APPENDIX

PSYCHOSURGERY

THE NATIONAL COMMISSION FOR THE PROTECTION OF HUMAN SUBJECTS OF BIOMEDICAL AND BEHAVIORAL RESEARCH

THIS APPENDIX CONTAINS THE REPORTS CONCERNING PSYCHOSURGERY THAT WERE PREPARED FOR THE COMMISSION.

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THE PRACTICE OF PSYCHOSURGERY: A SURVEY OF THE LITERATURE (1971-1976)

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Summarizing the heterogeneous and often inadequately described information in a large number of clinical reports can be a huge and frustrating task. It would have been impossible for me to complete the task alone. This report could not have been completed without the help of a small, but very efficient, staff. I am particularly pleased to be able to express my gratitude to one of my graduate students, David M. Marques, for the diligence, dedication, and organizational ability he applied to all stages of the project. David's help in creating order out of disorder often made the difference in our being able to see "the forest for the trees." Mary Browning was involved in the project from the very beginning. Her help in organizing and maintaining our records, locating often obscure articles, corresponding with neurosurgeons and psychiatrists around the world, and in collating and coding information was invaluable. Kenneth Gibb and Susan Cassell also provided valuable assistance in coding the literature. When faced with what seemed to be an impossible deadline, my secretary, Judy Baughn, volunteered (as she always does when needed) to work extra hours typing the manuscript, constructing tables, and completing all of those innumerable tasks required to convert chaos into coherence.

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Elliot S. Valenstein

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I. SCOPE OF REPORT

Psychosurgery, the practice of destroying a part of the brain of psychiatric patients, has aroused great controversy. Widely differing views have been expressed on the success of these operations in alleviating psychiatric disorders, on whether or not they are likely to produce serious emotional and intellectual deficits, and whether any ethical principles are violated in the process. The National Commission for the Protection of Human Subjects in Biomedical and Behavioral Research has sought to obtain objective answers to these questions. The present report represents an attempt to contribute to this end by summarizing the evidence available in the published literature. More specifically, the author has been asked to survey the relevant world literature published from 1971 to the present for the purpose of determining the extent of psychosurgery being practiced, the results of these operations, the risks or complications that exist, the new trends in this field, and the ethical or social problems that are peculiar to its practice.

Some definitions were necessary to establish the limits of the proposed literature survey. At least among those involved in its practice, psychosurgery is defined as a destruction of some region of the brain in order to alleviate severe psychiatric disorders. It is implied that the area of the brain destroyed is not known to be pathological and therefore surgery related to tumors, strokes, traumatic accidents, or infections would be excluded from this definition. Operations performed to alleviate movement disorders (Parkinson's Disease, spastic disorders and tremors) and seizures are not considered to be psychosurgical procedures even though it is not always possible to prove that the brain area destroyed was pathological. In some instances, epileptic patients also had severe psychiatric problems and consequently it was not always clear whether the brain operations were performed primarily for the seizures, the psychiatric disorders, or for both reasons. In such cases, information about the results of the surgery was included under the heading, "epilepsy with psychiatric disorders."

The subject of brain operations to alleviate intractable pain deserves a special note. Emotional and psychiatric disturbances are frequently present in patients suffering from intractable pain and in some instances it is impossible to distinguish the total preoccupation with pain from similar preoccupations of certain anxious, phobic, or obsessive psychiatric patients. Moreover, the same brain operations (primarily cingulotomies and frontal lobe procedures) may be performed on patients suffering from intractable pain and on these psychiatric patients. For these reasons, it was decided to include information on brain operations for pain in the report. Excluded, however, was neurosurgery for pain that was restricted to the spinal cord or the peripheral nervous system. Lastly, although the vast majority of the psychosurgical procedures involved the destruction of some region of the brain, those operations that were restricted to the implantation of electrodes for the purpose of therapeutic stimulation of deep brain structures were included in this report. Electroconvulsive shock treatment does not involve surgery and even though there are controversies surrounding its use, the topic was not covered in the present survey.

The search strategy used to obtain the literature to be surveyed is explained in the introduction to the bibliography. In brief, all relevant articles published in English were sought. In total, approximately 700 articles that treated some aspect of psychosurgery or related scientific or ethical issues were located. The great majority of these papers did not present firsthand data on the results of psychosurgery. Some of these articles were concerned primarily with the theory and history of psychosurgery. In other instances, the results of brain operations were discussed only in broad and general terms. Many other articles in this group presented ethical, legal, and sociopolitical views and these varied in purpose and tone from scholarly presentations of reasoned arguments to emotionally-charged polemics by participants in the "psychosurgery controversy." All of this literature was surveyed and is cited in the bibliography.

The data on the results of psychosurgery were obtained primarily from 209 articles that contained information published after 1970 and written by persons either having direct contact with the patients or their records. Probably with very few exceptions, these "data articles" represent the total number of substantive papers on psychosurgery published anywhere in the world. Fifty of these articles described the results of brain operations on patients suffering from intractable pain and six articles presented information only on electrical brain stimulation. Therefore, the total number of data articles published between 1971 and the present that contained information on the results of psychosurgery alone (excluding the operations for pain and brain stimulation) is 153. Of these 153 articles, 26 presented data on psychosurgery performed in the United States and 39 such articles were from the United Kingdom. Although all the "data articles" were written after 1970, several of them included information from patients operated on in the mid to late 1960's.

The information in all the "data articles" was summarized on record sheets. Descriptions of the patients and their pre-operative histories, the types of surgery and their rationale if presented, the post-operative evaluations, complications, and ethical issues were all recorded on forms suitable for later retrieval and collating. This information was summarized and is presented in the tables that are included throughout the report. In addition, the scientific merit of each data article was rated according to a system described by May and Van Putten (375). The basis for the ratings was dependent on the presence of adequate controls, the use of standardized tests to evaluate patients, appropriate statistical treatment of data, the independence of those doing the evaluation from those performing the treatment, the length of patient followup, and similar experimental considerations.

In order to obtain useful data on the extent of psychosurgery, it was necessary to use information collected from questionnaire surveys conducted by others as well as by the present author. The nature of the questionnaires and the information obtained are summarized in Section V. In addition, clarification of ambiguous or incomplete information in the literature was frequently obtained by direct correspondence with the authors. In this way, further details about the data and demographic information on age, sex, and race of patients were obtained.

Lastly, a note on the style and scope of the report. The goal was to present a report that would be appropriate for persons lacking extensive technical knowledge in the neurosciences and clinical neurology. Although readability was considered important, it was also considered essential to include sufficient documentation to make the report useful as a resource for those who might wish to pursue the subject further in the future. To accomplish this goal, the appendices contain references to the articles used to construct the tables and the specific tests administered to evaluate changes produced by the surgery. The Table of Contents presents the overall organization of the report.

II. BRIEF HISTORY OF PSYCHOSURGERY

Because the history of psychosurgery has been described elsewhere by the author (587), only a brief summary of the main developments are required to provide the perspective needed for present purposes. The earliest published account of psychosurgery was reported in 1891 by Gottlieb Burckhardt, the director of the Insane Asylum in Prefargier, Switzerland. Burckhardt hoped to calm very excitable patients by destroying a strip of cerebral cortex between sensory and motor areas. These operations were vigorously opposed by the medical community and in spite of Burckhardt's belief that some patients improved, the operations were discontinued. In 1910, Ludwig Puusepp, a neurosurgeon in St. Petersburg (Russia), made knife cuts between the frontal and parietal lobes in three manic-depressive patients. Puusepp regarded the outcome as very poor and performed no other psychosurgery.

It was the Portuguese neuropsychiatrist, Egas Moniz, who is generally considered to have been responsible for originating the widespread adoption of psychosurgery. In 1935, just a few months after listening to a report of the calming effect of frontal lobe ablation on monkeys and chimpanzees, Moniz and a neurosurgical colleague, Almeida Lima, started operating on the frontal lobes of psychiatric patients. Moniz' monograph describing the generally favorable results obtained on his first twenty patients encouraged neuropsychiatrists and neurosurgeons around the world to explore the use of frontal lobe psychosurgical procedures. The neurosurgeon James Watts, but particularly his neurologist colleague, Walter Freeman, probably did more than anyone else to spread the adoption of psychosurgery. In 1936, Freeman and Watts introduced psychosurgery into the United States, performing their first operations at George Washington University. Moniz and Lima's surgical technique was quickly modified and the Freeman-Watts "standard" lobotomy procedure was developed. By 1950, Freeman and Watts had operated on over 1000 patients. The rate picked up during the next five years before it started to decline. By his own account, Freeman later indicated that up to the time of his retirement he had performed, or supervised, various psychosurgical procedures on more than 3500 patients, During the 1940's, Freeman's many lectures and publications on psychosurgery did much to stimulate interest in the subject. By 1950, the very influential book by Freeman and Watts, <u>Psychosurgery in the Treatment of Mental Disorders</u> (Charles Thomas), was in its second edition and the year before, Moniz had been awarded the Nobel Prize "for his discovery of the therapeutic value of prefrontal leucotomy in certain psychoses."

Psychosurgery was rapidly adopted in almost all countries where neurosurgery was relatively advanced. The "popularity" of psychosurgery can be understood in part by the great need for psychiatric treatment and the few alternatives that existed at the time. World War II made it very evident that psychotherapy was completely inadequate to deal with the large numbers of mental patients that were crowding all facilities. The psychiatrist, William Menninger, wrote that of the 15 million men examined for admission to the armed forces of the United States during World War II, 12 percent (1,846,000) were rejected for psychiatric reasons and 632,000 were discharged because of "mental breaks" after admission. There were no pharmacological treatments available (chlorpromazine, the first of these, was not introduced until 1952). The urgent need for an "efficient" treatment to cope with the many psychiatrically disturbed soldiers and veterans of World War II and the optimistic reports of the results of psychosurgery combined to produce a mood favoring the wide scale adoption of this type of therapy. In 1943, the Veterans Administration issued a communication encouraging staff neurosurgeons at their institutions to obtain special training in prefrontal lobotomy operations. This was a world-wide phenomenon and even during World War II, the Freeman-Watts standard lobotomy technique was introduced in Japan.

It is impossible to obtain accurate figures on the total number of prefrontal lobotomies, of one type or another, performed around the world. Estimates for the United States alone are of the order of 40,000. In England and Wales, one survey summarized the results on 10,365 patients lobotomized between 1942 and 1954 (567). The great majority of the operations were performed during the 1945-1955 decade. By the late 1950's, availability of psychoactive drugs and the many reports of undesirable side effects resulting from the operations produced a sharp decline in psychosurgery. Although there was a rapid decline in the amount of psychosurgery performed after the mid-1950's, there were still a great number of psychiatric patients who were not being helped by any treatment. This fact tended to sustain a relatively low level of psychosurgery through the 1960's and up to the present. The recent controversy over what has been called "a resurgence of psychosurgery" is probably more a reaction to the "surfacing" of the fact that psychosurgery is still being practiced and to discussions of possible applications of psychosurgery than it is to any marked increase in the number of operations performed during the last few years.

The evolution of psychosurgical theory and surgical procedures are described in subsequent sections of this report (Sections III and IV). Briefly, however, it is clear that the accumulation of knowledge of the neuroanatomical regions that regulate emotionality helped to support the belief that it would be possible to alleviate crippling psychiatric symptoms (see description of the patients in Section VI) with a minimum of risk of adverse intellectual and physical side effects. Moreover, the refinement of surgical techniques from very crude and highly variable procedures involving the "blind" rotation of knives (leucotomes) in the brain to much more precise stereotaxic techniques for destroying small and relatively well localized structures also helped to sustain the confidence of some neurosurgeons and neuropsychiatrists in the usefulness of psychosurgery.

III. RATIONALE FOR PSYCHOSURGERY

The arguments justifying psychosurgery can be divided into those that are essentially empirical and practical in their orientation and those that attempt explanations based on physiological mechanisms. Even though this dichotomy is convenient for purposes of exposition, it should be obvious that the two types of arguments are often blended in the rationale offered by any one person. The first category of arguments is relatively easy to characterize as the justifications for psychosurgery it contains are completely unpretentious. In some instances, authors may be quite explicit about not knowing "how" or "why" psychosurgery works and they openly state that physiological explanations at this time are pure conjecture. The supporting arguments combine evidence that the operations work, that alternative treatments are ineffective, and that the dangers of doing nothing are significant. Evidence is usually presented to support the position that psychosurgery significantly improves most patients (see Section VII, Part 2B) whose illnesses have proven to be intractable to other types of treatment for long periods of time (see Section VI) and that the risk of serious complications is slight (Section VII, Part 2C). Often the fact that deaths from suicide and other causes have been reported to be significantly higher among psychiatric patients than among normals (213, 437, 526) is offered as an additional argument for psychosurgery. Similarly, the danger of a deterioration of psychiatric state is frequently offered as a justification for psychosurgery. In a sense, these arguments are much like those given in Support of electroconvulsive shock. Here too, there is no adequate explanation of how the treatment may work, but evidence of its effectiveness, the ineffectiveness of other treatments, and the dangers of doing nothing can all be offered as supporting arguments.

