FRONTAL HEMISPHERE LATERALIZATION AND DEPRESSIVE PERSONALITY TRAITS

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Summary.—To assess the relationship between hemispheric differences in information processing and interhemispheric asymmetries in terms of brain bioelectrical activity, we correlated scores on the MMPI Depression scale with interhemispheric asymmetry, measured as peak amplitude and latency of the P3 component of somatosensory evoked potentials (SEPs) at the frontocortical region of 14 healthy unselected volunteers (8 men and 6 women) who were about to start a course in autogenic training. The sample was subdivided into two groups on the basis of the median score on the MMPI Depression scale. Subjects scoring above the median showed a right lateralization at the frontocentral region and a significantly shorter P3 latency at the right hemisphere compared to the left.

Since the late 19th century, mood disorders were supposed to be related to hemispheric cerebral asymmetries. C. B. Lewis (1895) introduced this view by reporting the case of a patient with manic depressive illness wherein cerebral hemisphere dominance changed according to the phase of the illness. During the depressive phase, the patient was almost immobile, spoke incoherently and in Welsh only, and used his left arm almost exclusively. During the manic phase he became agitated, aggressive, spoke both in English and Welsh, and used mainly his right arm.

The importance of frontal areas in the control of mood is supported by more recent data, although in 1923, Feuchtwanger, observing more than 400 cases of brain gunshot injury, noted that the group of patients with frontal lesions presented with either euphoric or depressive mood changes and showed apathy or exuberant thought, but had only slight intellectual impairment (Feuchtwanger, 1923).

Today there is a great deal of evidence on the involvement of the right hemisphere in depression; this evidence derives from studies of psychiatric patients and patients with brain lesions (Hecaen, 1962; Hommes, 1965; Martin, Ford, McDonald, & Towler, 1965; Gainotti, 1972; Cronin, Bodley, Potts, Mather, Gardner, & Tobin, 1970; Sackeim, Greenberg, Weiman, Ruben, Hungerbuhler, & Geschwind, 1982; Fromm & Schoepflecher, 1984). Quantitative studies, based on spontaneous cerebral bioelectrical activity recording, indicate that depressive patients show greater EEG variability, especially at the right hemisphere (Perris, 1975; von Knorring, 1983). More...

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over, a greater activation of right frontal areas was often observed compared to the left (Perris, Monakhov, von Knorring, Botskarev, & Nikiforov, 1978; Tucker, 1981; Tucker, Stenslie, Roth, & Shearer, 1981; Schaffer, Davidson, & Saron, 1983). This was shown not only in clinically depressed subjects (Perris, et al., 1978; Schaffer, et al., 1983) but as well in healthy volunteers subjected to imagery of a negative emotional state comparable to dysphoric mood (Tucker, 1981; Tucker, et al., 1981; Banich, Stolar, Heller, & Goldman, 1992). These studies stressed the importance of right-hemisphere function, particularly in the frontal area, during depressive experiences.

The evaluation of brain bioelectrical activity evoked by sensory stimuli permits obtaining “dynamic” data on central processing of environmental stimuli. Therefore, brain evoked-potential (EP) recording gives the opportunity to assess information processing and its possible alterations through the adoption of adequate experimental paradigms. In this context, the P3 component, which appears at about 250 to 450 msec. after stimulation, depending on the modality of stimulation, corresponds to the processes of memory updating by means of the incorporation of new information (Picton & Hillyard, 1988). Moreover, by using experimental paradigms based on the detection of target stimuli interspersed in a series of more frequent nontarget stimuli (“oddball” paradigm), the P3 component permits the evaluation of the subjective reaction to novelty; the more unexpected the stimulus, the greater the P3 peak amplitude (Donchin, Ritter, & McCallum, 1978; Hillyard & Kutas, 1983).

The few studies that used EPs to assess hemisphere function in depression point to the existence of right-hemisphere dysfunction (Perris, 1974; Buchsbaum, Carpenter, & Fedio, 1979). On this ground we speculate that there may be a correspondence between hemispheric asymmetries, probed through the EEG, and hemispheric differences in information processing to be tested by means of EPs. The aim of this study was to investigate whether the presence of marked depressive personality traits identifies subjects with P3 component asymmetry. To do this, we focused specifically on the frontocentral cerebral region.

**Method**

**Experimental Design**

Somatosensory stimuli were administered to 14 volunteers by means of electrodes applied on the skin surface of the right wrist. Brain bioelectrical activity was recorded during such stimulation. The personality characteristics of these subjects and the possible presence of psychopathological traits were investigated by means of the MMPI, R-form (Dahlstrom, Welsh, & Dahlstrom, 1972).

**Sample**

Fourteen right-handed, physically healthy volunteers (8 men and 6 wom-
carried out for a 1000-msec. period. A 100-msec. prestimulus period was considered as baseline. The P3 component was identified as the most positive deflection in the 250- to 450-msec. interval separately by two of the authors (P.V. and L.R.) who were unaware of other results. For each subject the following data were analyzed, (1) peak amplitude and latency of P3 elicited by 40- and 30-mA stimuli at the left and right frontocentral leads and (2) the index of cerebral hemisphere lateralization evaluated on the basis of the P3 wave peak amplitude evoked by target stimuli in the right and left frontocortical regions. The formula used (Hiramatsu, Kameyama, Saitoh, Niwa, Rymar, & Itoh, 1984) was

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\text{Laterality Index (LI)} = \frac{\text{P3 left} - \text{P3 right}}{\text{P3 left} + \text{P3 right}} \times 100.
\]

In this study, we report only on data recorded from the F3/C3 and F4/C4 leads, since such leads reflect much of the activity of the frontal cortex, an area appearing to be primarily involved in mood control.

