affect

		Facilitation Verbal/ Analytic	Facilitation Imaginal/ Global	Unclassified	Total
Inhibition	Imaginal/Global	0	3	4	7
	Verbal/Analytic	0	11	10	21
	Unclassified	0	8		
	Total	0	22		50

$\chi^2(1) = 9.09$, $p = .0026$

Table 9

McNemar Test of Change: Classifiable Reports of Arousal and Inhibition Strategies During Negative Affect

		Facilitation Verbal/ Analytic	Facilitation Imaginal/ Global	Unclassified	Total
Inhibition	Imaginal/Global	0	1	3	4
	Verbal/Analytic	3	5	21	29
	Unclassified	0	2		
	Total	3	8		44

$\chi^2(1) = 3.2$, $p = .074$

Other Results

Descriptive data, intercorrelations among variables, and analyses of sex differences for all variables are presented in Appendix B.

CHAPTER IV

DISCUSSION

In summary of the results, differential hemispheric activation, as evidenced by mean attentional bias across conditions, was not observed for the grouped data: a slight right bias was evident across conditions. Prediction of attentional bias using subject involvement variables suggested that both success in generating aversive arousal and lack of success in inhibiting aversive arousal in response to the slides were accompanied by relatively greater right hemisphere activation. However, greater right hemisphere activation was characterized by less physical arousal, thus emphasizing the heterogeneous nature of aversive arousal. The most salient finding was provided by categorical analyses of subjects' descriptions of their subjective experience across conditions. Under instructions to facilitate arousal, subjects' reports of their subjective experience were generally characterized by imaginal/global thought. Conversely, under instructions to inhibit arousal, subjects' reports of their subjective experience were generally characterized by verbal/analytic thought. However, subjects' reports of differential cognitive strategies across the facilitation/inhibition dimension were not corroborated by their attentional bias scores across conditions.

The interactional theories of Bakan (Note 5), Galin (1974, 1977), and Tucker (Note 12) would predict that the right hemisphere would be relatively more active during the facilitation of emotional arousal, whereas the left hemisphere would be relatively more active during the inhibition of emotional arousal. In the present study, subjective experiences of subjects under instructions to facilitate emotional arousal were generally characterized by images, fantasies, and global perception of the slides, in the absence of internal verbal dialogue or analytic thinking. Under instructions to inhibit arousal, subjects' reported experiences were largely characterized by internal verbal dialogue, rationalizations, and analytic perception of the slides, in the absence of imagery. As mentioned previously, other research suggests that verbal processing involves relatively greater left hemisphere usage (e.g., Schwartz, Davidson & Maer, 1975), while imagery involves relatively greater right hemisphere usage (e.g., Morgan, McDonald & McDonald, 1971). Furthermore, it seems that the left hemisphere tends toward analytic processing while the right hemisphere tends toward processing wholes in a global manner (Bogen & Bogen, 1969; Levy, 1969; Nebes, 1974). Thus, the present study's categorizations of subjects' self-reports suggest that the inhibition of affective arousal may be mediated primarily by left hemisphere processing, while the facilitation of affective arousal may be mediated primarily by right hemisphere processing, across both positive and negative affect.

The subjects' self-reports were not corroborated by the attentional bias assessment; no significant differences were obtained among the mean attentional bias difference scores across the various conditions, either for the grouped data as a whole or for those subjects whose reported cognitive strategies were classifiable. In addition to obvious limitations of indirect measurement of brain activity, it appears that the very nature of the attentional bias task may have biased responding. Although the tone judgements were presented as a "secondary task," many subjects informally reported that the tone presentations had required very focused, analytic attention. Thus, the obtained right bias across conditions could plausibly reflect the relatively greater left hemisphere activation which may have been required by the inherent nature of the attentional bias task, or alternatively, a right hand response bias. However, a few subjects informally reported an impressionistic scanning strategy aimed at localization of the combined tone on either side of the midline; such a strategy could plausibly involve relatively greater right hemisphere activation, in contrast to a focused, analytic approach to tone loudness judgement. Thus, although it appears that the attentional bias task may necessarily produce a slight right bias for grouped data, it seems that individual differences in approaching the task may be an important variable. In contrast to measures of hemispheric activation which assess a passive subject (e.g., EEG), assessment of attentional bias in the present framework requires an actively responding subject. This requirement of attentional bias assessment is likely to interfere with obtaining an index of relative hemispheric activation which is independent from individual differences in cognitive approach or response bias which may interact with the nature of the task. The apparent difficulty in the use of the attentional bias paradigm is difficult to reconcile with its apparent successful use in previous research (Tucker, Antes, Stenslie & Barnhardt, 1978; Tucker, Roth & Shearer, Note 7). However, it appears that further basic research on this indirect measure is necessary prior to continued applied usage.