The physiological rationale for psychosurgery is based on much more indirect, heterogeneous and often tortured sets of arguments. Many of the arguments lean heavily on the evidence from animal experimentation which demonstrates that destruction of particular brain regions can produce dramatic changes in emotional behavior. Thus, certain brain regions and their inter-connecting fiber bundles have come to be considered an inter-related neuroanatomical system regulating emotions. This conclusion is also supported by physiological evidence that specific nerve cell groupings or fiber bundles intensify or inhibit emotional behavior or the visceral reactions associated with emotional states. Many of the arguments have to be viewed as "pseudo-physiological" in that the rationale is supported by analogies that imply some physiological process, but do not actually provide any specific explanatory mechanisms.

The conclusion that animal research has directly influenced the selection of brain targets used in psychosurgery is easy to support. Jacobsen’s observations of the emotional changes of monkeys and chimpanzees after ablation of their frontal lobes had a definite influence on Moniz's decision to explore the effects of frontal lobotomy on agitated patients. In 1948, when John Fulton was encouraging psychosurgeons to destroy a portion of the anterior cingulate area, he based his arguments on evidence of behavioral changes in brain-ablated monkeys, which had been reported by Wilbur Smith and Arthur Ward. More recently, several German neurosurgeons and neuro-psychiatrists have justified hypothalamic operations on persons who had committed sexual crimes by using the argument that similar brain operations reduced hypersexuality in experimental animals (477). Even though the results of the animal experiments were often misinterpreted (see pages 326-335 in ref. 587), the many demonstrations that selective brain ablations could calm animals or change their sexual behavior frequently provided the initial impetus for exploring the therapeutic effects of brain ablations in psychiatric patients. As already noted, the information from animal neurobehavioral experiments, particularly when viewed together with relevant neuroanatomical arguments, gave support to the conclusion that specific parts of the brain play a major role in regulating emotions. Thus, portions of the frontal lobes, certain thalamic and hypothalamic regions, the "limbic area" of the brain, and their inter-connecting nerve fiber systems came to be considered a complex system for modulating emotional reactions. A more detailed and critical account of this history has been presented elsewhere by the author (587).

Explanations of how destructions of these brain areas produce their changes have often been based on analogy or metaphors rather than physiological mechanisms. Thus, Moniz argued that psychiatric symptoms were the result of an abnormal stabilization of conditioned neural patterns in the frontal lobes and he wrote that “to cure these patients we must destroy the more or less fixed arrangements of cellular connections that exist in the brain, and particularly those which are related to the frontal lobes." It is obvious that this is an argument by analogy as Moniz certainly had no evidence of the existence of any "fixed arrangements of cellular connections" or any idea how they might be identified even if they did exist.

It may be recalled that Walter Freeman claimed that transorbital leucotomies (see Section IV) should be performed after electroconvulsive shock. He believed the shock would disorganize the pathological neural connections and the cutting of the nerve bundles would prevent them from reforming. The prevalence of these ideas can even be seen in the writings of Norbert Wiener, the "father of cybernetics:"

> "It may be that, in the future, we can do something better with situations where circulating memories have led to bad traffic jams than to destroy a part of the connections of the brain by a frontal lobotomy or to intervene brutally in all synaptic connections by one or the other varieties of shock therapy."
> (N.Y. Academy of Sciences, Annals, 1948, 50, 197-220)

This idea of stabilized, abnormal connections between nerve cells has persisted to the present. As late as 1971, Walter Freeman wrote:

> "The most tenable theory would seem to be that the fibers severed in transorbital lobotomy are collaterals of the thalamo-frontal projections. It would further seem that these collaterals are highly unstable and thus unimportant in mental health, but that during the course of a functional mental disorder they become stabilized in their synaptic connections and thus serve to perpetuate the stereotyped thinking disorder and emotional reaction that underlie the psychosis. Thus the original hypothesis of Egas Moniz appears more probable than ever." (182)

Throughout the history of psychosurgery, the "metaphorical argument" that persistent emotional disorders such as obsessions, phobias, anxieties, and depression are caused by stable pathological neural connections has frequently been expressed. One neurosurgeon used the analogy of a stuck phonograph needle, while another recently wrote:

> "One thinks of the analogy of the uncontrolled feedback in a public-address system, which then starts to howl. There are as yet no neurophysiologic observations to support the hypothesis of abnormal activity in the limbic or any other specific neural pathways in psychotics." (553)

The writer in this case clearly indicated that only an analogy was being offered. In an article (55) to be published later this year, however, a group of Soviet clinicians have attempted to "explain" how brain stimulation produces beneficial results by stating:

> "Thus the therapeutic electrical stimulation of the brain's deep structures may lead to destabilization of the stable pathological condition."

There should be no doubt that many of the persons who engage in the type of arguments illustrated above clearly recognize that they are only using analogies. Nevertheless, the frequent interjection of what really are "pseudo-physiological" phrases tends to create the illusion of an explanatory power that does not in fact exist at all. In some instances, the liberal use of neuroanatomical and other technical terminology may completely conceal the little knowledge of underlying processes that really exists. fit best, terms such as "limbic imbalance" (95) and "diencephalic instability" (577) may point to possible physiological disturbances, but at present they must be considered only "neurologizing."

The need to disrupt, or to reduce the intensity of, persistent ideas and emotions has been expressed with little change almost from the beginning of psychosurgery. This theme is consistent with the characterization of the patients most suitable for psychosurgery. Very early it was recognized that patients with exaggerated emotional states, not the "burnt out" schizophrenics, were most likely to be helped. A 1947 report of the first one thousand pre-frontal leucotomy cases performed in England and Wales (205) described the types of patients who are the best candidates for psychosurgery, in language that is not distinguishable from that currently in use (see Section VI). Thus it was written that:

> "A melancholic may be so preoccupied with his sense of failure orill-health and by his own feelings of guilt about it that he can talk of nothing else. The tension of the urge toward scrupulosity and cleanliness may be so strong in the obsessional that he spends many hours a day carrying out rituals and becomes quite unfitted to lead a normal life."

The authors of this report concluded that the purpose of the operation was "to break the connection between the patient's thoughts and his emotions. It is to relieve mental tension, to take the sting out of experience..." Approximately ten years later, in describing the effects of psychosurgery, Freeman and Watts wrote: "The emotional nucleus of the psychosis is removed, the 'sting' of the disorder is drawn."

In the 1973 Presidential Address to the International Congress of Psychosurgery the best candidates for psychosurgery were described as follows:

> "The work to date indicates that functional mental disease is benefitted by surgical lesions only when they exhibit an excess or exaggeration of normal feelings or thoughts. In other words, there must be an excess of guilt; of depression; . . . . or an excess of anxiety and of neurotic fixations. This exaggeration of normal feeling tone or sensory input can be benefitted by surgical lesions resulting in a lowering of such excess down to a normal level. Because of these observations, I believe that psychosurgery of the prefrontal lobes does have a blunting effect, hopefully of a selective nature, on those thought processes and feeling tones which are grossly exaggerated above the normal." (502)

As already noted, the belief that certain anatomical areas are critically involved in regulating the intensity of emotional reactions is supported in part by the demonstrations of physiological changes induced by either electrical stimulation or ablation of particular brain structures. The conclusion from a large body of experimental literature is that there are neural circuits traversing through regions of the frontal lobe and limbic system (including related thalamic and hypothalamic areas) that either facilitate or inhibit the visceral reactions and mental states characteristic of emotional states. Thus, for example, electrical stimulation at some parts of these circuits inhibits visceral responses such as heart rate and respiration, while stimulation at other areas may accelerate or exaggerate these responses. Destruction of the same brain areas often, but not always, has the opposite effect. A number of recent reviews of these physiological reactions to selective stimulation and ablation of discrete brain areas in animals and humans have been published (278, 339, 340). In general, there is at least some evidence that electrical stimulation of the brain sites that are most commonly selected for psychosurgery (lower medial quadrant Of the frontal lobes and the anterior cingulum) intensifies the visceral responses that normally accompany exaggerated emotional states. Destruction of these regions tends to produce a calming effect both in terms of visceral responses and mental states. Psychosurgery does not always produce a calming effect, however, and in some cases patients may display irritability, impulsiveness, and other signs of activation by disinhibition. It is often suspected that the different results can be attributed to differences in the brain structures destroyed, but there is almost no evidence to support this argument. It seems necessary, therefore, to postulate that many factors not yet understood contribute to the variability in the effects produced by psychosurgery.

Although experiments on animals and clinical observations in humans lend support to the view that there may be separate "fronto-limbic" and "fronto-thalamic" circuits which either facilitate or inhibit psychic states, there exist only highly speculative ideas of how this might be accomplished. Moreover, the recent puzzling reports that beneficial effects of some psychosurgical operations may depend upon the partial destruction of corpus callosum fibers (44, 307, 313, 314) at present seems to even defy speculation.

One way to characterize the level of understanding of the physiological basis of psychosurgery is to examine the differing views on the relationship of psychiatric disorders to specific brain structures. It is clear to anyone familiar with the views and practices of those who perform psychosurgery that individual surgeons have their preferred brain target. This means that within certain limits, a candidate for psychosurgery might be given any one of ten or more different operations (see Figure 1) depending on the surgeons to which they were referred. By itself, this could be viewed as a reflection of the possibility that the disruption of a given brain circuit at any point along its route has very similar effects on emotionality. Indeed, this argument was expressed by a number of surgeons in attendance at the Fourth International Congress of Psychiatric Neurosurgery (September,

1975) after hearing many reports indicating the same success following different operations on patients appearing to have identical symptomatology. A few neurosurgeons, however, have argued that some of these brain targets had proven to be ineffective sites in their hands. Thus, it has been argued in the literature that destruction of the rostral cingulum does not produce beneficial results (502) in spite of the fact that impressive statistics demonstrating success has been presented by others (44, 45, 46). Similarly, there is even greater disagreement on the effectiveness of amygdalectomy when performed on patients that do not have demonstrable pathology in this temporal lobe structure.

There is clearly strong disagreement about the effectiveness of psychosurgery aimed at some brain targets and whether different brain targets should be used with different symptoms. It is easy to find many statements in the literature arguing that "different mental illnesses do not need different operative procedures" (413, and see also 502) that stand in sharp contrast to other statements that imply that different brain circuits underlie perceptual, cognitive, and affective disorders (95).

The author of this report conducted a limited survey among some of the leading spokesmen in the field of psychosurgery in order to obtain their views on the specificity of brain targets in psychosurgery. A statement that was slightly paraphrased from a 1975 review (340) of psychosurgery was mailed to a number of neurosurgeons and neuropsychiatrists who were asked to indicate whether they were (1) essentially in agreement; (2) agreed, but with some qualification; (3) did not believe that one could justify the view that different psychosurgical targets were more effective with certain psychiatric disorders. The following statement was mailed:

> "Based on anatomical and functional considerations, a distinction is frequently made between medial and lateral limbic circuits in the brain. The medial limbic circuit is said to include (among other structures) the medial frontal cortex, the cingulate gyrus, the anterior thalamic nucleus,

and connecting fiber systems. The lateral limbic circuit is believed to include (among other structures) the orbital frontal cortex, the dorsomedial thalamic nucleus, the amygdala and connecting fiber systems.

"Damage to the medial limbic system often produces states of motor and psychic hypoactivity. Stimulation or irritative disorders on the other hand often produce signs of motor and psychic hyperactivity such as restlessness, anxiety, and irritability. The lateral limbic system appears to be involved in a broad spectrum of disturbances including depression, perceptual and hallucinatory disorders, and uncontrolled aggression.

"In broad terms, the types of psychiatric disabilities for which lesions of medial or lateral limbic structures are likely to be most beneficial have been established. Lesions of the medial frontal area, the anterior cingulate region, or closely related fiber systems, are most effective in syndromes characterized by psychic hyperactivity such as seen in patients suffering from tension, anxiety, restlessness, and obsessive behavior. Lesions involving the orbital frontal cortex and closely related fiber systems have been found to be most effective in syndromes characterized by various manifestations of depression. Lesions of the amygdala are most likely to be beneficial in cases where hyperkinetic activity and/or unprovoked assaultive behavior is the major behavioral problem."

