Chapter 13

Design of the Psychologic Investigation

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TOPECTOMY offered the psychologist both an opportunity and a challenge to study some of the basic problems connected with frontal lobe function. The present chapter will list the particular questions to which the psychologic research team addressed themselves, describe the experimental design developed to answer certain questions, and explain the methods applied for evaluating the results. In the chapters which follow, the application of this design to various mental functions will be described and the results and conclusions presented. It is hoped that by presenting the basic design first, it will serve as a background against which the findings and conclusions may stand clear.

The Problem. The primary question for which we sought an answer was: Does excision of frontal lobe tissue influence behavior and mental life? This century-old problem has attracted many brilliant workers and the literature now abounds in reports of animal studies following cortical tissue ablation as well as of clinical studies of traumatic brain injuries, tumors, other brain diseases, and, more recently, lobectomies and lobotomies. Each type of brain damage is said to lead to a variety of changes in mental functioning or behavior in some but not all instances. There is, however, little or no agreement on the description of these changes and on their characterization. Some of the changes that have been reported in cases of verified brain tumors of the frontal lobes are personality changes, affective disturbance, euphoria, facetiousness, and memory or intellectual defects.

Reports on changes following more or less complete bilateral frontal lobectomy are for the most part based on single cases reported by isolated observers. Among the changes mentioned are difficulty in registering more than one impression at a time, diminished ability to perform mental synthesis, impaired memory, decrease in arithmetic ability, disorders in sense of humor, loss or decrease in ability to abstract or to generalize, impairment of the abstract attitude, reduction in biologic intelligence, constricted or restricted personality, lack of clarity in thought, decrease in ability to form new associations, greater emotional expressiveness, and diminished perceptual efficiency. In addition to these widely varying reports, both Hebb ('45) and Jefferson ('57) have independently reported that in cases studied by them there was an improved personality and intellectual ability following bilateral lobectomy.

Removal of frontal lobe tissue in animals has resulted in a variety of symp-

toms in the different species studied. For example, Bianchi ('22) reported that in dogs and monkeys there were motor disabilities, changes in inhibition and attention, and interference with “higher intellectual functions” following prefrontal lobe excision. Mettler ('44) has reported that the removal of frontal lobe tissue in monkeys leads to a change in “outgoingness” and to an increase in activity. Jacobsen ('35) reported that in the chimpanzee there were disturbances in delayed reaction, in sustained attention, and in frustration tolerance following frontal lobectomy.

Prefrontal lobotomy or leukotomy, that is, the severing of the tracts connecting the frontal lobe with the thalamus, has now been carried out on several thousand mental patients. The results vary from a mental condition which is worsened to a restoration of sanity or normality said to be better than that which existed before the onset of the mental illness. Various investigators have attempted to characterize the mental change going on with the return to normality. These changes have been described as decreased attention, emotional re-patterning, attitudinal changes towards life, decreased planning ability with recourse to trial and error, a diminution of superego tendencies, lack of deliberativeness and sustained attention, decreased sex urge, quantitative loss in intellectual function, constriction of the mental field, and bleaching of affect from self-consciousness or the diminution of the consciousness of self.

There have been a number of studies reported where standard or specially devised psychologic tests have been applied to patients in whom there was some structural change or alteration of the frontal lobes. Many of the findings are unclear and some of them are contradictory. They may be summarized as follows:

1. Most investigators report that there are changes in the performance on sorting tests, on the Rorschach Test, and on figures in which there is reversible perspective.

2. There is a general consensus that standardized intelligence tests do not show any significant alteration after operation. The Porteus Maze Test, however, has been reported to show a significant pattern of change following operation.

3. Changes in emotional responsiveness or affectivity have been reported with considerable variation from report to report.

In general the findings are not too definite, leaving the psychologist with very little to guide him in the selection of a battery of tests that might turn out to be crucial in determining changes following operation.

However, a review of the above literature does bring into relief the important questions that need to be answered. These may be listed as follows:

1. Are there any objectively demonstrable psychologic changes which invariably accompany bilateral removal of the frontal lobe tissue?

2. Does the amount of tissue excised relate to the magnitude of psychologic change?

3. Are the psychologic changes related to specific areas of the frontal lobe or are they concomitants of removal of any part of the frontal lobe?

Had the operation been performed on healthy normal persons in whom there was unquestioned normality of frontal lobe function, our problems in interpreting the results would have been considerably reduced. It is debatable whether the frontal lobes of psychotic patients are functioning normally. Any alteration in their postoperative behavior could arise from the operation itself or from a change in their psychosis. This interference with the psychotic
process may be connected with the operation or may be only coincidental with it. Furthermore, the patients whom we studied had been in the back-
wards of the mental hospital and were essentially “hopeless” cases. Their sud-
den exposure to so-called “total push” of the experimental ward may of its
own accord bring about either permanent or temporary changes in psychologic
function. In designing the testing procedure and its evaluation both the pri-
mary as well as the secondary problems had to be borne in mind.