It is puzzling that attentional bias could be significantly predicted using subject involvement variables during the facilitation of aversive arousal, but not during the other affect conditions. Subjects' ratings of their affective involvement did not vary significantly across the positive/negative dimension, yet parallel prediction of attentional bias during the facilitation of sexual arousal was not evident. This result appears to corroborate the Dimond et al. (1976) suggestion that the right hemisphere is characterized by horrific affect, yet does not support EEG findings that the right hemisphere is significantly more active during sexual arousal (Cohen, Rosen & Goldstein, 1976; Goldstein, Sugerman, Marjerrison & Stoltzfus, Note 13).

Although ratings of subjects' reported success in inhibiting aversive arousal were an important component in the prediction of attentional bias during aversive arousal, no direct support for greater left hemisphere activation during inhibition of affective arousal was obtained in the attentional bias data. Although a left/right and inhibition/facilitation interaction was not evident, the results did not support earlier EEG findings that suggest that the left hemisphere is characterized by negative affect (Harman & Ray, 1977; Ehrlichman & Wiener, Notes 10, 11), while the right hemisphere is characterized by positive affect (Ehrlichman & Wiener, Notes 10, 11). In the present study, aversive affective arousal was accompanied by relatively greater left attentional bias, presumably reflecting relatively greater right hemispheric activation during negative affect. Considering that less success in inhibiting aversive arousal and greater success in facilitating aversive arousal were related to relatively greater right hemisphere activation, it is somewhat surprising that less physical arousal was apparently related to less left and more right hemisphere involvement. Subjects who noted their physical arousal generally reported bodily processes characteristic of the activity of the sympathetic nervous system, i.e., increased heart rate, increased depth of respiration, excess perspiration, etc. Bakan (Note 5) has suggested that the sympathetic division of the autonomic nervous system is part of the left hemisphere system and that the parasympathetic division is part of the right hemisphere system. Thus, this apparently contradictory result may support Bakan's contention that the sympathetic and parasympathetic divisions are differentially related to the two cerebral hemisphere systems. More specifically, this result suggests that sympathetic arousal may be accompanied by greater left hemisphere activation, and that psychological arousal and physical arousal may be orthogonal in their relationship to hemispheric functioning.

It is interesting to note that reported degree of psychological arousal is not an effective predictor of attentional bias, although success in approximating aversive arousal and reported physical aversive arousal are effective predictors. However, self-ratings of aversive psychological arousal were positively correlated with relatively greater left bias, i.e., right hemispheric activation ($r = +.20$, $p = .08$). This suggests that the ratings of psychological arousal did not account for any unique variance in attentional bias which was not accounted for by the other variables. It is important to note the contrast between the "main effect" component predictions and the overall, multiple prediction of attentional bias during aversive arousal, as presented in Table 4. Whereas the physical arousal rating accounts for a significant proportion of the variance (p = .02), the ratings of success under inhibition and facilitation instructions merely reflect trends. However, when the variables are combined in a multiple regression equation, the resulting prediction is highly significant, (p = .006). This suggests that there was considerable overlap among the predictor variables and that knowledge of multiple facets of affective responding are necessary for effective prediction of relative hemispheric activation.

A possible attenuating or distorting factor in the present study should be mentioned. Individuals participating in this study were asked to create affective states using relatively mild slides as facilitating stimuli. It is plausible that such fabricated arousal is both quantitatively and qualitatively different than spontaneous affective arousal. However, the paradoxical nature of instructions to "Be spontaneous!" makes realistic study of affective arousal in the laboratory a difficult task when deception is not employed. The use of more potent visual/auditory stimuli, such as sexual demonstration films and films regarding highway safety or primitive tribal rites, with willing subjects, would perhaps allow more realistic investigation of "positive" and "negative" affective arousal without such reliance upon subjects' abilities to involve themselves.