Fifty percent of the respondents disagreed completely with the statement and one-half of the remaining responses indicated very significant, but different, areas of disagreement. A number of neuropsychiatrists and neurosurgeons, who often had a great many years of experience observing psychosurgical patients, indicated that there was no evidence that brain targets should be varied as a function of psychiatric syndromes. Other clinicians with equally long experience believe that they can justify varying the brain targets in psychosurgery. It seems clear that with such strong and significant disagreement among those who practice psychosurgery, it cannot be convincingly argued that our understanding of the physiological basis of psychosurgery has advanced very far. The knowledge that has accumulated over the years is mostly empirical- Even if there is no consensus, there is certainly some agreement about the brain targets that are the most likely to produce the best results. There is also a reasonable amount of agreement on the patients most likely to be helped, although here too there are definite areas of disagreement.

IV. DESCRIPTION OF PSYCHOSURGICAL PROCEDURES

Psychosurgical operations have evolved from crude procedures for destroying poorly defined regions of the frontal lobes to much more precise techniques that make it possible to ablate relatively specific targets in the brain. The original "core" lobotomy technique of Moniz and Lima was never generally adopted, primarily because the anatomical reference points were considered unreliable. Essentially, the "core" technique consisted of drilling several burr holes into the top of the skull and inserting a cutting instrument (leucotome) into the brain. When the leucotome was believed to be in place, a sharpened wire was extruded through a slot in the side of the instrument and the whole tool was rotated.

In contrast, the Freeman-Watts standard lobotomy technique, which was introduced approximately one year after Moniz and Lima's first operation, was widely used throughout the world. The technique consisted of placing a knife into the frontal lobes through trephine holes drilled on both sides of the skull. The location of the holes were defined by skull landmarks and for this reason, Freeman referred to the method as the "precision technique." The knife was pivoted up and down to make a cut in the desired plane. The holes were placed more or less forward on the skull depending on the severity of the symptoms and if a "standard" lobotomy was not successful, a more posterior "radical" lobotomy was frequently undertaken. In 1948, Freeman introduced the transorbital leucotomy procedure--a technique for reaching the frontal lobes by piercing the bone at the roof of the eye socket with a transorbital leucotome, an instrument resembling an ice pick. Transorbital leucotomy deserves special mention not only because of the large number of these operations performed, but also because it was the only psychosurgical operation that was done as an office procedure.

During the late 1930's and 1940's, a number of other surgical approaches to the frontal lobe were introduced. In 1938, Lyerly of Jacksonville, Florida, modified the Freeman-Watts lobotomy procedure and in 1948, Poppen of the Lahey Clinic in Boston described a "superior" approach (from the top of the skull) to that region of the frontal lobes believed to be critical for best results. The following year, Pool of Columbia University introduced his topectomy operation, a technique involving the undercutting and removal of blocks of frontal lobe tissue.

Modifications of the various lobotomy procedures were introduced in many countries around the world. What was characteristic of most of these early lobotomy procedures was that they were designed to destroy brain tissue in the prefrontal area (in front of the region known to control speech and bodily movement) and that the majority of the operations were "blind" procedures. The labels "blind" and "closed" referred to the fact that the destroying of tissue was not guided by vision. Customarily, the brain tissue was destroyed by a knife inserted through a small hole in the skull. The wound was rinsed with a warm saline solution until the bleeding stopped, but because the surgeon did not have any view of the destroyed area there was always a danger of hemorrhage at a later time.

In 1948, Scoville introduced an "open" method for selectively cutting the fibers at the base of the frontal lobes. This "orbital undercutting" operation, which permitted the surgeon to view the area of the brain being destroyed, was adopted with some modification by several other surgeons including Hirose in Japan. At first, the fibers under both the medial and lateral portions of the frontal lobes were destroyed, but later the operation was confined to the medial area. This switch was consistent with the accumulating evidence that intellectual deficits followed destruction of the lateral frontal areas while the more medial areas seemed to play a relatively greater role in regulating emotionality.

Three major changes in psychosurgical operations were introduced during the 1950's and 1960's. One of these involved the gradual introduction of stereotaxic instruments. Basically, a stereotaxic instrument positions the head in a fixed plane, and with aid of three-dimensional anatomical maps (stereotaxic atlases) it is possible to place electrodes or other devices through small holes in the skull into almost any sector of the brain. Although the instrument had been used in animal research since 1908, it was Spiegel and Wycis of Temple University who first applied the technique to psychosurgery. In 1949, Spiegel and Wycis described the use of the stereotaxic instrument to destroy a circumscribed region in the dorsomedial thalamus of psychotic patients. The use of this instrument gradually gained acceptance by those performing psychosurgery and today most of these operations use some variation of the basic principle of stereotaxic surgery. Gildenberg (195) has listed over twenty different stereotaxic instruments being used today by neurosurgeons in the U.S. and Canada.

Although stereotaxic surgery is also "blind" and "closed," the accuracy of its coordinate system justifies placing these operations in a separate category. Moreover, in current practice, the accuracy of stereotaxic surgery is increased by information gained from on-line X-rays, brain scanners, and electrical recording. This information complements the stereotaxic coordinates, which are based on average data, and makes it possible to reach targets with significantly greater precision. In spite of the great increase in sophistication of stereotaxic surgery there is still a considerable amount of so-called "free-hand" psychosurgery currently being performed (122, 208, 505).

The second major change introduced involved variations in the method of destroying brain tissue. Initially, all of the psychosurgery was performed with some special type of knife (leucotome). Later, several neurosurgeons used a "suction" technique for removing brain tissue. With the introduction of the stereotaxic technique, electrolytic destruction of brain tissue began to be used more commonly. Gradually, the stereotaxic instrument was used in conjunction with a number of different techniques each of which is believed by its advocates to have some special advantage in destroying tissue. Gildenberg's survey (195) Of neurosurgeons in the U.S. and Canada revealed that 73% of the neurosurgeons using stereotaxic techniques produce brain lesions with radio frequency waves. Also mentioned by the respondents to Gildenberg's questionnaire were the following methods (listed in decreasing frequency of use): cryoprobe (freezing), leucotome, electrolytic (DC current), radioisotopes (including the implantation of Yttrium seeds), proton beams, ultrasound, balloon cannula (compression), and thermocoagulation. Other neurosurgeons around the world have destroyed brain tissue using injections of alcohol and an inert oil or wax. A great variety of techniques are used, some of them by only a single neurosurgeon.

The third major development that occurred during the 1950's and 1960's was the extension of psychosurgery to brain regions outside the frontal lobes. The realization that the most effective frontal lobe targets were the medial and deep (ventral) portion of that part of the brain tended to draw attention to distant areas that were anatomically connected to ventromedial surfaces of the frontal lobe. It was this consideration which was partly responsible for Speigel and Wycis' selection of the dorsomedial thalamic nucleus as the target for their first stereotaxic surgery on psychiatric patients. The very influential neurophysiologist, John Fulton, also encouraged the exploration for other effective brain sites for psychosurgery. Disturbed by the evidence of intellectual deterioration in a number of prefrontal lobotomized patients and at the same time encouraged by the animal experimental evidence of emotional changes following selective destruction of limbic brain structures, Fulton advised neurosurgeons to investigate the effects of selective damage to limbic brain structures and fronto-limbic fiber connections.

Stimulated by Fulton's plea for more selective psychosurgical operations and by the animal experimental data, a number of neurosurgeons started to explore other brain sites as potential targets. In the early 1950's, Sir Hugh Cairns in Oxford and J. Le Beau in Paris independently reported favorable results following destruction of the anterior region of the cingulum, one of the major structures of the limbic lobe of the brain. Subsequently, a great number of other neurosurgeons have reported success after destroying either specific limbic structures or by disrupting fronto-limbic connections in regions where it is believed possible to selectively destroy critical fiber bundles. Among the principle limbic structures that were selected for destruction were the amygdala, in the temporal lobes, and to a lesser extent thalamic structures such as the dorsomedial, anterior, centromedian, and parafascicular nuclei--areas known to have direct connections to limbic structures. In addition, selective regions of the hypothalamus including the posterior region, the ventromedial nuclei and the lateral area have been selected as targets for psychosurgical operations with specific types of psychiatric disorders. The anatomical and behavioral evidence and the rationale (see Section III) for exploring each of these brain regions has been presented in detail by the author elsewhere (587).

More recently, several neurosurgeons have developed multiple-target psychosurgical procedures. For example, a neurosurgeon (95), who has accumulated one of the largest populations of psychosurgical patients in the U.S., performs an operation aimed at six targets in the brain. This procedure involves the partial destruction of portions of the amygdala, cingulum, and substantia innominata on both sides of the brain. In England, several neurosurgeons perform an operation called limbic leucotomy (462). This operation is designed to destroy portions of the ventromedial frontal lobes and the anterior cingulum. Figure 1 represents an attempt to depict the main brain targets for psychosurgical operations currently being practiced around the world. As can be seen from the figure, several of the operations are aimed at disrupting specific fiberbundles (including parts of the internal capsule and commissural fibers connecting one side of the brain to the other). In several instances, the operations are performed by only one neurosurgeon who (based on experience) has abstracted the fiber bundle believed to be most critical for successful results.

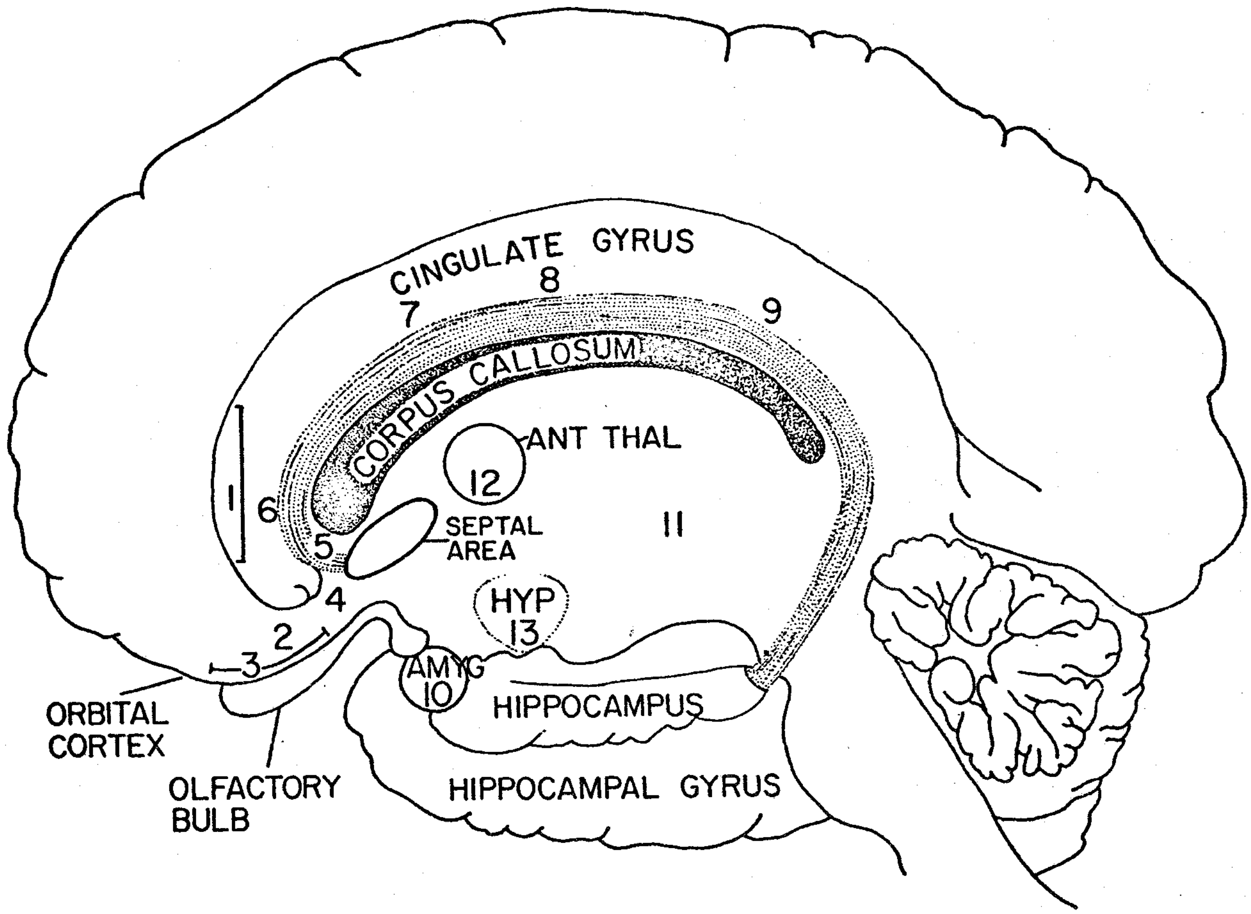

FIGURE 1. APPROXIMATE BRAIN TARGETS OF CURRENT PSYCHOSURGICAL PROCEDURES

Frontal Lobe Procedures

1. Bimedial leucotomy
2. Yttrium lesions in subcortical white matter
3. Orbital undercutting
4. Basal tractotomy and substantia innominotomy
5. Anterior capsulotomy (destruction of fibers of internal capsule)
6. Mesoloviotomy (similar to rostral cingulotomy, but lesion invades genu "knee" of corpus callosum)

