PERSONALITY CORRELATES OF ELECTROENCEPHALOGRAPHIC PATTERNS: RORSCHACH FINDINGS

M. SAM RABINOVITCH, MARGARET A. KENNARD
Department of Neurological Research, University of British Columbia
AND W. P. FISTER
Crease Clinic of Psychological Medicine, Essondale, B.C.

There have been many reports describing meaningful relationships between electroencephalographic (EEG) patterns and psychological phenomena in individuals with no known neurological dysfunction (9, 12). However, the findings are not completely consistent, nor is there agreement among workers in the field about the reliability of many of these relationships. This lack of agreement is particularly evident among those who have tried to correlate brain wave patterns with personality and with psychological disorders. Such a situation is not surprising in view of the clinical, rather than experimental, approach that has characterized most of these studies. Clinical appraisal of personality, normal or abnormal, and clinical evaluation of EEG records are both subject to many unknown sources of variability, and generalizations based on unreliable data are likely to be tenuous.

The present study is concerned with the area of personality. It is part of a larger research project designed to apply more refined methods of psychological and electroencephalographic analysis to the relation between brain wave patterns and psychological variables, in the hope that such methods may yield reliable data which will be productive of testable hypotheses and permit comparison with the results of other relevant studies.

In the study of a complex phenomenon such as personality, it is tempting to isolate its discrete components and deal with them one at a time.
a time. This approach has obvious experimental advantages, but has also the disadvantage that in isolation such components may be distorted, and only remotely related to the basic problem. This consideration prompted the use in the present study of two general approaches in categorizing personality. First, three groups of subjects were so selected that they represented three different behaviour modes of personal and social adjustment, modes which previous reports (9, 12) have related to EEG patterns. Secondly, in the light of encouraging results from other studies (15, 22), the Rorschach method of personality evaluation was used, together with other tests enumerated below, so that various components of personality could be studied both in isolation and in relationship to each other. The present paper reports the relationships between personality as categorized in the above two ways and EEG patterns.

**Methodology**

**Subjects.**

Three groups of subjects were used: 64 consecutive admissions to a provincial psychiatric hospital (Crease Clinic, Essondale, B.C.); 33 inmates of a provincial prison (Oakalla Prison Farm) who had at least two convictions and were free of psychosis or psychoneurosis; and 50 normal subjects selected from among stenographic staff, student nurses, and laboratory technicians at the Mental Hospital, who had neither psychiatric nor criminal histories, and who had been evaluated as successful workers and pleasant working companions by their job supervisors. These made a total of 147 subjects.

The psychiatric patient group consisted of 31 males and 33 females; mean age was 23.86 years. The prison inmates comprised 28 males and 5 females; mean age 22.94 years. The normal controls included 23 males and 28 females; mean age 22.62 years. Age range for the total group was 16 to 30.

Subjects were excluded if they were of subnormal intelligence (below 80 I.Q. on the Full Scale of the Wechsler-Bellevue test), if they had any history suggestive of an organic brain condition, and if they had undergone any physical treatment within the preceding four months which might affect their EEG patterns. The psychiatric patients were examined within 72 hours of admission to hospital, before any treatment procedures were instituted.

**Procedure.**

Each subject received: an EEG examination with a Grass 8-channel, Model III apparatus, connected and synchronized with an Offner Frequency Analyser; a psychiatric interview; and a battery of psychological tests, including the Wechsler Bellevue Intelligence Scale, Bender-Gestalt, Shipley-Hartford Abstraction Scale, and Rorschach test. All psychological testing was done within 48 hours after the EEG, most of it within 24 hours.

All the patient group were given satisfactory EEG examinations before any treatment procedures were begun. However, 20 of them were too disturbed and uncooperative to be given psychological tests. Hence the relationships to be described between Rorschach scores and EEG characteristics are based on 44 patients, whereas the comparisons not involving test scores are based on 64 patients.
Electroencephalograph Data

Each EEG was recorded, examined, and interpreted according to the usual clinical procedure. In addition, to obtain a precise, objective, and yet comprehensive picture of the frequency aspect of the electrical activity of the brain, an electronic frequency analyser was used. This analyser records graphically the amount of electrical output between two electrodes in a given 10-second period in each desired frequency from one to 30 per second. The analysis is recorded simultaneously with the regular electroencephalogram, and the focus may be shifted to yield an analysis from any one of the eight recording EEG channels.