The correlational results obtained in the present study suggest that the Trait Anxiety Inventory and the Sex-Guilt Inventory are relevant indices of individual differences in aversive and sexual affective responding. Considering the methodological difficulties of the attentional bias task mentioned above, the fact that these measures did not effectively predict attentional bias should not declare them irrelevant. Correlations between subjects' ratings of their involvement in the suggested affective conditions and their TAI and SGI scores suggest that such individual difference measures could plausibly be effective predictors of relative hemispheric activation assessed in a more viable manner.

Despite the somewhat inconsistent nature of the data, and the methodological problems already mentioned, the present study offers some tentative empirical direction to speculation about the cerebral hemispheres' contributions to emotionality. The results, taken as a whole, suggest that traditional views of the "rationality" of the left hemisphere and the "emotionality" of the right hemisphere, or more recent dichotomizations of the hemispheres as affectively "positive" or "negative" (e.g., Ehrlichman & Wiener, Notes 10, 11; Harman & Ray, 1977) may overlook a significant functional interaction of the hemispheres in emotionality (Galin, 1974, 1977; Bakan, Note 5; Tucker, Note 12). In other words, it appears that subjectively experienced emotions may be a composite of the primitive, subcortical arousal of the limbic system, coupled with the spontaneous, often imaginal emotional tone of the right hemisphere, and the controlling, inhibiting, often verbal emotional tone of the left hemisphere. Within such a conceptualization, a given hemisphere would be neither inherently "emotional" or "rational," or inherently "positive" or "negative;" the valence of experienced emotion would be determined by the interaction itself.

The intriguing possibility that the cerebral hemispheres may be differentially employed during affective arousal and during inhibition of arousal seems to parallel recent preliminary research on relative hemispheric activation in psychopathology. Tentative data suggest that the left hemisphere may be relatively more active in depression (Tucker, Roth & Shearer, Note 7) and obsessive-compulsive neurotic styles (Shevrin & Smokler, Note 15), while the right hemisphere may be relatively more active in hysteric neurotic styles (Shevrin & Smokler, Note 15). Clinically, depressives and obsessive-compulsives typically manifest a constricted, inhibited, ruminative cognitive style, whereas hysterics typically present as unconstrained, impressionistic, and diffuse individuals. Perhaps these various forms of psychopathology may reflect exaggeration of the functioning of a given hemisphere system. More generally, perhaps psychopathology often involves overreliance upon a given hemispheric system, with the relative preclusion of the other hemisphere system, although this does not imply a cause and effect relationship. Bogen and Bogen (1969) have suggested that optimal integration of the hemispheres may be a prerequisite to creativity. Similarly, perhaps, integration of hemispheric functioning may be a prerequisite to "existential creativity," i.e., effective, adaptive coping with life's problems. Thus, perhaps psychotherapy focused away from usual cognitive style modalities may often prove to be more effective, as if this somehow balances differential hemispheric functioning. Tucker, Shearer & Murray (1977) have reported tentative supportive data for such speculation: individuals who were characterized by relatively greater right hemisphere usage tended toward greater reduction in self-reported and behavioral anxiety when they had participated in a primarily verbal cognitive-behavioral treatment, whereas individuals characterized by relatively greater left hemisphere usage tended to improve more if they participated in treatment focused primarily upon imagery.

Although such speculation is interesting, and may eventually prove to be useful, the simple hemispheric dichotomization of emotionality, even across the facilitation/inhibition dimension, is not possible from the present study, and may well be ultimately impossible. The present data do suggest that the cerebral component of emotionality may involve hemispheric interaction based upon the relative facilitative or inhibitory functioning of the right and left hemispheres, respectively. However, understanding of affective arousal, inhibition of arousal, and perhaps some forms of psychopathology, must necessarily focus upon the more general interaction of the cerebral component, including psychodynamic factors, with autonomic functions and subcortical systems. Pending further research, the present study offers tentative insight into the nature of the cognitive component of emotionality.