Cingulotomies

7. Anterior cingulotomy
8. Mid-cingulotomy
9. Posterior cingulotomy

Amygdalectomy

10. Amygdalectomy or amygdalotomy

Thalatomies

11. Dorsomedial, centromedian, parafascicular nuclei
12. Anterior thalatomy

Hypothalotomy

13. Posterior, ventromedial, and lateral hypothalamic targets

V. EXTENT OF PSYCHOSURGERY

U.S.A. and Canada

It became obvious early that it would not be possible to obtain a valid estimate of the extent of psychosurgery from a literature survey alone. These difficulties were not completely unanticipated as it was known that the results of many operations are never written up for publication. Moreover, many of the published articles summarize the results of procedures performed over a number of years. Under these circumstances it was often impossible to determine the number of operations performed in a given year, even when several consecutive publications from the same author were available. It was necessary therefore to utilize information obtained from questionnaire surveys conducted by others and to a limited extent to circulate questionnaires of our own in order to estimate the extent of psychosurgery in selected foreign countries (cf., Appendix 1). A comparison of the results of the questionnaire surveys with the information obtained from our literature search confirmed the belief that a relatively small percentage of the neurosurgeons performing psychosurgery actually publish their results;

Dr. John Donnelly, Chief Psychiatrist at the Institute of Living (Hartford, Connecticut) undertook a questionnaire survey of psychosurgical practices as part of the scope of the Task Force on Psychosurgery of the American Psychiatric Association. A brief questionnaire (Appendix 2) was sent to active members (as of 1973) of the American Association of Neurological Surgeons and the Congress of Neurological Surgeons. In total, 1901 questionnaires were sent to neurosurgeons from the U.S. and Canada. The questionnaire was designed to determine the number of psychosurgical operations and neurosurgical procedures for pain that were performed for the years 1971, 1972 and 1973 and the number of neurosurgeons performing these procedures. Seventy-eight percent (1481) filled out and returned the questionnaires.

For the 1971-1973 period covered by Donnelly's survey, 110 U.S. and 19 Canadian neurosurgeons indicated that they performed psychosurgery. These results were obtained from a preliminary report written by Donnelly and are summarized in Table 1. (Copies of Donnelly report have been submitted to the staff of the Commission.)

TABLE 1

Number of U.S. and Canadian Neurosurgeons Performing Psychosurgery*

Year	U.S.A.	Canada
1971	75	15
1972	71	17
1973	59	12

* The total number of different U.S. neurosurgeons indicating that they performed psychosurgery during the three years is 110. These data were obtained from the 1481 neurosurgeons responding to Donnelly's questionnaire.

The data summarized in Table 1 suggest that the number of neurosurgeons Performing psychosurgery was decreasing over the three years surveyed. Although there are no reliable data available, it is frequently stated by those informed about psychosurgical practices that the number of surgeons doing these operations has continued to decline during 1974 and 1975. This opinion is based primarily on what is believed to be the deterrent effect of the public controversy over psychosurgery in addition to the effect of several well publicized law suits against neurosurgeons performing (or Proposing to perform) these procedures.

Of the neurosurgeons responding, 7.5% reported having done psychosurgery. If this percentage is used to estimate the number of non-responders performing these procedures, the total number of 110 for the U.S. would be increased to 141 and for Canada from 19 to 25. These corrected figures probably represent a slight overestimation as Donnelly examined the names and affiliations of the 420 non-responding neurosurgeons and concluded that there was no evidence that they performed any more psychosurgery than those returning the questionnaires. Actually, it seemed more likely that the non-responders performed relatively less psychosurgery.

Table 2 summarizes the number of operations performed by the 110 U.S. and 19 Canadian neurosurgeons reporting having done any psychosurgery during the years 1977-1973.

TABLE 2

Number of Psychosurgical Operations Performed in the U.S. and Canada*

Year	U.S.A.	Canada
1971	308	22
1972	343	27
1973	321	18
Total	972	67

* These numbers are based on the 1481 questionnaires returned. If it is assumed that the same percentages apply to the 420 neurosurgeons who did not return the questionnaires, the average number of psychosurgical operations for the U.S. would be increased from 324 per year to 414 and for Canada from an average of 22 to 29 per year.

The figures obtained from Donnelly's questionnaire can be compared with the results of a survey published by Dr. Philip Gildenberg, Chief of the Division of Neurosurgery, of the University of Texas Medical School in Houston (195). Gildenberg sent out 2028 questionnaires to neurosurgeons in the U.S. and Canada during mid-1973. The wording of the questionnaire was not published, but essentially it requested information from the recipients on whether or not they were currently performing any "stereotaxic and functional neurosurgery." Only 637 neurosurgeons completed and returned the form. This figure represents a return percentage of only 31.5% compared to Donnelly's 78% returns. Gildenberg noted that the 637 respondents reported that they were doing an average of 246 (the number was estimated from 228 to 264) brain operations for emotional disorders per year. The procedures included cingulotomies (over 50% of the total), frontal leucotomies, dorsomedial thalamotomies, hypothalamotomies, and prefrontal ultrasonic operations. If it is assumed that the non-responders were performing these operations at the same rate as the responders, an estimate of 772 psychosurgical procedures per year is obtained for the U.S. and Canada combined. The comparable figure from the Donnelly report is 443 procedures per year for the U.S.A. and Canada. The difference between the two estimates is considerable, but it is likely that the estimate of the amount of psychosurgery performed by those not returning the Gildenberg questionnaire is too large. It is likely that many of the non-responders have no interest in the subject. Considering all the information available, the average number of psychosurgical procedures performed is very likely to have been between 400 and 500 in the United States during the years 1971-1973. The average number of such operations performed per year appears to have decreased after 1973, but there are little reliable data available.

An analysis of the amount of psychosurgery performed by the neurosurgeons doing these procedures reveals that approximately 25% of the total operations are done by surgeons doing three or less operations per year (Table 3). Approximately 70-80% of neurosurgeons perform less than three procedures in a year and many of these average only one psychosurgical procedure per annum. If it is true, as a number of neurosurgeons would argue, that it may not be possible to maintain adequate skill if a procedure is performed very infrequently, then the above figures may point to a serious problem.

TABLE 3

Analysis of Procedures Performed Per Year by Psychosurgeons in the U.S.*

	1971		1972		1973	
Procedures (per year)	% of Surgeons	% of Procedures	% of Surgeons	% of Procedures	% of Surgeons	% of Procedures
1-3	80.0	28.9	70.4	22.7	78.0	22.4
4-10	10.6	17.1	19.7	22.5	11.8	13.4
11-15	5.4	18.0	4.2	10.2	6.8	16.2
16-20	0	0	1.4	5.8	0	0
21-	4.0	36.0	4.3**	38.8	3.4**	48.0

* Data based on the Donnelly report.

** One neurosurgeon reported performing between 61-80 procedures in 1972 and one reported performing 132 procedures during 1973. If the latter figure is accurate this individual was responsible for over 41% of all procedures that were reported by the respondents for 1973.

It is important to compare the number of neurosurgeons indicating on questionnaires that they performed psychosurgery with the number of neurosurgeons that can be identified from the published literature. A thorough search of the relevant literature since 1971 revealed at most only 30 names of neurosurgeons performing psychosurgery. In two of these instances, it was not clear whether the neurosurgeon ever performed brain surgery unless there was evidence of neurological damage. While it is possible that some articles were missed if they were neither published in journals surveyed by the major abstracting services nor ever cited in other articles, it is unlikely that the names of more than a few relevant neurosurgeons were missed by our literature search. Therefore, at most only 27% (30 out of 110) of the neurosurgeons performing psychosurgery publish their results. This percentage is further reduced to only 21% if it is assumed that 141 neurosurgeons (a figure including estimates from the non-responders) actually perform psychosurgery. It seems evident that a considerable amount of experience with psychosurgery does not become a part of the archival literature. The present writer, for example, is personally aware of several neurosurgeons who have performed psychosurgery and have never published any account of these operations. Undoubtedly, the fact that a relatively large number of neurosurgeons perform three or less operations per year contributes to this problem. It is unlikely that a neurosurgeon doing so few operations can generate sufficient interest of those competently trained professionals who could evaluate the results of surgery. Without such evaluation, there would be little justification for publishing any record of the surgery.

The number of neurosurgeons performing brain operations for intractable pain also cannot be estimated very reliably from the published literature. The responses of neurosurgeons to Donnelly's questionnaire indicated whether the respondent had performed surgery for intractable pain. Descriptions of the procedures employed made it possible to distinguish peripheral and spinal cord operations from those performed on the brain. Based on the responses to his questionnaire, Donnelly's estimates of the number of brain operations for intractable pain are presented in Table 4.

TABLE 4

Number of Neurosurgical Procedures for Pain*

	1971		1972		1973	
	U.S.A.	Canada	U.S.A.	Canada	U.S.A.	Canada
Intractable Pain Only	92	3	97	1	63	1
Intractable Pain Due to Malignancies	20	-	30	1	28	-

* Based on responses to Donnelly's questionnaire.

Of some interest is Donnelly's finding that many neurosurgeons perform psychosurgical procedures, but apparently do not operate for intractable pain as well as the converse. These figures are summarized in Table 5.

TABLE 5

Number of U.S. and Canadian Surgeons Performing Psychosurgery and Operations for Intractable Pain (1971, 1972, and 1973 combined)*

	Number of Neurosurgeons
Intractable Pain Only (no psychosurgery)	66
Psychosurgery Only	78
Both Psychosurgery and Intractable Pain	50

* Based on responses to Donnelly's questionnaire.

THE EXTENT OF PSYCHOSURGERY IN OTHER COUNTRIES

United Kingdom

Robin and Macdonald (471) estimated that approximately 200 psychosurgical procedures were performed in Britain in 1974, but this figure was based on general familiarity with the situation rather than on any survey (personal communication). The suggestion that information be obtained from the Medical Statistics Division of the Office of Population Censuses and Survey in London did not prove rewarding. The reply from this Bureau revealed that no British agency has reliable and comprehensive statistics on the amount of psychosurgery performed (personal communication).

The replies to a questionnaire (Appendix 1) indicated that about 20 neurosurgeons in 15 surgical units perform stereotaxic psychosurgery with some degree of regularity. In addition, some responses suggested that an undisclosed number of additional neurosurgeons perform the older, "free-hand" psychosurgical operations at the rate of about one every two years.

The Geoffrey Knight Psychosurgical Unit at the Brooks General Hospital in London performs more psychosurgery than any other unit in Britain. There are eight beds reserved for psychosurgery in this unit and approximately one operation is performed each week. Geoffrey Knight has recently retired from hospital practice, but the staff at his unit reported that they had done 54, 38, and 46 psychosurgical operations in 1973, 1974 and 1975 respectively. The neurosurgical group at the St. George's Hospital in London averages about 20 operations a year, while the neurosurgical team at the Guy's, Maudsley, and King's College Hospital in London reported that they had performed only 1, 6 and 4 operations in 1973, 1974 and 1975 respectively. Other neurosurgical units performing psychosurgery exist in Birmingham, Sheffield, Edinburgh, Cambridge, Southampton, Plymouth, Bristol, Glasgow, Dundee, Aberdeen, Salford, Manchester, and Derby.

The neurosurgeons responding to the questionnaires estimated that between 200 and 250 psychosurgical operations have been performed per year between 1973 and 1975 in the United Kingdom. The respondents generally indicated that they believed that the number of brain operations performed for the relief of intractable pain was somewhat less.