Concerning personality characteristics, scores on all MMPI scales were separately analyzed. To investigate the relationships between the Laterality Index and individual MMPI scale scores, we first used Pearson's product-moment correlation. Since right-hemisphere lateralization was hypothesized to be present only in subjects with marked depressive traits (Flor-Henry, 1979), we dichotomized the sample on the basis of the median scores on the Depression scale (T score mean = 68) into a higher depression (H-D) and a lower depression (L-D) group of seven subjects each. The H-D profile shown in Fig. 1 with peaks at the MMPI D, Pt, Sc, and Si scales, is characteristic of subjects with marked depressive traits (Butcher, Pancheri, & Straccia, 1976); however, none of these subjects received a psychiatric diagnosis.

Since our dichotomized sample consisted of small groups, we used non-parametric statistics. For intergroup comparisons we used the Mann-Whitney U test, whereas for intragroup comparisons we used the Wilcoxon matched-pairs signed-ranks test. The \( \chi^2 \) test was used to assess sex differences between the two subgroups (Siegel, 1956). The significance level was set at \( p < .05 \).

RESULTS AND DISCUSSION

The mean MMPI profiles of higher- and lower-scoring groups on Depression are shown in Fig. 1. On the Depression scale, means and standard deviations were for the group scoring lower on Depression 57.1 and 10.2, respectively, and for the group scoring higher on Depression 84.4 and 11.2, respectively. The male to female ratios in the two groups did not differ significantly (\( \chi^2; p = .08 \)). No correlation was found between the Laterality Index and the MMPI Depression scale scores.

The mean Laterality Indexes were -26.4 (SD = 36.3) for the group scoring higher on Depression and +16 (SD = 19.6) for the group scoring lower on Depression. The Laterality Index showed a significant lateralization to the right in the group scoring higher on Depression when compared with the lower scorers (\( U = 8, p < .02 \)). Further, the left-to-right comparison of P3 peak latency relative to target stimuli yielded a significantly shorter P3 latency at right for the group scoring higher on Depression (\( T = 0, p < .01 \)) but not in the lower scorers (\( T = 11, \) nonsignificant). This difference could not be attributed to age, since age did not differ statistically between the two groups (\( U = 12.5, \) nonsignificant). A SEP of a typical higher scorer on Depression is shown in Fig. 2.
In this study we found a lateralization of the P3 peak amplitude evoked by target stimuli at the right cerebral hemisphere of subjects scoring higher than the median on the Depression scale of the MMPI. The lack of correlation between the estimates of Laterality Index and MMPI D-scale scores supports the view that right-hemisphere lateralization would be characteristic of subjects with marked depressive traits. This points to the presence of a Depression scale score threshold above which P3 lateralization would appear.

Flor-Henry (1979) speculated that the left hemisphere normally controls neuronal structures of the right hemisphere, thereby modulating the expression of emotions laden with a negative meaning. On this ground he hypothesized that a lack of such control would result in greater lateralization towards the right; this would be associated with a depressive condition (Flor-Henry, 1979). The above model constitutes an important reference for the interpretation of our results. The generator of the P3 component is probably a right frontocentral site that could be the result of reduced inhibitory control of the left hemisphere on brain processes that contribute to the expression of depressive traits. Moscovitch (1979) went further to poise that hemispheres focus attention differentially as a result of the expectations engendered by various stimuli. If we refer to the model that considers the right hemisphere to be basic in the processing of experiences laden with a negative affect (Galin, 1974; Ahern & Schwartz, 1979; Sackeim, et al., 1982), our results would suggest that a dynamically recorded interhemispheric asymmetry would constitute the functional neurobiological basis on which depressive subjects build their own view of the world.

In conclusion, a method of “dynamic” recording of brain bioelectrical activity permits the evaluation of “phasic” responses of the two hemispheres to the same sensory input. The use of this method in our study yielded results similar to those obtained in studies using nonspecific, “steady-state” data, such as resting EEG. Moreover, the integration of psychophysiological data with personality traits offers support for the hypothesis of the presence of a right-hemisphere dysfunction during the expression of depressive traits.

It should also be recalled that our findings regard a population of clinically depression-free subjects. This allows us to rule out that our results were influenced by drug intake. However, since our sample is small and no patient was assessed, our results should be considered preliminary and warrant replication and confirmation among patient populations before conclusions are drawn.

**REFERENCES**


Kinsbourne (1970) hypothesized that the two hemispheres have different ability to use attention and that the kind of material processed differentially activates the two hemispheres. Moscovitch (1979) went further to propose that hemispheres focus attention differentially as a result of the expectations engendered by various stimuli. If we refer to the model that considers the right hemisphere to be basic in the processing of experiences laden with a negative affect (Galin, 1974; Ahern & Schwartz, 1979; Sackeim, et al., 1982), our results would suggest that a dynamically recorded interhemispheric asymmetry would constitute the functional neurobiological basis on which depressive subjects build their own view of the world.

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