APPENDIX A

CONSENT FORM AND ASSESSMENT MATERIALS

Consent Form for Experiment No. 18

Description of the Study

This research project is a study of negative and positive emotions. It is difficult for us to study students in actual emotional situations; thus, we are requesting your cooperation in recreating positive and negative emotions in our laboratory. We will be asking you to view color pictures which have either sexual content (positive emotion) or frightening or repulsive content (negative emotion). You will be asked to either let yourself fully experience emotional thoughts and feelings or to keep yourself from experiencing emotional thoughts and feelings while you view the pictures. We cannot tell what you are thinking or feeling, so it will be a very private experience. You will be in a room by yourself while you are viewing the pictures. You will be asked to complete some questionnaires regarding your experience, but a number, rather than your name will be used to identify the forms. All of the persons who will be assisting in this project have agreed to maintain the privacy and confidentiality of your experience. Again, remember that we are depending upon your cooperation and abilities to assist us in studying these emotions.

If you have any qualms or misgivings about participating because of the nature of the research, please do not participate. If you do choose to participate, completion will require 1 1/2 - 2 hours, and you will receive the appropriate amount of course credit. We will be happy to share our findings with you after completion of the research project.

Informed Consent

I understand the nature of the research as described above and agree to participate. If I wish to discontinue participation in the experiment at any time, I may do so and still receive course credit.

____________________ ____________________

Date Signature

____________________ ____________________

Telephone No. Address

TALLY SHEET

Do circled condition first.

Subject Number: ______

Sex: M F

Headphone cord on: L R

Positive: Slide Set - 1 2

Negative: Slide Set - 1 2

	Positive Affect (Sexual arousal)		Negative Affect (Aversive Arousal)	
	Inhib/Facil	Inhib/Facil	Inhib/Facil	Inhib/Facil
1.	L R	L R	L R	L R
2.	L R	L R	L R	L R
3.	L R	L R	L R	L R
4.	L R	L R	L R	L R
5.	L R	L R	L R	L R
6.	L R	L R	L R	L R
7.	L R	L R	L R	L R
8.	L R	L R	L R	L R
9.	L R	L R	L R	L R
10.	L R	L R	L R	L R
11.	L R	L R	L R	L R
12.	L R	L R	L R	L R
13.	L R	L R	L R	L R
14.	L R	L R	L R	L R
15.	L R	L R	L R	L R
16.	L R	L R	L R	L R
17.	L R	L R	L R	L R
18.	L R	L R	L R	L R
19.	L R	L R	L R	L R
20.	L R	L R	L R	L R
21.	L R	L R	L R	L R

Record Stroop scores here: 1.) words______; colors______; color/words______

2.) words______; colors______; color/words______

PERSONAL REACTIONS QUESTIONNAIRE

(Negative - Facilitate)

1) To what degree were you able to let yourself experience frightening or revolting thoughts and feelings as you watched the slides? (Please circle appropriate number.)

1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5
Not at all ... Very Much

2) How much frightening or revolting arousal were you experiencing during most of the slides?

Mental or Psychological Arousal

1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5
Not at all ... Very Much

Physical Arousal

1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5
Not at all ... Very Much

3) Please describe briefly the nature of the arousal which you experienced.

PERSONAL REACTIONS QUESTIONNAIRE

(Negative - Inhibit)

1) To what degree were you able to stop yourself from experiencing frightening or revolting thoughts and feelings as you watched the slides? (Please circle appropriate number.)

1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5
Not at all ... Very Much

2) How much frightening or revolting arousal were you experiencing during most of the slides?

Mental or Psychological Arousal

1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5
Not at all ... Very Much

Physical Arousal

1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5
Not at all ... Very Much

3) Please describe briefly how you tried to keep yourself from becoming mentally or physically aroused.

PERSONAL REACTIONS QUESTIONNAIRE

(Positive - Inhibit)

1) To what degree were you able to <u>stop</u> yourself from experiencing sexually-arousing thoughts and feelings as you watched the slides? (Please circle appropriate number.)

1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5
Not at all ... Very Much

2) How much sexual arousal were you experiencing during most of the slides?

Mental or Psychological Arousal

1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5
Not at all ... Very Much

Physical Arousal

1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5
Not at all ... Very Much

3) Please describe briefly how you tried to keep yourself from becoming mentally or physically aroused.