Australia

Dr. J. Sidney Smith of the Neuropsychiatric Institute in Rozelle, New South Wales contacted all "possible surgeons and psychiatrists involved in psychosurgery" in Australia in 1973 (personal communication). Based on the information obtained, Smith estimated that 83 psychosurgical procedures were performed per annum in Australia in 1973. Smith believes the rate has remained constant to the present. A report of a recent symposium on psychosurgery summarized much of the history and current practice of psychosurgery in Australia (554). The two main groups performing psychosurgery consist of neurosurgeons in private practice and those associated with the Neuropsychiatric Institute, a state financed unit. Both groups are located in Sydney. With the exception of amygdalectomy procedures, most of the operations (primarily "cingulotractotomies") are performed by the private practitioners. It is estimated that approximately 8-12 neurosurgeons perform psychosurgery in Australia. There appear to be much fewer brain operations performed for intractable pain than for psychiatric disorders.

India

Psychosurgery in India seems to be completely restricted to the Institute of Neurology of the Madras Medical School. Approximately one-half of the surgical patients are referred from the Madras Mental Hospital, a government facility. There are three neurosurgeons performing these operations and they constitute one group of colleagues (36, 37, 39, 455). Surprisingly, their estimates of the number of psychosurgical procedures performed per year varied between 36-61, 24-36, and 26-35 for 1973, 1974 and 1975 respectively. The procedures performed include amygdalectomies (the most frequent), hypothalamotomies, cingulomotomy and prefrontal leucotomies. Of special interest is the group of 65 patients on whom cingulomotomies were performed for physical dependence on narcotics (cf., Appendix 3 and reference 39).

Japan

In 1972 there were three main neurosurgeons (and their colleagues) performing psychosurgery in Japan (238, 239, 240, 400, 401, 402, 487, 488, 489). The three surgeons were all located in Tokyo in the Department of Neurosurgery, University of Tokyo; Department of Neuropsychiatry, Nippon Medical School; and the Department of Neurology, Juntendo Medical School. In 1972 approximately 25 psychosurgical procedures were performed, but starting in 1973 an active protest movement (described by one neurosurgeon as "militant psychiatrists and medical students") gradually brought the practice of psychosurgery to a halt. In 1973 approximately 25 procedures were performed. In 1974 the number appears to have been reduced to 15 and as far as can be ascertained, no psychosurgery was performed in 1975.

Czechoslovakia

There are 3 to 4 neurosurgeons performing psychosurgery (397, 398, 399, 540, 541) in Czechoslovakia. Estimates from two of these neurosurgeons indicate that the amount of psychosurgery performed ranges between 20-47, 40-41, and 50-53 for 1973, 1974 and 1975. Although the numbers are not large, it appears that Czechoslovakia may be the only country of those in which information was obtained that increased the number of operations performed between 1973 and 1975. The estimates of the number of brain operations performed for intractable pain vary too greatly to be considered reliable. The use of brain stimulation for psychiatric disorders and intractable pain appears to have been initiated in 1974. Four to five patients were treated for psychiatric disorders with brain stimulation in both 1974 and 1975 and approximately the same numbers of patients were treated by this technique for intractable pain.

Mexico

Based only on one reply, it is estimated that three neurosurgeons have performed between 10-25 psychosurgical operations per year between 1973 and 1975 (155, 156). Brain stimulation for psychiatric disorders has been used in approximately 4 patients in total between 1973 and 1975.

Other Countries

It is known that some form of psychosurgery is currently being performed with some degree of regularity in Spain, Argentina, Poland, France, Germany, Holland, Denmark, Sweden and Finland, but it was not possible to obtain estimates of the frequency of these operations in these countries.

Soviet Union

Psychosurgery was outlawed in the Soviet Union in the early 1950's. Although there have been unconfirmed statements that some form of psychosurgery is practiced, it was not possible to obtain any reliable information on the validity of these claims. Kornetov (297) recently reviewed the results of 40 prefrontal leucotomies (Freeman-Watts and Lyerly procedures) mostly performed at the 1st Moscow Medical Institute between 1947 and 1950. The patients were chronic schizophrenics and according to Kornetov's brief account of the long-term results, some of them have made excellent recoveries. Kornetov's conclusion implied that at least he believes there may still be a place for psychosurgery in cases of "pernicious schizophrenia." Several recent reports have appeared which indicate that Dr. N.P. Bechtereva and her colleagues at the Institute of Experimental Medicine in Leningrad have used "therapeutic electrical stimulation" (TES) through implanted electrodes to treat intractable pain (including phantom limb pain) and temporal lobe epilepsy associated with aggression or psychiatric disorders such as paranoia and other psychotic thought processes (53, 54, 55). Some of these patients had as many as 64 electrodes assembled in 14 bundles implanted in the temporal lobes. In a few instances, patients were allowed to engage in self-stimulation, i.e., to control the delivery of stimulation themselves. Stimulation at some brain sites was said to reduce troublesome symptoms and to elevate mood. The neurosurgeons working with Bechtereva are Drs. A.N. Bondartchuk and O.P. Pissarevsky.

Summary

It is estimated that 141 neurosurgeons in the U.S.A. performed between 400 and 500 operations per year during 1971, 1972, and 1973. There are indications that the annual rate was lower during 1974 and 1975. Approximately 75% of the U.S. neurosurgeons practicing psychosurgery do not publish their results in the archival literature.

Comparisons with other English language countries revealed that approximately 200-250 psychosurgical procedures are performed per year in the United Kingdom and about 83 such operations are done in Australia. Taking into consideration the differences in populations, psychosurgery is performed in the United Kingdom at approximately twice the rate, and in Australia about three times the rate, of that of the U.S.A. Again considering population differences, Canada has a greater relative number of neurosurgeons that have done some psychosurgery, but the relative number of

operations performed is approximately one-half that of the U.S.A.

Estimates have also been given for other foreign countries where information could be obtained.

VI. THE PATIENTS AND THE SURGICAL PROCEDURE

A. The Patients

A number of psychiatrists and neurosurgeons have described the patients they consider most likely to be helped by psychosurgery. There is close to a general agreement that patients suffering from severe disturbances of mood and emotion are most likely to benefit from psychosurgery; patients with serious impairment of thought processes are much less likely to improve significantly following surgery. The best candidates are believed to have very intense and persistent emotional responses. In the more severe cases, these patients are said to be so possessed by an unfounded fear or thought that they are not able to leave their homes, let alone work. Some patients expend great amounts of energy. and time repeating a ritualistic behavior over and over again. Others are described as equally disabled by severe depression and thoughts of suicide. Often these patients are psychologically crippled by phobias and somatic complaints. Frequently included in this group are persons experiencing a medically dangerous loss of appetite (anorexia nervosa) or those who are dependent on drugs. Diagnostically, these patients include the very severely depressed, anxious, and the obsessive-compulsive neurotics.

These severe disturbances of mood and emotion are usually described as being of long duration and resistant to such alternative treatments as Psychotherapy, drugs, and electroconvulsive shocks. As far as can be determined, all psychosurgical candidates in the U.S.A. and U.K. are referred to the neurosurgeons by psychiatrists, who consider the patient's symptoms intractable to other treatments. This is undoubtedly true of other countries as well. Psychiatrists do differ, however, in the length of time they will explore treatments, the therapies they view as reasonable alternatives, and therefore, in their criteria for concluding a patient's symptoms are intractable. It is also clear that some psychiatrists would never refer a patient for psychosurgery under any circumstances. Such factors tend to establish "regular channels of referral" between particular psychiatrists and neurosurgeons. In some instances, neurosurgeons may participate in the decision to abandon alternative treatment possibilities and to consider psychosurgery. When referrals originate outside these "regular channels," neurosurgeons presumably apply their own criteria for accepting a patient for surgery. Unfortunately, these criteria are only rarely made explicit by psychiatrists and neurosurgeons in the published literature. Consequently, the statement that "all therapeutic alternatives have been exhausted," which commonly appears in the psychosurgical literature, must be accepted or rejected as a matter of faith. One example of explicit criteria was recently expressed by the Canadian psychiatrist, Dr. Heinz Lehmann, who described what he means by sufficient exploration of alternative therapies:

> "Psychotherapy should be administered for at least six months by someone well experienced, not just a first-year resident.
>
> With drug therapy, the time varies. Antianxiety drugs, such as chlordiazepoxide hydrochloride (Librium) or diazepam (Valium), should be tried for at least two months--but not much longer, because dependency might develop. And the dosage must be adequate. Chlordiazepoxide hydrochloride should be given up to 100 mg/day. If an antidepressant, such as imipramine hydrochloride (Tofranil), is used, the dosage should go as high as 250 mg/day for at least six weeks. If it hasn't been effective by then, it's not going to be. The neuroleptic drugs--chlorpromazine hydrochloride (Thorazine Hydrochloride) or an equivalent--should be given in pretty high dosages, up to 1,000 mg/day. And they should be tried for two or three months without success before giving up on them.

> In addition, there should be at least one, but preferably two, courses of electroconvulsive therapy given with 10-15 convulsions per course." (323)

In addition, Lehmann believes that there must also be "clear symptoms of anxiety, depression, or obsessive-compulsive disorder" which have disabled the patient for at least two years. Obviously, not everyone would agree with Lehmann's criteria, but at the very least his clear statement may help to produce a useful dialogue. Some neurosurgeons also insist that the patient must have sufficient support in the postoperative period from family or friends before they would consider performing a psychosurgical procedure. The question about the adequacy of the exploration of alternative treatments will be discussed more fully in Section VIII of this report.

Although the specific symptoms and clinical history vary greatly, the following case history is not unrepresentative of many of those who are candidates for psychosurgery:

> Case 1: Severe intractable obsessional neurosis: J.G., Aged 34, female. Referred for treatment of an intractable obsessive-compulsive disorder. Her symptoms began when she was 23, after an unwanted pregnancy had forced her into an unhappy marriage. A year later, when the baby developed asthma, her feelings of guilt deepened and from that time her symptoms were of such severity that she was unable to cope with even the simplest tasks of everyday life. Her day was totally occupied with checking and rechecking actions such as washing, dressing and household tasks. She had, for example, to wash her face in a special order--starting with the left side, nose, right side, forehead--up to thirteen times. A similar elaborate system was involved in her bathing, which took her over an hour each day. After washing clothes she had to squeeze them a certain way, repeating the proceedings twenty-two times, the bottom of the bowl was then examined, checking the maker's mark numerous times to make sure the bowl was empty. Cleaning her teeth was a major task, taking over a half an hour. Making a bed, with

checking at each stage that the sheets and blankets were exactly symmetrical, might take over half an hour.

Household chores such as washing-up or polishing a table were completely impossible for her, as they took so long and caused her such distress. Her husband and mother were, therefore, forced into running her home and, on medical advice, her two children were at boarding school. The patient felt extreme guilt at her disruption of the family's existence and, at times, felt very depressed and that life was not worth living. Between 1962 and 1970 she was admitted to Severalls Hospital seven times, and received a variety of treatments including ECT, MAOI drugs, tricyclics, major and minor tranquilizers and psychotherapy. During 1968 and 1969 she was admitted on two occasions to the Royal Waterloo Hospital and had a total of five courses of modified narcosis, combined with ECT and antidepressants. After each admission she obtained symptomatic relief for about 2-4 weeks and then relapsed." (283)

While there may be general agreement on the patients that are the most promising candidates for psychosurgery, there is certainly less agreement about the appropriateness of psychosurgery for other types of patients. Even among those performing these operations, there is considerable disagreement on whether psychosurgery is effective or safe for some patients. Many psychiatrists and neurosurgeons have concluded that psychosurgery is ineffective in schizophrenic patients, while others have reported significant improvement following psychosurgery (32, 179, 323, and Appendix 7). Those who argue against the value of psychosurgery for schizophrenia state that it has no beneficial effect on the thought disorders of these patients, particularly when the symptoms have had a long duration. There is little doubt that some of the disagreement is based on the lack of clarity of diagnostic labels in psychiatry. A number of patients with severe obsessive-compulsive symptoms may have thought disorders that are judged similar to those of schizophrenia. Some of these patients are labelled as "schizo-affective" neurotics, a term that implies an emotional disturbance associated with some schizophrenic-like symptoms. Other psychiatrists would diagnose these patients as schizophrenics thereby implying a psychotic mental disorder.

The problem of lack of clarity in describing patients is not only due to the lack of discrete diagnostic categories. A substantial part of the problem may be related to the fact that institutions use the different diagnostic labels with greatly varying frequency. It is well known, for example, that the difference in incidence of schizophrenia in the U.S. and United Kingdom is due almost entirely to differences in diagnostic criteria (212, 299). In the U.S., the label schizophrenia has become a "wastebasket" category and is used many more times as often as in the U.K. where more stringent criteria are applied. On the other hand, British psychiatrists have used the affective-disorder diagnostic -labels much more frequently.