The Testing Program. The first step in setting up the testing program was to
select the experiments and tests. It was felt necessary to use as wide a variety of
psychologic procedures as could be applied. The physical circumstances surrounding
the operations caused certain tests to be inappropriate. Other than this we did sample
as wide a variety of psychologic test performances as has ever been tried. All in all
we considered approximately 100 tests or experiments for inclusion in the battery.
Limitations of time, space, and personnel resulted in selection of thirty-five tests.
The tests were grouped into seven major categories and an attempt was made to have
each category represented as fully as possible. In this way a representative sampling
of tests in the following areas were selected: (1) Intelligence, (2) Sorting and Abstrac-
tion Tests, (3) Learning and Retention, (4) Personality, (5) Visual Perception, (6)
Attention, (7) Time Judgment.

Only five of the tests which were selected were of the standardized type: Wechsler-
Bellevue Intelligence Test, Porteus Maze Test, Benton Visual Retention Test, Eisen-
son Aphasia Test, and the Harris Laterality Test. The remaining tests were either
entirely new, being devised expressly for this project, or were in various stages of
standardization or adaptation.

A set of directions for administering and scoring each procedure was devised before
the administration of the test began and these directions were closely followed. Each
of the examiners was given adequate practice in the use and scoring of these tests
and frequent conferences were held to eliminate difficulties that arose in the course
of the administration.

The selection of patients has been described in previous papers. It should be
mentioned, however, that the availability of the results of certain of our tests per-
mitted the establishment of matched pairs of individuals from which one could be
selected for operation, and the other designated as a control.

The testing procedure was as follows: During the month before the first operation
was undertaken, all the patients, both those that were subsequently operated upon
as well as those who served as controls, were tested with the entire battery. This
testing is designated as the O (original) testing. Most of these tests were repeated
upon each individual three weeks after the operation. This repetition of the test
is designated as the R1 testing (first repetition). A third period in which all tests
were applied was undertaken approximately three months after the date of operation.
This will be designated as the R2 testing (second retest). Because the operations were
distributed over several weeks the scheduling of the test and retest had to be arranged
so as to allow approximately equal intervals between the O, R1, and R2 testings for
each patient.

Since the nature of this project required a test before operation and subsequent
repetition of tests it was necessary to consider what changes might be expected from the
effect of repetition itself. It might be expected that most patients would show an
improvement arising from the practice effect when the same test is administered a
second or a third time. In order to avoid the error of attributing changes resulting
from practice to the influence of the operation a control group was utilized. This
control group served as a check on practice effects as well as on the expected improve-
ment arising from the “total push” exerted on all the patients.

The operation may enhance the gain from practice and total push, leave it un-
affected, or interfere with it. It may also cause a basic deterioration or a facilitation
of mental functioning independent of the practice effect. Each of these changes actually occurred in our results but each had to be interpreted in the light of the factors associated with it.

Since our experiments contrast two groups—operatees and controls—there are other measures than group averages that need to be considered. One of the significant characteristics of a distribution of scores obtained from a group of individuals is variation or variability. These individual differences within the group exist not only in the original score but also in the differences obtained when the same test is repeated; some individuals showing increased scores with repetition, others very little change, and some decreased scores. In general, continued repetition of a test might result either in greater variation or less variation in the group, and a consideration of the spread of the scores made by any group is important for an understanding of the outcome of the experiment. Whenever the operatee group becomes more variable, contrary tendencies within it due to some patients who gain and others who lose may account for the increase in variability. These contrary trends may neutralize each other so that the average gain for the whole operatee group may not differ from that of the controls but the scatter within the groups may be differential. On the other hand, the operatees may become less variable than the controls in which event the effects of the operation may have been to produce greater similarity among the patients upon whom operation was performed than was observed in the control group. The cause of this increase in similarity has to be determined from a study of the associated factors. Finally, patients vary not only from each other but also from the other level of performance from time to time. This last form of variation is called "intraregional variability" or "scatter."

Another possible alteration which the operation may produce is a change in the relationship between the tests. Thus tests which had shown rather high correlation before operation may decline in their relation after operation. When this happens it may be concluded that the way in which the patients ranked or arranged themselves before has somehow been altered or disrupted. Tests which showed no preoperative correlation may show one after operation. This would mean that something had happened which tended to make the patients alike in the two things which are being measured.

Analysis of Results. The techniques for analyzing the results depended mainly on standard statistical procedure as far as group comparisons were concerned but new techniques had to be introduced for dealing with analysis of individuals. In comparing the two contrasted groups, the method of analysis of variance was used for the comparison of averages. The scores of the operatees and controls were compared at O, R₁, and R₂ to determine whether any statistically significant difference occurred at any of these points. Then the differences between R₁ and O and R₂ and O were statistically treated to determine whether the group gains and losses could have occurred by chance or whether the change was beyond that which may be attributed to chance variation. In some tests, especially those on which the patients had been matched, no differences were apparent at the O testing, and hence whatever difference was found at the postoperative testing could be related to the influence of the operation. When, however, the two groups were not equal initially on a given test, no satisfactory conclusion could be drawn from the postoperative and postanesthesia differences until some correction was introduced for the initial inequality. The correction utilized in this study was the method of analysis of covariance which consists essentially of equating the two groups through an application of correlation methods.

When the psychologist is confronted with so many variables as this project affords, his natural tendency is to try to reduce the number of variables to a more comprehensible number. The technique for accomplishing such a reduction is known as factor analysis. In view of the limited number of patients, it was considered unwise to try a factor analysis over all the variables but partial factor analyses were performed in several psychologic areas such as learning