PERSONAL REACTIONS QUESTIONNAIRE

(Positive - Facilitate)

1) To what degree were you able to let yourself experience sexual thoughts and feelings as you watched the slides? (Please circle appropriate number.)

1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5
Not at all ... Very Much

2) How much sexual arousal were you experiencing during most of the slides?

Mental or Psychological Arousal

1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5
Not at all ... Very Much

Physical Arousal

1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5
Not at all ... Very Much

3) Please describe briefly the nature of the arousal which you experienced.

APPENDIX B

ADDITIONAL DATA

TABLE 10

Descriptive Data For

All Variables

VARIABLE	MEAN	STANDARD DEV	CASES
DFPI	18.4167	9.8668	48
DFPF	17.0000	10.4189	48
DFNI	16.1667	10.8967	48
DFNF	17.3750	10.1931	48
TRAI	39.5000	8.0794	48
PIDG	4.0208	0.9998	48
PIPS	2.2917	0.8742	48
PIPH	1.6458	0.9107	48
PFDG	3.5625	0.9204	48
PFPS	3.6667	0.9302	48
PFPH	2.5417	1.0907	48
NIDG	3.6875	1.1139	48
NIPS	2.4375	1.0499	48
NIPH	1.6875	0.9029	48
NFDG	3.5000	0.9893	48
NFPS	3.4167	0.9187	48
NFPH	2.3333	0.9964	48
INTR	30.8958	8.0668	48
DOMI	132.6250	15.7272	48
SEXG	30.1667	16.4101	48

TABLE 11

Correlational Matrix For All Variables

	DFPI	DFPF	DFNI	DFNF	TRAI	PIDG	PIPS	PIPH	PFDG	PFPS	PFPH	NIDG
DFPI	1.00000	0.48099	0.65239	0.56410	-0.00854	0.03361	-0.08839	-0.17266	-0.00761	-0.07264	-0.19539	-0.06534
DFPF	0.48099	1.00000	0.58715	0.48764	0.10818	-0.05106	0.16586	-0.03812	0.13757	0.06806	-0.06178	-0.08800
DFNI	0.65239	0.58715	1.00000	0.68827	0.05123	0.04459	0.08190	-0.03466	-0.01591	0.03079	-0.07757	-0.08151
DFNF	0.56410	0.48764	0.68827	1.00000	-0.00103	0.07855	0.01373	-0.10228	0.06549	0.04712	-0.18324	-0.39799
TRAI	-0.00854	0.10818	0.05123	-0.00103	1.00000	-0.14092	0.17171	0.32821	-0.11016	-0.05662	0.18108	-0.24233
PIDG	0.03361	-0.05106	0.04459	0.07855	-0.14092	1.00000	-0.66440	-0.55257	-0.38297	-0.31267	-0.26421	0.08239
PIPS	-0.08839	0.16586	0.08190	0.01373	0.17171	-0.66440	1.00000	0.53341	0.34709	0.48843	0.36632	0.11745
PIPH	-0.17266	-0.03812	-0.03466	-0.10228	0.32821	-0.55257	0.53341	1.00000	0.26813	0.38512	0.53995	0.11930
PFDG	-0.00761	0.13757	-0.01591	0.06549	-0.11016	-0.38297	0.34709	0.26813	1.00000	0.74558	0.49542	0.15436
PFPS	-0.07264	0.06806	0.03079	0.04712	-0.05662	-0.31267	0.48843	0.38512	0.74558	1.00000	0.60116	0.20535
PFPH	-0.19539	-0.06178	-0.07757	-0.18324	0.18108	-0.26421	0.36632	0.53995	0.49542	0.60116	1.00000	0.40498
NIDG	-0.06534	-0.08800	-0.08151	-0.39799	-0.24233	0.08239	0.11745	0.11930	0.15436	0.20535	0.40498	1.00000
NIPS	0.01489	0.03890	-0.00279	0.14140	0.30474	0.05194	-0.00290	0.13775	-0.03991	0.00000	-0.04412	-0.48097
NIPH	-0.13315	-0.08143	0.07245	0.17253	0.26397	0.10165	-0.01685	0.25068	-0.21924	-0.02533	0.02431	-0.35305
NFDG	0.26156	0.04128	0.17366	0.29961	-0.11712	0.24738	-0.27062	-0.24797	-0.10515	-0.11560	-0.19717	-0.35720
NFPS	0.08841	0.04001	0.14807	0.20336	-0.20353	0.24516	-0.15455	-0.15047	-0.03145	0.06640	-0.06016	-0.22352
NFPH	-0.09666	-0.09632	-0.09145	-0.21995	0.15593	0.12102	-0.06514	0.20320	0.02320	0.14538	0.31974	0.01917
INTR	-0.10102	-0.02658	0.13236	-0.14468	-0.00441	0.17703	-0.21585	0.03542	-0.07505	-0.12949	0.02348	0.09102
DOMI	-0.09468	0.15582	-0.04507	0.15180	0.29269	-0.04415	0.12265	-0.02284	-0.00717	-0.03927	0.12000	-0.15015
SEXG	0.07972	-0.01070	0.03542	0.07823	-0.02840	0.10094	-0.05241	-0.03156	-0.37825	-0.23463	-0.17989	-0.15772