The problem of characterizing the patients receiving psychosurgery is further confounded by the use of pseudo-diagnostic labels that are completely lacking in precision. It is not uncommon in the psychosurgical literature for patients to be labelled with such terms as "emotional illness," "maladjusted states," and similar phrases that are left completely undefined or otherwise explained. This problem will be discussed further in Section XI of the report.

The disagreement over the effectiveness of psychosurgery for certain types of patients does not all hinge on the confusion over diagnosis or the use of imprecise labels. There are also some disagreements on matters of substance. In some instances, there is strong disagreement on the value of psychosurgery for specific diagnostic categories. Several psychiatrists and neurosurgeons have noted for example, that certain patients are not only resistant to psychosurgery, but these operations may increase the problem.

In this context, one neurosurgeon has recently written:

> "In conclusion, I wish to mention those types of mental and and behavioral diseases which are not benefitted by surgical lesions. They are criminals, constitutional psychopaths and possibly sex perverts... the patient must be acutely suffering with an intense desire to get well and have character integrity. The majority of criminals and psychopaths are constitutionally or genetically lacking in these characteristics and surgical ablations will make them worse rather than better." (502)

Other neurosurgeons, while perhaps not disagreeing on the importance of the patient's motivation to get well, have concluded that criminals, psychopaths and sexual perverts do benefit from psychosurgery. In Germany, several neurosurgeons have performed psychosurgery (ventromedial hypothalamic ablations) on pedophillic homosexuals and individuals who have committed violent sexual crimes (141, 142, 395, 426, 477). Although this operation is viewed as successful by those performing the procedure, others have argued that the amelioration of behavior problems results from a partial, "functional castration" and a very significant reduction in all sexual expression (587). Moreover, some recent tests suggest that there are adverse side effects of these operations that may have far-reaching consequences for intellectual and emotional capacities (494). It has also not escaped the attention of those concerned with ethical issues that a number of the ventromedial hypothalamic operations are performed on persons either in prison or during a time when they are facing imprisonment. Several neurosurgeons have argued that "functional neurosurgery" should not be performed on persons imprisoned (310, (358), but this view has not gone uncontested. At least one neurosurgeon in the U.S. has argued that persons in prison, including those exhibiting behavior characterized as "sociopathic aggression," should not be deprived of the benefits of psychosurgery (95, personal communications, comments at professional meetings and during radio interviews, Appendix 8b, Par.4). A more comprehensive discussion of these ethical issues will be presented in Section X.

Although only a small group of patients has been involved so far, there has also been considerable controversy over the appropriateness and safety of destroying a portion of the lateral hypothalamic area of the brain in order to control the excessive eating of very obese patients (448, 449). These operations, which were performed in Denmark, have been strongly criticized because of the possibility of causing endocrine disorders, severe disturbances in sensory and motor responsiveness, as well as producing decrements in motivation in general (364, 588). Because the lateral hypothalamic operations were performed in an institutional setting that did not require the approval of a review panel, this procedure will be discussed further in Section X of the report.

The appropriateness of psychosurgery far-aggressiveness and assaultive patients has also been the subject of much dispute. There seems to be a general agreement that there are patients in whom aggressiveness is related to clear brain damage who sometimes benefit remarkably from brain surgery. There is no such agreement, however, on the effectiveness of psychosurgery for violent patients who do not present clear evidence of brain damage. One neurosurgeon who has performed brain operations (amygdalectomies) on violent, epileptic patients and was thought to be recommending such brain surgery in the absence of evidence of brain damage has more recently written:

> "Our claim is that psychiatric neurosurgery to control violence should be limited to cases where the primary cause of the violence is brain dysfunction... Abnormal violent behavior <u>not</u> associated with brain disease should be dealt with politically and socially, not medically ... we would not approve neurosurgery unless the personal violence could be traced to organic brain disease and could not be treated by nonsurgical methods." (358)

Although there may be some question about what constitutes sufficient evidence to trace violent behavior to brain disease, at least the underlying guiding principle is stated explicitly. Neurosurgeons do not all agree on this principle, however, and psychosurgery (amygdalectomies) has been performed on violent patients who did not present evidence of brain damage (38, 42, 95, 125, 245, 401, 527, and others. See discussion in 587.)

B. Diagnostic Labels and Site of Brain Operation

Tables 6 and 7 summarize the data from the U.S.A. and the United Kingdom on the psychosurgical procedures used for patients in different diagnostic categories. The information was abstracted from all articles published since 1971. These articles were scrutinized in order to determine the probable date of surgery and, as far as could be determined, all operations performed prior to 1969 were eliminated from the data presented in the tables. The few uncertain cases are not likely to influence the overall statistics. Moreover, articles by the same neurosurgeon or neurosurgical unit were compared in order to eliminate (again, as far as possible) redundancy. Therefore, even though the same patients may have been included in several different summary articles, an effort was made to count each patient only once. Because the same patients were often included in several articles by the same neurosurgeon-psychiatrist "team," the number of articles used to construct Table 6 and 7 (see Appendices 4 and 5) was markedly reduced from the total.

A great variety of psychosurgical procedures are performed (see Section IV). In order to make the data manageable, the operations were grouped in Tables 6 and 7 according to the general brain area involved. Under the heading, "Frontal Lobe Procedures," for example, bimedial leucotomies, orbital undercutting, substantia innominata operations and various tractotomies designed to partially ablate frontal lobe connections to either the thalamus, hypothalamus, or limbic structures have all been included (see Figure 1). Similarly, thalamic operations

TABLE 6. Diagnostic Labels and Site of Brain Operation (U.S.A.)[1]

Diagnostic Labels[2]	Total # of Patients[3]	Site of Brain Operation: Frontal Lobe Procedure	Cingulum	Amygdala	Thalamus	Hypothalamus	Multiple Target Sites[5]	Midbrain	Brain Stimulation
Aggression	35			12(34.3%)		4(11.4%)	19(54.3%)		
Neurotic Depression	136	9(6.6%)	127(93.4%)						
Psychotic Depression [4]	11		11(100.0%)						
Fear & Anxiety	4	3(75.0%)	1(25.0%)						
Obsessive-Compulsive Neurosis	37	9(24.3%)	25(67.6%)				3(8.1%)		
Schizo-Affective Disorders	7	7(100.0%)							
Schizophrenia and Other Psychoses	80		32(40.0%)				47(58.8%)		1(1.2%)
Drug Addiction and Alcoholism	14	1(7.1%)	13(92.9%)						
Pain	379	17(4.5%)	177(46.7%)		120(31.7%)		25(6.6%)	8(2.1%)	32(8.4%)
Psychopathic Behavior	6				6(100.0%)				
"Emotional Illness"	9		1(11.1%)				8(88.9%)		
"Agitated States of Aged"	2	2(100.0%)							
Involutional Melancholia	1		1(100.0%)						
Epilepsy with Psychiatric Disorders	45			45(100.0%)					

[1]For each diagnostic category the number and percentage of patients is listed according to target of brain surgery. The articles (1971-1976) that were used to obtain this information are listed in Appendix 4. As far as could be determined, only data from patients receiving operations after 1970 were included.

[2]Labels are those used in the published articles.

[3]In those cases where author(s) did not provide a quantitative breakdown of their patients, diagnostic labels were assigned in proportion to the average frequency of usage of these labels for psychosurgical patients.

[4]Including Manic-Depressive Syndrome.

[5]Multiple target sites include the cingulum, amygdala, substantia innominata and thalamic structure in different combinations.

TABLE 7. Diagnostic Labels and Site of Brain Operation (United Kingdom)[1]

Diagnostic Labels[2]	Total # of Patients[3]	Site of Brain Operation: Frontal Lobe Procedure	Cingulum[6]	Limbic Leucotomies[4]	Amygdala	Multiple Target Sites[5]	Subthalamus (Field of Forel)
Aggression inc. self-mutilation	12		2(16.7%)		8(66.6%)	2(16.7%)	
Depression	201	169(84.1%)	2(1.0%)	28(13.9%)	2(1.0%)		
Fear & Anxiety	82	58(70.7%)	1(1.2%)	23(28.1%)			
Obsessive-Compulsive Neurosis	96	50(52.1%)	5(5.2%)	41(42.7%)			
Anorexia Nervosa	13	11(84.6%)		2(15.4%)			
Psychopathic Behavior	13	7(53.8%)		6(46.2%)			
Schizophrenia and other Psychoses	13	6(46.2%)		7(53.8%)			
Drug Addiction and Alcoholism	13	13(100.0%)					
Epilepsy with Psychiatric Disorders	36		3(8.3%)		30(83.4%)		3(83.3%)

[1]For each diagnostic category the number and percentage of patients is listed according to target of brain surgery. The articles that were used to obtain this information are listed in Appendix 5. As far as could be determined, only data from patients receiving operations after 1970 were included.

[2]Labels are those used in the published articles.

[3]In those cases where author(s) did not provide a quantitative breakdown of their patients, diagnostic labels were assigned in proportion to the average frequency of usage of these labels for psychosurgical patients.

[4]Frontal lobe procedure (medial leucotomy) and anterior cingulotomy.

[5]Multiple target sites include the cingulum, amygdala, substantia innominata and thalamic structure in different combinations.

[6]Most involve anterior portion, but one neurosurgeon performs a posterior cingulotomy (575).

TABLE 8. Comparison of Psychosurgical Procedures in the U.S.A. and United Kingdom (U.K.)

	Total # of Operations[1]	Frontal Lobe Procedure	Cingulum	Limbic Leucotomy[2]	Amygdala and Temporal Lobe	Thalamus	Hypothalamus	Multiple Target Sites	Midbrain	Subthalamus (Field of Forel)	Brain Stimulation
U.S.A.	768[3]	6.3%	50.5%	0	6.0%	16.7%	0.5%	13.3%	1.0%	0	5.7%
U.K.	479	65.6%	2.7%	22.3%	8.4%	0	0	0.4%	0	0.6%	0

[1] Total operations reported in published articles. Operations performed prior to 1970 and those estimated to have been reported more than once were omitted.

[2] Frontal lobe procedure (medial leucotomy) and anterior cingulotomy.

[3] Includes 379 brain operations for pain.

include ablations of either the anterior, dorsomedial, centromedian, or parafascicular thalamic nuclei. There are some neurosurgeons who would probably argue that such groupings violate important distinctions, but in view of the fact that most surgeons perform the same psychosurgical procedure for all patients, the broad categories used seem adequate for present purposes. Furthermore, stereotaxic and "open" operations were grouped together as were those employing different ablation techniques such as radio frequency waves, ultrasonic beams, radioactive yttrium seeds, suction, and knife cuts. Lastly, in Tables 6 and 7 the hetereogeneous diagnostic labels were collapsed into groups that were judged not to violate important differences in the symptomatology of patients.

Inspection of Tables 6 and 7 reveal some differences in the psychosurgical practices between the U.S. and the United Kingdom. These differences are summarized in a simplified form without diagnostic labels in Table 8. It can be seen from Table 8 that there is a greater relative percentage of frontal lobe procedures performed in the U.K. while cingulotomies are more frequently performed in the U.S. When cingulotomies are performed in the U.K. they tend to be done in conjunction with frontal lobe operations (bimedial leucotomies) resulting in a combined procedure often termed limbic leucotomy. Excluding limbic leucotomies, there is a much greater tendency to perform multiple-target psychosurgery in the U.S.A. Some of these differences between the two countries can be attributed to a very few very active neurosurgeons in one or the other country. As far as could be determined from the published literature, neither thalamic or hypothalamic operations, nor electrical stimulation of deep brain structures were performed in the U.K. since 1971.

With respect to diagnostic categories, the data confirm the conclusion that, with the exception of operations for intractable pain in the U.S.A., the majority of psychosurgery is performed on patients suffering from fear and anxiety, obsessive-compulsive disorders, and neurotic depression. This trend is less striking in the U.S. because of the relatively higher number of schizophrenic and other psychotic patients who were given psychosurgery. There seems to have been a relatively lower frequency of psychosurgery for psychotic patients in the U.K. in the 1970's. It is not possible to determine how much of this difference between the two countries results from differences in diagnostic labelling. Lastly, if the published literature correctly reflects the actual practice, there is a much greater tendency for brain operations to be performed for intractable pain in the U.S.A. than in the U.K.