Figure 1. A sample EEG record. The lines labelled A through H are the ordinary EEG tracings. The line marked X is the frequency analyser tracing corresponding to channel G. The number beneath each rise in the analyser tracing indicates the specific frequency associated with that rise.

Figure 1 is a small sample of an EEG record. The lines labelled A to H are the usual EEG tracings. The frequency analyser tracing, which here records from channel G, is labelled X. The number below each rise in this latter tracing indicates the specific rate per second associated with that rise. The extent of each rise is a direct index of the relative amount of electrical energy output in each frequency as compared to the other frequencies in the specific electroencephalogram.

After the electroencephalogram and electronic frequency analyses were completed for each of the eight EEG channels, the height of each frequency analyser deviation in the record was measured. These measurements were graphed, and resulted in a profile of the distribution and relative amounts of the electrical wave frequencies recorded from the various underlying cortical areas. In the EEG material to be cited here, frequency measurements, obtained by bipolar recording, were used from eight
cortical areas: the left and the right frontal, motor, parietal, and occipital areas. Figure 2 shows the graph profile of a normal control subject. To simplify this illustration, the analyser measurements of only four of the eight channels, those from the left side, are presented. In practice it was found profitable to use different colours and symbols in graphing the eight channels (13).

Careful study of a large number of graph profiles indicated 10 characteristics which provide a useful scheme for describing the general pattern revealed in each

![Graph Profile](image)

**Figure 2.** A sample graph profile of a normal subject, showing graphically the analyser tracing measurements of four EEG channels from the left side of the head.
These 10 criteria make it possible to compare large groups of profiles. They are defined as follows:

1. **Well organized**: All eight lines run close together with no exceptions to the common direction of progress.

2. **High alpha**: The presence of a distinct rise in 5 of the 8 channels of the alpha (frequency 8 to 12) band, with a single peak and a narrow base.

3. **Peak in frequency 16 to 20**: A sharp upward shift in 5 of the 8 channels in this frequency range.

4. **Peak in frequency 5 to 7**: A sharp upward shift in 5 of the 8 channels in this frequency range.

5. **Peak in frequency 13 to 15**: A sharp upward shift in 5 of the 8 channels in this frequency range.

6. **Spread**: When the 8 lines of the graph run in a band more than 2 centimeters in width.

7. **Poly-peak alpha**: When 5 of the 8 channels in the alpha range show more than one peak.

8. **Peak in frequency 22 to 30**: A sharp upward shift in 5 of the 8 channels in this frequency range.

9. **Poor organization**: When an outstanding characteristic of the profile is the failure of its various lines to converge in any way, where they criss-cross frequently and seem to bear no relation to each other.

10. **Left right dys-synchrony**: Where there is a significant left-right difference in three of the four channel pairs.

The above criteria are in a sense qualitative rather than quantitative. This is in keeping with the frequency analyser data which are of a comparative, rather than absolute, nature. That is, the data allow for appraisal of the electrical output in the various frequency ranges within each individual graph. Day to day fluctuations in the critical balance of the analyser apparatus and various other technical considerations4 make the data unsuitable for quantitative inter-individual comparisons.

**Results**

**EEG Profile Characteristics of the Three Subject Groups**

Table I presents the incidence, in percentages, of each graph profile characteristic for the three groups of subjects, as well as the significant t ratios of the differences among these groups. Thirty t ratios were calculated; hence one would expect two of them to be significant by chance alone, using the 5% level of confidence. However, since there were 17 significant t ratios, 14 of them at the 1% level, it is felt that the profile characteristic differences shown in Table I can be accepted with reasonable confidence.