	NIPS	NIPH	NFDG	NFPS	NFPH	INTR	DOMI	SEXG
DFPI	0.01489	-0.13315	0.26156	0.08841	-0.09666	-0.10102	-0.09468	0.07972
DFPF	0.03890	-0.08143	0.04128	0.04001	-0.09632	-0.02658	0.15582	-0.01070
DFNI	-0.00279	0.07245	0.17366	0.14807	-0.09145	0.13236	-0.04507	0.03542
DFNF	0.14140	0.17253	0.29961	0.20336	-0.21995	-0.14468	0.15180	0.07823
TRAI	0.30474	0.26397	-0.11712	-0.20353	0.15593	-0.00441	0.29269	-0.02840
PIDG	0.05194	0.10165	0.24738	0.24516	0.12102	0.17703	-0.04415	0.10094
PIPS	-0.00290	-0.01685	-0.27062	-0.15455	-0.06514	-0.21585	0.12265	-0.05241
PIPH	0.13775	0.25068	-0.24797	-0.15047	0.20320	0.03542	-0.02284	-0.03156
PFDG	-0.03991	-0.21924	-0.10515	-0.03145	0.02320	-0.07505	-0.00717	-0.37825
PFPS	0.00000	-0.02533	-0.11560	0.06640	0.14538	-0.12949	-0.03927	-0.23463
PFPH	-0.04412	0.02431	-0.19717	-0.06016	0.31974	0.02348	0.12000	-0.17989
NIDG	-0.48097	-0.35305	-0.35720	-0.22352	0.01917	0.09102	-0.15015	-0.15772
NIPS	1.00000	0.55130	0.33798	0.40256	0.20337	0.09091	0.07973	0.26118
NIPH	0.55130	1.00000	0.10719	0.26293	0.30745	0.14442	0.08897	0.15725
NFDG	0.33798	0.10719	1.00000	0.77254	0.36692	0.10798	0.04376	0.19528
NFPS	0.40256	0.26293	0.77254	1.00000	0.26342	0.22131	-0.00810	0.20982
NFPH	0.20337	0.30745	0.36692	0.26342	1.00000	0.13676	0.10318	-0.09065
INTR	0.09091	0.14442	0.10798	0.22131	0.13676	1.00000	-0.40264	0.12936
DOMI	0.07973	0.08897	0.04376	-0.00810	0.10318	-0.40264	1.00000	-0.10808
SEXG	0.26118	0.15725	0.19528	0.20982	-0.09065	0.12936	-0.10808	1.00000