VII. POSTOPERATIVE EVALUATION

Stripped of all rhetoric, at the center of most arguments over psychosurgery are conflicting views about the nature and frequency of occurrence of emotional and intellectual changes as well as about the likelihood of producing serious side-effects. There is little doubt that evidence can be selected to support any of the extreme positions on psychosurgery. It is most important, therefore, to try to arrive at an unbiased and representative summary of the results of these operations. This chapter of the report represents an attempt to contribute to this goal from information that can be obtained from the published literature. Information on the changes produced by psychosurgery was derived from 153 data articles published from 1971 to the present. These articles represent the total number of articles describing the results of psychosurgery written by persons of all countries having direct contact with psychosurgical patients or their records. In addition to these, there were 50 "data articles" which contained information on the results of brain operations for intractable pain (cf., page 3).

It is apparent that the ability to obtain a meaningful summary of the effects of psychosurgery from a literature survey is dependent on the reliability, validity, and comprehensiveness of the data that are reported. It is important, therefore, to examine the way the data have been collected and reported. Part 1 of this chapter is a commentary on the scientific validity of the data reported in the psychosurgical literature. Part 2 presents the results of the surgery in three separate sections. Section A summarizes the results obtained from objective tests, while Section B describes the estimate of the overall changes in the patients' adjustment as presented (in most cases) by the psychiatrists and neurosurgeons responsible for the treatment. Section C offers data on the nature and incidence of complications attributable to the surgery.

Part 1: The Psychosurgical literature: Reliability, Validity and Scientific Merit

For obvious reasons, it is usually impossible for neurosurgeons and psychiatrists to use the type of experimental control procedures that are routinely used in animal research. Understandably, patient care must and should take precedence over considerations of research design. The random assignment of subjects to different experimental (treatment) groups, the use of sham operations to control for placebo effects, and other similar procedures routinely used in animal studies are difficult, and sometimes impossible, to institute in clinical research without violating the rights of patients. Even though many of the shortcomings of the psychosurgical literature are a necessary concommitant of ethical concerns, the recognition of this necessity does not thereby improve the quality of the information presented in clinical reports. It is probably true that a number of the shortcomings in the psychosurgical literature probably cannot be remedied without introducing some risks to patients; other shortcomings, however, could be reduced with no detrimental effects.

One criterion that should be used in evaluating the reliability and validity of the information presented on postoperative changes is the extent that objective and standardized tests are used to evaluate these changes. While not denying that clinical acumen and subjective impressions may provide valuable leads, it is clear that the results obtained from objective tests are more likely to be replicable, comparable, and free of personal bias. Even where standard tests are not employed, the use of operationally defined criteria that explicitly describe the basis for statements about postoperative changes is clearly desirable.

We have listed all the objective tests cited in the 153 data articles on Psychosurgery (Appendix 6). Our list of tests has been compiled liberally in that we have included tests that the authors implied were standardized even when there was no published evidence supporting this assertion. Excluded from the list, however, were patient questionnaires referred to by some terms as "tests of self-scrutiny," and "pleasure ratings" when they appeared to be idiosyncratic to one author and were not stated to have been standardized. The tests are grouped according to categories reflecting their major focus and purpose. The following categories, while somewhat arbitrary, were judged to adequately describe the characteristics being tested: Behavior Evaluation Tests, Test of Psychiatric Symptoms or Status, General Personality Tests, Specific Personality Scales (e.g., anxiety, depression, hostility), Tests of Abstract Thinking, Intelligence Tests, Learning and Memory Tests, Neurological or Psychoneurological Tests (including perception tests), Motor Performance Tests and Tests of Language Ability. Tests having multiple purposes are listed in more than one category; the reference number of the articles reporting the use of these tests are included in Appendix 6. Our purpose in compiling this list was to establish the frequency of use of objective tests for evaluating patients following psychosurgery and to determine if there were any trends in the changes in specific capacities following different operations.

Figure 2 presents the percentage of the "data articles" that report the results of objective tests. The data are presented for articles from all countries combined and also separately for the articles from the United States and the United Kingdom. It can be seen that 58% of the world-wide articles have no information obtained from objective tests. Only 70 articles out of the 153 even mentioned the use of any objective tests. Five of the 70 articles referred only to the use of "psychometric evaluation," but did not otherwise specify the tests used; sixteen of the articles used only an IQ test. In total, 49 articles reported the use of intelligence tests, but only

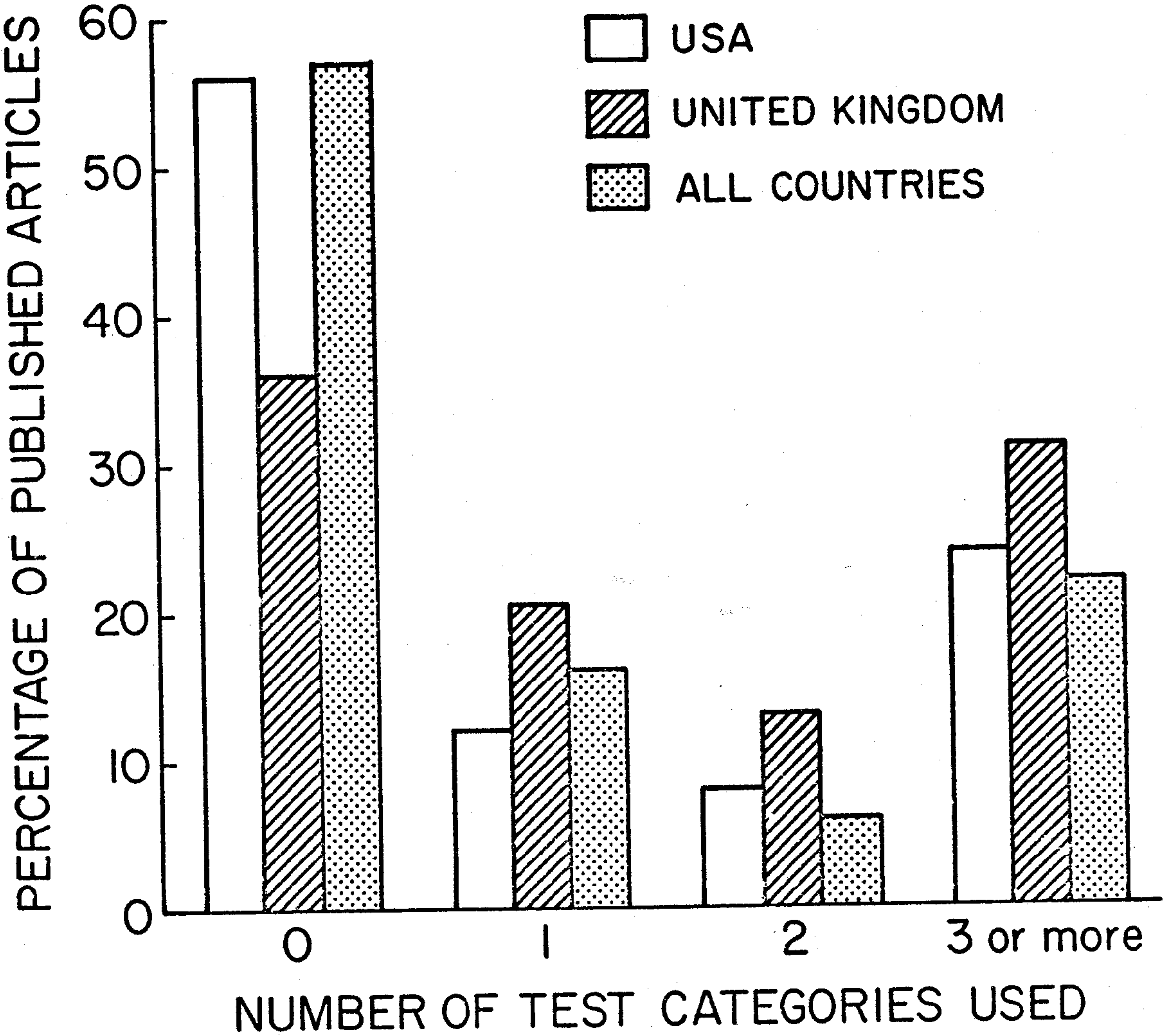

FIGURE 2 PERCENTAGE OF PUBLISHED ARTICLES PRESENTING RESULTS OF OBJECTIVE TESTS

27 of these specified the name of the test. A number of articles gave the names of specific objective tests without describing the results other than stating there was no change. The record from the United States was no better than the world average; articles from the United Kingdom generally described the use of objective tests more frequently. Only 25% of the U.S. articles reported data from three or more objective tests (Figure 2).

Tables 9, 10, and 11 present data on the use of objective tests analyzed separately by the main brain target ablated during psychosurgery. Table 9 lists the results from all articles, while Tables 10 and 11 summarize the U.S. and U.K. record respectively. The U.S. record (Table 10) suggests some differences depending on the brain target of the operation. There have been no results of objective tests reported, for example, in any of the articles describing multiple target or hypothalamic operations. In general, Table 10 suggests that the objective tests used are those that are easiest to administer and to score. It can be seen, for instance, that intelligence tests tend to be used more frequently than tests of abstract thinking. This trend has to be viewed as disappointing in view of the fact that the bulk of the evidence suggests that the overall IQ test results generally did not detect postoperative changes even following the older, more extensive, lobotomy procedures.* There has been evidence, however, of postoperative deficits in abstract thinking (199, 200, see also Mirsky and Orzack's data from the Wisconsin Card Sorting Test in their June 1, 1976, report to the Commission).

The results presented in Tables 10 and 11 support the trend seen in Figure 2 in that they show that articles from the U.K. present the results

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* Two studies did report IQ changes following the older, lobotomy procedures (481, 529, 530) and a few studies have reported deficits in specific subtests of an IQ battery. The vast majority of the studies, however, did not report any postoperative deficits in IQ. A discussion of this issue is presented elsewhere (587, page 321 and footnote 43, page 398).

TABLE 9. Percentage of Articles Specifying Use of Objective Tests (All Countries)[1]

Target of Operation	Number of Articles	No Test Specified	Test Categories: Behavior Evaluation	Psychiatric Symptoms	Personality Tests	Specific Psychiatric Scales	Abstract Thinking	Intelligence	Learning and Memory	Neurology and Psycho-neurology	Motor Performance	Language
Cingulum	34	44.0%	2.9%	5.9%	41.2%	35.3%	23.5%	50.0%	29.4%	29.4%	20.6%	2.9%
Amygdala	34	58.8%	8.8%	11.8%	8.8%	11.8%	8.8%	29.4%	8.8%	8.8%	5.9%	5.9%
Frontal Lobe	64	57.8%	0	4.7%	26.6%	26.5%	4.7%	28.1%	6.2%	1.6%	3.1%	1.6%
Thalamus	15	73.3%	13.3%	0	13.3%	6.7%	0	13.3%	0	6.7%	0	0
Hypothalamus	25	84.0%	0	0	4.0%	0	4.0%	20.0%	0	0	0	0
Multiple Targets	10	80.0%	0	0	20.0%	20.0%	10.0%	20.0%	10.0%	10.0%	10.0%	0
Other	14	64.3%	0	0	21.4%	21.4%	7.1%	35.7%	14.3%	0	14.3%	0

[1]Percentages are calculated separately for each brain target based on the proportion of papers reporting data in each test category. The specific tests included in each test category are listed in Appendix 6.

TABLE 10. Percentage of Articles Specifying Use of Objective Tests (U.S.A.)[1]

			Test Categories									
Target of Operation	Number of Articles	No Test Specified	Behavior Evaluation	Psychiatric Symptoms	Personality Tests	Specific Psychiatric Scales	Abstract Thinking	Intelligence	Learning and Memory	Neurology and Psycho-neurology	Motor Performance	Language
Cingulum	7	43.0%	14.0%	0	28.0%	14.0%	14.0%	43.0%	57.0%	57.0%	14.0%	14.0%
Amygdala	5	60.0%	0	20.0%	0	0	0	40.0%	0	20.0%	0	0
Frontal Lobe	9	77.0%	0	0	33.0%	0	0	22.0%	0	0	0	0
Thalamus	3	0	66.7%	0	66.7%	33.3%	0	33.3%	0	33.3%	0	0
Hypothalamus	1	100.0%	0	0	0	0	0	0	0	0	0	0
Multiple Targets	3	100.0%	0	0	0	0	0	0	0	0	0	0
Other	-	-	-	-	-	-	-	-	-	-	-	-

[1]Percentages are calculated separately for each brain target based on the proportion of papers reporting data in each test category. The specific tests included in each test category are listed in Appendix 6.