These results may be summarized as follows. (a) The psychiatric patients differ from the normals in that their EEGs tend to be less well

---

3. See footnote 3.

4. A more detailed account of the development of this entire system of evaluating EEG data as well as a comparison of electronic and clinical methods of EEG appraisal will be presented in a forthcoming publication.
organized (characteristics 1, 6, 9); show more electrical activity in all frequencies except the 16 to 20 range (characteristics 4, 5, 8); show more tendency to have multi-peaks in the alpha range (characteristic 7); and show more left right dys-synchrony in their graph profiles (characteristic 10). (b) The psychiatric patients differ from the prison inmates in that their graph profiles show less organization (characteristics 1, 6); fewer high alpha pictures (characteristic 2); more activity in all frequency ranges except 16 to 20; and more left right dys-synchrony. (c) The prisoners and normals differ significantly only in that the former show more high alpha pictures (characteristic 2), and more theta activity (characteristic 4). The only characteristic which yields no significant differences between the three groups is that relating to the frequency range 16 to 20. All three groups have a high incidence of activity in this range.

### TABLE I

**INCIDENCE, IN PERCENTAGES, OF THE 10 GRAPH PROFILE CHARACTERISTICS, WITH SIGNIFICANT t RATIOS OF DIFFERENCES AMONG THE THREE GROUPS**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Graph profile characteristics (numbered as in the text)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
<th>(10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Psychiatric patients (N = 64)</td>
<td></td>
<td>11.36</td>
<td>27.27</td>
<td>86.36</td>
<td>75.00</td>
<td>72.73</td>
<td>63.64</td>
<td>54.55</td>
<td>65.91</td>
<td>45.45</td>
<td>40.91</td>
</tr>
<tr>
<td>(2) Prison inmates (N = 33)</td>
<td></td>
<td>41.20</td>
<td>58.80</td>
<td>79.40</td>
<td>61.80</td>
<td>50.00</td>
<td>35.30</td>
<td>26.50</td>
<td>23.53</td>
<td>26.50</td>
<td>5.90</td>
</tr>
<tr>
<td>(3) Normals (N = 50)</td>
<td></td>
<td>38.00</td>
<td>30.00</td>
<td>74.00</td>
<td>36.00</td>
<td>38.00</td>
<td>40.00</td>
<td>24.00</td>
<td>10.00</td>
<td>16.00</td>
<td>14.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>t Ratios</th>
<th></th>
<th>(1) vs. (2)</th>
<th>(1) vs. (3)</th>
<th>(2) vs. (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) vs. (2)</td>
<td></td>
<td>3.20*</td>
<td>3.12*</td>
<td>2.22**</td>
</tr>
<tr>
<td>(1) vs. (3)</td>
<td></td>
<td>3.36*</td>
<td>4.49*</td>
<td>4.93*</td>
</tr>
<tr>
<td>(2) vs. (3)</td>
<td></td>
<td>2.70*</td>
<td>2.58**</td>
<td>3.52*</td>
</tr>
</tbody>
</table>

*Significant at the 1% level. **Significant at the 5% level.

**Relations between Rorschach and Profile Characteristics**

Each subject's Rorschach protocol was administered and scored essentially as outlined by Beck (1) and the following categories calculated: R, W%, D%, A%, H%, P, T/1R, F-%, F%, M, Sum C, Sum Y (computed in the same basic way as Sum C), Sum V (computed in the same basic way as Sum C), and S. With the entire 127 subjects treated as a whole, each of the 14 Rorschach categories was related to the 10 EEG graph profile characteristics. This was done by taking the highest and lowest thirds for each Rorschach category and computing the incidence of the profile characteristics for these two groups of subjects.
Of the 140 pairs of comparisons thus made, only two indicate significant relationships. Those subjects with no M responses on their Rorschach record had a significantly greater incidence of electrical activity in the frequency range 16 to 20 (characteristic 3) than did those subjects who had three or more M responses ($t$ ratio $2.20$, $P<.05$); and those subjects with no S responses had a significantly lower incidence of well organized graph profiles (characteristic 1) than did those subjects with two or more S responses ($t$ ratio $2.56$, $P<.02$). The reliability of these relationships is questionable since, in making 140 comparisons, chance factors alone could account for 7 significant relationships at the 5% level. Thus it would be safer to conclude that there is probably no relationship between any single Rorschach scoring category and the EEG characteristics.

