Asymmetrical Frontal Lobe Function during a Transient Depressive State

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Evidence from a variety of sources indicates that the major forms of human psychopathology are accompanied by consistent patterns of asymmetrical function of the cerebral hemispheres. While there are a variety of methodological issues which must be addressed in this research, the theoretical significance of this asymmetry must also be considered. Observing lateralized impairment of brain function traditionally leads to the interpretation of a lateralized brain lesion. Although many instances of psychopathology may be caused or complicated by organic pathology, I suggest that evidence of asymmetrical activation and function of the two hemispheres in normal emotion has important parallels to the evidence of asymmetrical brain function in psychopathology. This research with normal emotion has led to a consideration of lateralized arousal processes in the brain, mediated by specific neurotransmitter systems, that differentially regulate the contributions of the two hemispheres to ongoing cognition. The operation of these arousal processes may be closely associated with the subjective experience of emotion [1].

Research by Flor-Henry [2, 3] has indicated that in contrast to a left hemisphere dysfunction in schizophrenia, patients with affective disorders show impaired right hemisphere contribution to neuropsychological task performance. Congruent findings with affective disorder patients by Yozawitz et al. [4] and Bruder and Yozawitz [5] showed a pattern of dichotic listening performance in these patients which was similar to that shown by patients with known right hemisphere lesions. Other research has shown that a right hemisphere deficit characterizes patients who are diagnosed specifically as depressed.

Examining the specific symptom of depression in this research is important given findings that when the depression is improved the right hemisphere’s performance capacity may normalize. Kronfol et al. [6] showed that when ECT clears the depression, right hemisphere performance improves. A similar cognitive improvement specific to the right hemisphere was found following tricyclic treatment in depressed children [7]. These observations suggest a close corre-
spondence between an individual's mood level and the right hemisphere's performance ability.

In initial research on normal emotion with college students, Tucker et al. [8] found that those students who reported greater depression on an adjective checklist also reported less vivid visual imagery. Questioning whether this finding may indicate a normal analogue to right hemisphere dysfunction in psychiatric depression, we attempted to manipulate mood level experimentally, then to examine measures of relative hemispheric activation and performance. We worked closely with undergraduate students to insure that the hypnotic mood induction procedures would be effective and would be an educational experience for the students. After an induction period, direct suggestions of mood level were given, taken from diagnostic descriptions of mania or depression. During the mood condition, the subjects performed an auditory attentional bias task, in which tones were presented to both ears simultaneously and the subject was asked to report which tone sounded louder. The subject also performed two cognitive tasks, one involving mental arithmetic and the other visual imagery, in counterbalanced order. The subject was then removed from the hypnotic trance, debriefed to insure the mood had cleared, then the opposite mood condition was initiated, with a parallel set of attentional and cognitive tasks.

The mood induction procedures in this research, particularly for depression, were effective, and often several minutes were required for the mood to clear. The results for the auditory attentional bias task showed symmetrical judgments of tone loudness during the euphoric mood, but a bias toward reporting the right ear as louder during the depressed mood condition. This result suggests relatively greater left than right hemisphere activation during the depressive state, and may parallel findings of asymmetrical dichotic listening performance in affective disorders [4, 5]. The results for the cognitive tasks indicated that arithmetic performance was stable across mood conditions, but imagery was impaired in depression.

It is not possible to draw clear inferences as to hemispheric performance from these simple tasks. Imagery and arithmetic differ on many features other than the requirement for lateralized processing. However, this study does indicate that the relationship between depression and poor imagery that we observed in our earlier research could be found with a transient affective state. Also, the auditory attentional bias data provide some independent indication of a relative shift in hemispheric activation during the depressive mood. To gather electrophysiological data on hemispheric activation during induced mood states we repeated our mood induction procedures with a new group of students, this time recording EEG signals from the left and right frontal (F3, F4), central (C3, C4), parietal (P3, P4), and occipital (01, 02) electrode sites. The EEG was amplified with low-noise, optially coupled, battery-powered amplifiers with a 0.1 time constant, and digitized at 500 samples per second. Epochs of 2 s of EEG data
were Fourier analyzed; with a 2-s inter-epoch interval, power spectra for 15 epochs were generated for each 1-min recording period, the length of each of the arithmetic and imagery tasks in each mood condition. Power in the alpha band (7.5–12.5 Hz) was extracted from each power spectrum, and the mean left minus right alpha power values for each region were subjected to a mood by task repeated measures analysis of variance. The task factor was significant for the occipital region (F = 7.49, p < 0.02), in the direction consistent with previous research. The mood factor was significant only for the frontal lobes (F = 8.34, p < 0.01), with the direction of the asymmetry indicating relatively less alpha over the right frontal region during depression.

Under the assumption that alpha desynchrony indicates cortical activation, these results indicate that the depressed mood in this research was characterized by activation of the right frontal region. A similar pattern of asymmetrical frontal alpha as a function of normal emotion has been reported recently by Davidson [9]. Independently of our research, he found that normal subjects' reports of negative emotion in two experimental conditions were associated with activation of the right frontal region, while positive emotion appeared to be associated with greater left frontal activation.

Davidson [9] interprets the data as congruent with his view that the left hemisphere handles positive emotion, while the right hemisphere is more involved in negative emotion. This interpretation is in agreement with interpretations of the emotional effects of unilateral brain lesions recently offered by Sackeim et al. [10], although other interpretations of this literature are possible [1]. Since my colleagues and I observed frontal lobe activity during the same mood conditions which seemed to produce impairment of the right hemisphere's performance, we have considered whether the right frontal lobe activity may represent an inhibitory process, rather than indicating a general involvement of the right hemisphere in negative emotion.

More research and theoretical work is required to reach a definite understanding of the role of the frontal lobes in emotion. What does seem clear at this point is that particular emotions may involve asymmetrical frontal activity. That the findings of frontal asymmetry in normal emotions may be relevant to brain function in psychopathology is supported by recent EEG findings in relation to specific symptoms in depressed psychiatric patients by Perris and Monakhov [11] and Perris et al. [12]. Beta activity of the right precentral area seemed to be relevant to depressive mood, while symptoms of ruminative ideation and anxiety appeared to covary more closely with activity of the precentral region of the left hemisphere. Through further research examining the relationship of lateralized cortical activation to specific psychiatric symptoms and to chronic or transient states of emotional arousal, it may be possible to better understand those processes in the brain which support the relationship between emotional integrity and cognitive competence.
Summary

An association between a depressed mood and impaired visual imagery in normal students, observed both cross-sectionally and with experimental mood induction, may parallel the poor right hemisphere performance of psychiatric depressives. Asymmetrical frontal lobe activation found during a transient depressed mood in normals suggests that altered lateralized arousal processes in psychiatric disorders may represent pathological forms of normal emotional processes.

References


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