TABLE 12

Additional Multiple Regression Data

Variable/Source	beta	SS	df	F	p
1) A.B. Dif. Score: Pos.-Inhib.					
Trait Anxiety	+.04	7.65	1	.08	>.5
SCWT Interference	-.18	122.47	1	1.20	.28
SCWT Percep.-Concept. Dom.	-.17	100.02	1	.98	.33
Sex-Guilt	+.09	32.66	1	.32	>.5
Total Regression		187.13	4	.46	>.5
Within		4388.53	43		
2) A.B. Dif. Score: Pos.-Facil.					
Trait Anxiety	+.06	18.42	1	.16	>.5
SCWT Interference	+.03	4.84	1	.04	>.5
SCWT Percep.-Concep. Dom.	+.15	87.51	1	.76	.39
Sex-Guilt	+.003	0.00	1	.00	>.5
Total Regression		150.76	4	.33	>.5
Within		4951.24	43		
3) A.B. Dif. Score: Neg.-Inhib.					
Trait Anxiety	+.05	15.25	1	.12	>.5
SCWT Interference	+.13	73.72	1	.58	.45
SCWT Percep.-Concept. Dom.	-.008	.25	1	.002	>.5
Sex-Guilt	+.02	2.54	1	.02	>.5
Total Regression		115.23	4	.23	>.5
Within		5465.44	43		
4) A.B. Dif. Score: Neg.-Facil.					
Trait Anxiety	-.04	6.52	1	.06	>.5
SCWT Interference	-.11	44.54	1	.41	>.5
SCWT Percep.-Concep. Dom.	+.13	63.00	1	.58	.45
Sex-Guilt	+.11	53.23	1	.49	>.5
Total Regression		212.32	4	.49	>.5
Within		4670.93	43		

TABLE 13

Attentional Bias Difference Scores For Subjects Whose Self-Reports Were Classifiable As Imaginal/Global During Facilitation And Verbal/Analytic During Inhibition

Positive Affect

Subject No.	Pos.-Inhib.	Pos.-Facil.
23	-5	-3
27	+5	-15
33	+5	+10
43	-5	+1
45	-11	-1
47	-21	-21
48	-9	-5
57	+5	-7
58	-7	-11
59	+5	+5
69	+16	-13
n= 11	M= -2.0	M= -5.5

dependent t = .929, p = .38

Negative Affect

Subject No.	Neg.-Inhib.	Neg.-Facil.
32	-11	-13
45	+1	-5
48	-11	-1
62	-7	-9
65	-21	-21
n= 5	M= -9.8	M= -9.8

TABLE 14

Analysis of Sex Differences (df=1,46)

Variable	Mean	SD	F	p
1) Trait Anxiety			.41	>.05
Males	38.8	8.2		
Females	40.3	8.0		
2) Sex-Guilt			3.68	.06
Males	25.8	14.9		
Females	34.6	17.0		
3) Stroop Interference			4.05	.05
Males	28.6	6.4		
Females	33.2	9.0		
4) SCWT Percep./Concep. Dom.			.13	>.5
Males	133.5	12.5		
Females	131.8	18.7		
5) Pos.-Inhib. Success			.52	.47
Males	3.92	1.10		
Females	4.13	.90		
6) Pos.-Inhib. Psychological			.11	>.5
Males	2.25	.94		
Females	2.33	.82		
7) Pos.-Inhib. Physical			.03	>.5
Males	1.67	1.05		
Females	1.63	.77		
8) Pos.-Facil. Success			.61	.44
Males	3.67	.96		
Females	3.46	.88		
9) Pos.-Facil. Psychological			.10	>.5
Males	3.71	1.08		
Females	3.63	.77		
10) Pos.-Facil. Physical			.63	.43
Males	2.42	1.21		
Females	2.67	.96		
11) Neg.-Inhib. Success			.02	>.5
Males	3.67	1.13		
Females	3.71	1.12		

Variable	Mean	SD	F	p
12) Neg.-Inhib. Psychological			1.55	.22
Males	2.25	.99		
Females	2.63	1.10		
13) Neg.-Inhib. Physical			1.26	.27
Males	1.54	.66		
Females	1.83	1.10		
14) Neg.-Facil. Success			1.37	.25
Males	3.33	1.05		
Females	3.67	.92		
15) Neg.-Facil. Psychological			3.77	.06
Males	3.17	.87		
Females	3.67	.92		
16) Neg.-Facil. Physical			3.16	.08
Males	2.08	.88		
Females	2.58	1.06		
17) A.B. Dif. Score/Pos.-Inhib.			.87	.35
Males	19.75	10.40		
Females	17.08	9.32		
18) A.B. Dif. Score/Pos.-Facil.			.001	>.5
Males	17.04	9.57		
Females	16.96	11.41		
19) A.B. Dif. Score/Neg.-Inhib.			.14	>.5
Males	16.75	10.53		
Females	15.58	11.45		
20) A.B. Dif. Score/Neg.-Facil.			.06	>.5
Males	17.75	9.92		
Females	17.00	10.65		

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