In clinical usage the Rorschach is most valuable when the test results are treated as an integrated whole, and least valuable when single response categories are considered as entities. To apply this integrated approach and still allow for some objectivity, three further analyses of the Rorschach data were carried out to yield the following: an index of maladjustment, based on each subject's entire test record; a rating based on those test responses which are generally accepted as indicative of personal anxiety; and an estimate of experience type (balance of intro- versive against extratensive personality trends), based on the quantitative balance of $M$ and $Sum C$ test response categories.

Fisher (6) has developed an index, in terms of pattern criteria, which evaluates "various degrees of personal maladjustment" as indicated in an individual's Rorschach record. This index was calculated for each subject. The mean maladjustment index of the group of psychiatric patients is 48.38, of the normal controls 38.82, giving a mean difference of 9.56 index units. This difference yields a $t$ ratio of 2.50, $P<.02$. To relate the maladjustment index and the EEG graph profile characteristics, the three groups of subjects taken as a whole were ranked according to degree of maladjustment, and the incidence of the ten profile characteristics among the highest and lowest thirds was calculated. Of the ten comparisons thus made, one indicates a significant difference. Forty-five per cent of the subjects whose Rorschach records reflect a greater degree of maladjustment ($N = 42$, index range 50–107, mean 69.07) show the high alpha picture (characteristic 2), whereas only 22 per cent of the group with the lesser degree of maladjustment ($N = 42$, index range 5–33, mean 24.49) show this EEG characteristic. The difference of 23 per cent yields a $t$ ratio of 2.03, $P<.05$. The high maladjustment group consists of 21 patients, 12 prisoners and 9 normals, the less maladjusted group of 15 patients, 9 prisoners, and 18 normals. The previous findings
of reliable graph profile and maladjustment index differences between patients and normals appears inconsistent with the finding of only one EEG characteristic which differentiates the extremes of the index ranking. Also unexpected is the fact that the low maladjustment group includes almost as many patients as the high maladjustment group. This prompted a further analysis.

From among the patient group, those who had been confidently diagnosed as schizophrenic on the basis of clinical history, psychiatric examination, and psychological testing, were selected. This yielded nine subjects with a mean maladjustment index of 58.22. When this group is compared to the normals (mean index 38.82) there is no significant difference between the two mean maladjustment indices ($t$ ratio 1.53, $P > .10$). However, these two groups have significantly different percentage incidences on five of the ten EEG profile characteristics. The schizophrenics show lower good organization (characteristic 1), more activity in all frequency ranges except 16 to 20 (characteristics 4, 5, 8), and more left right dys-synchrony. These five characteristics also differentiate the normals from the entire patient group (Table I). Thus, it appears that the ten graph profile criteria yield meaningful discriminations among subjects more consistently than does the maladjustment index.

Experimental studies (4, 17) and clinical experience (1, 14) indicate several categories of Rorschach scoring which reflect personal anxiety. Based upon the most general agreement among these sources, five categories were selected: (a) responses which use shading ($Y$ or $C'$) or texture ($T$ or $c$) as the only or the main determinant; (b) responses which use colour ($C$) as the only determinant; (c) responses which ascribe movement to inanimate objects ($Fm$); (d) responses which use vista ($V$ or $FK$); and (e) the presence of two or more card rejections. From among all the subjects, those whose Rorschach protocols contained three or more of the above five criteria were selected as an anxiety group. All the remaining subjects were considered non-anxiety for purposes of this phase of the analysis. This procedure resulted in an anxiety group made up of 13 patients, 5 prisoners, and 11 normals; total 29. The non-anxiety group consisted of 31 patients, 28 prisoners, and 39 normals; total 98. Table II presents a comparison of these two groups with regard to the incidence of the ten EEG graph profile characteristics. The results indicate that the graph profiles of the anxiety group, as compared with those of the non-anxiety group, are more often poorly organized (characteristics 6, 9), more likely to contain theta activity (characteristic 4) and fast frequency activity (characteristic 8), and more frequently show multi-peaks in the alpha range (characteristic 7). All these characteristics also differentiate the psychiatric patients from the normal controls.
TABLE II
INCIDENCE, IN PERCENTAGES, OF THE 10 GRAPH PROFILE CHARACTERISTICS, WITH SIGNIFICANT t RATIOS OF DIFFERENCES BETWEEN ANXIETY AND NON-ANXIETY GROUPS

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Graph profile characteristics (numbered as in the text)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety group ((N = 29))</td>
<td>20.69 24.14 72.41 72.41 62.07 58.62 51.72 44.83 48.28 27.59</td>
</tr>
<tr>
<td>Non-anxiety group ((N = 98))</td>
<td>29.59 35.71 76.53 50.00 50.00 39.79 27.55 22.44 19.38 19.38</td>
</tr>
<tr>
<td>t ratio</td>
<td>2.30 1.82 2.35 2.21 2.86</td>
</tr>
<tr>
<td>P</td>
<td>&lt;.05 &lt;.07 &lt;.02 &lt;.05 &lt;.01</td>
</tr>
</tbody>
</table>

(Table I), even though the anxiety group is made up of almost equal numbers of patients and normals.

To establish introversion and extratension personality trends the ratio of Rorschach M to Sum C scorings was used. From among all the subjects three groups were selected as follows: (a) An introversion group, made up of individuals whose M score was at least three times their Sum C score. This comprised three patients, five prisoners, and seven normals, a total of 15 subjects whose \(M/\text{Sum C}\) ratios ranged from 3.00 to 8.00, with a mean of 3.80. (b) An extratension group, made up of individuals whose Sum C score was at least three times their M score. This group consisted of three prisoners and five normals, a total of 8 subjects,

TABLE III
INCIDENCE, IN PERCENTAGES, OF THE 10 GRAPH PROFILE CHARACTERISTICS, WITH SIGNIFICANT t RATIOS OF DIFFERENCES AMONG THE INTROVERSIVE, EXTRATENSIVE, AND STABLE GROUPS

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Graph profile characteristics (numbered as in the text)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introversive group ((N = 15))</td>
<td>46.33 46.33 60.00 46.33 53.67 33.33 20.67 13.33 27.67 20.67</td>
</tr>
<tr>
<td>Extratensive group ((N = 8))</td>
<td>25.00 25.00 87.50 62.50 37.50 62.50 50.00 25.00 37.50 0.00</td>
</tr>
<tr>
<td>Stable group ((N = 11))</td>
<td>9.09 0.00 100.00 81.81 63.63 54.54 45.45 54.54 27.27 9.09</td>
</tr>
<tr>
<td>t ratios</td>
<td>(2.26^* 3.57^{<strong>} 3.17^{</strong>} 2.08^*)</td>
</tr>
</tbody>
</table>

\(^*\)Significant at 5% level. \(^{**}\)Significant at 1% level.
whose $M/\text{Sum } C$ ratios ranged from 0.18 to 0.33, with a mean of 0.28. (c) A stable group, made up of seven patients, one prisoner, and three normals, a total of 11 subjects, whose $M/\text{Sum } C$ ratios ranged from 0.86 to 1.33 with a mean of 0.99. Table III compares these three groups for the ten EEG graph profile characteristics. The introverted group differs from the stable group in that their profiles show more harmonizing of activity from the various cortical areas (characteristic 1), more high alpha pictures (characteristic 2), and less activity in the frequency ranges 16 to 20, 5 to 7, and 22 to 30. No significant differences appeared between the extratensive group and either of the other groups. However, in view of the small number of cases in the extratensive group, it would be incautious to assert that no relationship exists between extratensive personality trends and the graph profile characteristics. It is also interesting, although not surprising, that there are no patients whose Rorschach $M/\text{Sum } C$ ratio indicates clear extratensive personality trends.

**DISCUSSION**

Comparison of the EEG data from the psychiatric patients with those of the normal group indicates a strong tendency for the patients' EEGs to show more activity in the theta and the fast frequency ranges, and less inter-relatedness of activity between the various cortical areas. These findings confirm the observation by previous workers that gross differences in personal adjustment, in the absence of any neurological dysfunction, are related to EEG patterns.

The prison inmates' EEGs are essentially like those of the normals except that they show more high alpha and more theta activity. Several studies have related theta activity with aggressive psychopathic personalities (8, 10, 15). Others (19, 20) have reported that passive and receptive personality trends are most striking in people with the greatest alpha activity. It is interesting that at least one study (16) associates the theta pattern with shy, immature, schizoid types of personality that, at times, show symptoms of aggression. Thus the subjects who make up the prisoner group in the present study tend to have the EEG features of passive receptive persons who are subject to aggressive acting out. Both these characteristics are typical of immature personality organizations, and fit in well with the belief of Hill and his associates (8, 9, 10) that the EEG patterns of such people reflect a failure in biological maturational processes brought on by both genetic and acquired factors. It would be of great interest to study longitudinally a group of young people who are basically passive and subject to aggressive acting-out in order to obtain direct evidence, at both behavioural and physiological levels, regarding the maturational hypothesis.
In the present study there are no reliable relationships between single Rorschach scoring categories and EEG patterns. This is consistent with the report by Wishner (22). Fisher's maladjustment index (6) is also unproductive of meaningful Rorschach correlates of the EEG patterns. When, however, those subjects whose Rorschach responses indicate anxiety are compared with those whose responses fail to do so, the EEG patterns are significantly different. The features which differentiate these two groups are much the same as those which differentiate the psychiatric patients from the normals. This suggests that anxiety may be important in explaining the EEG patterns seen among the patients. Such a hypothesis is supported, with regard to the fast and slow frequency activity and the poly-peaks in the alpha range, by the work of Ulett et al. (21), Brazier et al. (2), and Finley (5).

The present results suggest that, in addition to the EEG features which have emerged from previous studies, anxious persons and psychiatric patients show less inter-relatedness of activity between the various cortical areas. This observation demonstrates an advantage of the graph profile method of EEG analysis. When the data from each of the eight recording channels are integrated to make up a composite picture, the design of the activity among different cortical areas becomes obvious upon even casual inspection of each graph profile.

In the present series those subjects whose Rorschach scores point strongly to introersive personality trends show well organized EEGs with a relatively large incidence of high alpha. This finding is contrary to that of Henry and Knott (11) who found no alpha differences between introverted and extraverted subjects. However, Saul, Davis and Davis (20), and Davis and Davis (3), have pointed out relations between passive personality trends and high alpha indices which would tend to support the present findings. Our method of determining introversion (M/Sum C) is akin to the psychoanalytic approach used by these latter authors, and quite different from the appraisal method used by Henry and Knott (Nebraska personality inventory). The M/Sum C ratio was considered by Rorschach to reflect "the manner in which the individual experiences [erlebt], but not how he actually lives [lebt]" (18, p. 94). The paper and pencil personality inventory is more likely to deal with lebt than with erlebt, and this could account for the differences in results.

From the material reported here it is possible to formulate two general statements which summarize the conclusions and point the way for future study:

1. The use of a precise objective method of EEG frequency analysis yields data which support the observation that EEG patterns of psychiatric patients as a group differ from those of non-patients as a group. It is
hypothesized that personal anxiety may be the feature of personality organization which is most closely related to certain EEG characteristics of the patients.

2. Our results suggest that people with strong aggressive and passive, or introversive personality trends show the EEG characteristics of high alpha and high theta activity. It is possible that this psycho-physiological constellation is related to maturational processes, an hypothesis which could be examined by longitudinal studies.

**Summary**

Differences in EEG frequency patterns among psychiatric patients, prison inmates, and normal controls have been demonstrated by the use of electronic frequency analysis of electroencephalograms. Some correlations between personality characteristics, as reflected in the Rorschach test, and EEG frequency patterns are reported, and hypotheses for further research into relationships between EEG patterns are discussed.

**References**