TABLE 11. Percentage of Articles Specifying Use of Objective Tests (United Kingdom)[1]

Target of Operation	Number of Articles	No Test Specified	Test Categories: Behavior Evaluation	Psychiatric Symptoms	Personality Tests	Specific Psychiatric Scales	Abstract Thinking	Intelligence	Learning and Memory	Neurology and Psycho-neurology	Motor Performance	Language
Cingulum	6	33.3%	0	16.7%	50.0%	50.0%	33.3%	50.0%	16.7%	0	0	0
Amygdala	8	25.0%	37.5%	37.5%	37.5%	50.0%	37.5%	25.0%	50.0%	25.0%	25.0%	25.0%
Frontal Lobe	29	41.4%	0	3.4%	37.9%	41.4%	3.4%	34.5%	3.4%	3.4%	0	3.4%
Thalamus	0	-	-	-	-	-	-	-	-	-	-	-
Hypothalamus	0	-	-	-	-	-	-	-	-	-	-	-
Multiple Targets	1	0	0	0	0	0	0	0	0	0	0	0
Other	1	0	0	0	0	0	0	100.0%	0	0	0	0

[1]Percentages are calculated separately for each brain target based on the proportion of papers reporting data in each test category. The specific tests included in each test category are listed in Appendix 6.

of objective tests significantly more frequently than those from the U.S. Although the differences between the two countries may be somewhat inflated by the tendency of one British group to describe essentially the same objective test results in several articles (283, 285, 388, 389), the trend remained even when these articles were eliminated from the comparison.

It is necessary to point out that there are no readily available objective tests that have proven to be sensitive to intellectual changes following psychosurgery. Testing for such capacities as abstract reasoning, facility to switch from one problem solving strategy to another, and creativity or originality as reflected in "divergent thinking" is not an exact science. There is no agreement on how to measure these capacities even in normal people and it is certainly conceivable that the testing of psychosurgical patients presents different problems. For example, some psychosurgical patients may reveal abilities when subjected to the challenge of a test situation that they seldom use in everyday life. There may be differences produced by the surgery in the probability of using some intellectual capacities rather than in the loss of these abilities in any absolute sense.

It is clear that we need to explore new ways of testing patients following psychosurgery. Whatever the shortcomings of the tests that are presently available, there is little justification for the frequent claim that there is no intellectual change following surgery when no meaningful data are presented. In one extreme case, an author reported that there were "no or little changes in intellect and discrimination ability" following psychosurgery, but the only evidence presented was a sample of a patient's postoperative knitting (620).

It may be important to recall in the present context that the use of insensitive tests following destruction of the corpus callosum in the human brain had led to the conclusion that there was no impairment in conversational facility, verbal reasoning and intelligence, established motor coordination, long-term memory, personality, sense of humor, and social interactions following surgery. Indeed no function at all could be attributed to the corpus callosum until it was revealed by the use of appropriate testing by Dr. Roger Sperry and his colleagues. More recently, additional testing has demonstrated short-term memory deficits (629) and impairment in transfer of learning between sensory modalities (202).

Most commonly, the postoperative results of psychosurgery are reported in terms of categories based on patient interviews, questionnaires sent to relatives, employment record, marital stability, and general information concerning the patients' adjustment. The following description (46) of categories used to report postoperative results is representative:

Category	Description
5	Patient is well, not taking any medications, no longer under regular psychiatric care and functioning 80-100% of his ability.
4	Patient feels well, markedly improved since operation, but takes medication, sees psychiatrist occasionally and is functioning 80-100% of his ability.
3	Patient is not well, but much improved. He is under the frequent care of his psychiatrist, takes medication and psychiatric treatment regularly and is functioning 40-70% of his ability.
2	Patient is not well, but has improved since operation. Severely disabled and is functioning 20-30% of his ability.
1	Patient has shown no improvement since operation and/or is 100% disabled.
0	Patient is worse since operation.

Information presented in this way is not without value, but it clearly has serious limitations. Because many of the judgments are based on subjective impressions, often from limited samples of the patient's behavior, and from information obtained from people who may not want to offend the physician, there are any number of ways the results may reflect unconscious bias.

Such phrases as the patient "is functioning at 80-100% (or 40-70%) of his ability" are clearly not as quantifiable as the statements imply. A summary of the results of psychosurgery as presented in broad categorical statements about change is presented in Part 2 of this section of the report.

The value of the "data articles" on psychosurgery was evaluated by assigning a rating of scientific merit according to a scale proposed by May and Van Putten (375). This rating scale is based on such factors as the use of control groups and standardized tests, the appropriate statistical treatment of data, the independence of the evaluators from those performing the treatment, the duration of the postoperative follow-ups, and other experimental considerations. A rating of 1 is assigned only to studies that have matched control groups, use objective tests, evaluate patients for an adequate period, employ independent testers, analyze data statistically, and do not confound any relevant variables (e.g., drug treatment, type and duration of psychotherapy, support from family or friends, etc.). A rating of 6 is assigned to those reports that present only descriptive information on the patients and have no comparison group. The results are summarized in Table 12 for the majority of the "data articles." It can be seen from Table 12 that most of the articles on psychosurgery were assigned a rating of 5 or 6. Almost 90% of the articles from the U.S. received ratings between 4 and 6. It is important to appreciate that a rating of 4 would be given only to articles of low scientific value. It is unlikely, for example, that an animal study with such a low rating would be accepted for publication by the editors of a respected experimental journal.

In the case of clinical reports, a rating of 4 is given to articles that have inadequate experimental controls against a biased selection of patients for psychosurgery. This factor may play a very significant role in determining any differences between patients receiving psychosurgery and so-called

TABLE 12. Scientific Merit of Articles Based on Experimental Design and Reliability of Data

Country and # of Articles	May Rating Scale[1]					
	I	II	III	IV	V	VI
U.S.A.(45)	0	3.3%	7.8%	16.7%	31.1%	41.1%
U.K.(31)	0	3.2%	1.6%	12.9%	50.0%	32.3%
All Other Countries (104)	0	0	1.0%	9.1%	30.8%	59.1%

[1] I=a well controlled study using objective evaluation methods; VI=Descriptive case reports with no control group. See text for details of rating scale.

"control groups' that are reported in the literature. Not atypical of the selection criteria for psychotherapy is that given in a recent article (616) which includes the following:

1) The patient must not show any psychotic features.

2) The level of motivation to get well must be high.

3) The patient must desire the operation.

4) There must be strong family and medical support.

Clearly, if any of these variables were not distributed equally between the "surgery" and "control" groups, any comparisons could be misleading.

In addition to the possibility of a biased selection of patients, articles receiving a rating of 4 usually have important variables confounded in a way that makes it impossible to determine whether the postoperative changes should be attributed to the psychosurgery or to an intensification of psychotherapy, pharmacological treatment, or to the additional effort made by the family and hospital staff. Not atypical is the following comment made in a recent report of the results of psychosurgery:

> "The importance of an intensive and long-lasting postoperative rehabilitation in conjunction with psychosurgical treatment cannot be overrated. The fact that this was given to virtually all our patients is presumably a contributing factor to the favorable long-term results." (65)

When such intensification of "rehabilitation" is considered together with the fact that the benefits of psychosurgery often do not appear for many months after the operation, it can be seen how difficult it may be to determine the relative importance of the surgery itself.

The possibility that the reduction of troublesome symptoms frequently reported in the psychosurgical literature may be attributed to some form of patient suggestibility has, of course, been raised very often. Many patients become convinced that psychosurgery represents their only chance of getting better and as a result there is a great anticipation of being helped. Undoubtedly these psychological factors can influence the results of any treatment. Such placebo effects are known to be very great under some circumstances. In the area of pain, it has been claimed that a very large proportion of the effectiveness of drugs and surgery can result from the patients' anticipation of beneficial effects (57). Some of these placebo effects emerge from patient-physician interactions, The combination of a patient that has great confidence in his physician and a physician that believes strongly in the efficacy of his treatment usually makes a significant contribution to the outcome of the therapy.

Although it is normally impossible to answer the "placebo argument" adequately because of the ethical restraints against performing sham-operations, there are several reports that present attempts to provide answers. In 1953, one neurosurgeon located at the Oregon Veterans Administration Hospital reported the following:

> "In 4 separated cases in this series we carried out a control procedure in which the skin incision is made and the bone button removed but no cerebral lesion produced. Each of these patients was included in a group of four operated on at one time, three of whom had a standard anterior cingulate isolation. The four patients were carried as a group through the entire postoperative routine without knowledge on the part of the patients or other hospital personnel that these control patients had not been subjected to the complete surgical procedure. None of these patients showed even slight improvement during this period of control study and all were subjected to cingulate isolation one to three months later." (336, p. 377)

In 1973, a group of Indian neurosurgeons reported the following results obtained in a study of stereotaxic cingulotomies on drug addicted patients:

> "The possibility of 'placebo effects' being responsible for the efficacy of surgery was considered and eliminated by the

following method. In three cases, at first only burrholes were done, but the patients were told that 'the operation' had been performed. They continued to ask for the drugs and had relief only after the cingulotomy was performed." (39, p. 64)

Setting aside objections on ethical grounds, the evidence from sham operations can be the most persuasive argument that the beneficial changes have been produced by surgery itself rather than by some placebo effects. In order for the evidence to be convincing, however, it is essential that the patients assigned to the surgery and sham groups be identical. In the few instances of reports of sham psychosurgical operations, there was inadequate evidence that appropriate controls had been employed to assure against bias in patient assignment. Indeed, in the Oregon study some of the patients in the sham group were assigned on the basis of their having refused to permit surgery to continue (the operations were performed under local anesthetic) after a burr bole had been made in the skull. It is certainly conceivable that such patients had less than average confidence in the surgery or the surgeon.

It has also been argued on several occasions that the results of psychosurgery that missed the proper brain target also provides a form of control for placebo effects. Thus in a 1967 article describing the results of stereotaxic cingulotomy for neuropsychiatric illness and intractable pain, it was written:

"One must also consider the possibility that most manic-depressive illnesses are self-limited; that there may be a 'placebo effect' to the operation; that the operated patients are treated differently and more intensively than the others; that the anesthesia could of itself reverse the course of the illness. Ten of the 40 patients in this series benefitted from secondary operation after the first failed. This group tends to refute the 'placebo argument'." (45, p. 494)

Here too, the evidence against "placebo effects" would have been much more convincing if the information was more complete. Although it would be difficult to arrive at reliable figures, a careful reading of the psychosurgical literature reveals that there are a substantial number of patients who-have under-= gone several different psychosurgical procedures. For example, one patient described in a study of cingulotomy in man (Teuber, H.L., Corkin, S. & Twichel, T.E. report submitted to the National Commission for the Protection of Human Subjects, June 11, 1976) received a cingulotomy, which was followed by a multiple-target procedure (involving bilateral destruction of part of the amygdala, cingulate, and substantia innominata) five years later, and a second cingulotomy within the same year. Many similar examples are readily available. Some operations that appear to have been correctly placed are unsuccessful as well as the converse. Although it may ultimately be proven true, the evidence that the success of the operation is highly correlated with the brain target destroyed is not convincing at present. A partial reporting Of some of the results from successive operations can be misleading.

It should be stressed that the arguments presented here have bearing only on the overall scientific merit of the psychosurgical literature. It is possible that the surgery does produce the benefits and no more impairments than are generally described. The lack of objectives evidence, however, leaves open the possibility that the improvement reported in the literature does not adequately summarize all the changes produced by the surgery. Moreover, the absence of adequate experimental controls makes it impossible to determine whether the brain destruction is the most important factor in producing the changes that do occur.

Part 2. The Postoperative Results

A. Objective Test Results

Tables 13-18 present the postoperative changes following psychosurgery that have been revealed by objective tests. These tables summarize the results as described in the literature published after 1971. The data are presented separately by the major brain targets of the surgery. In general, it can be seen from an inspection of the tables that in the majority of instances the changes are perceived as improvements (+), but some deficits (-) have also been reported. Some of the deficits are described as transient or short term (ST). It should be kept in mind when examining the tables that the test results are frequently confounded. A reduction in anxiety, for example, might be responsible for improved performance on an IQ test, because the patient is better able to attend to the task. It is not likely that the operations actually increase intelligence.

The most consistent improvements that are reported are those related to the symptoms commonly presented by psychosurgical patients. Thus, with few exceptions, depression, anxiety, neuroticism, obsessionalism, somatic complaints, tension, and phobias are reported as reduced after surgery. All of the postoperative changes in the results of objective test measures of emotions were viewed as improvements with the exception of a report of decreased impulse control and increased negativism and belligerence following an amygdalectomy (559).

The deficits reported are primarily evident in tests of abstract thinking, learning and memory, and language ability. Under the category abstract thinking, deficits have been reported on tests requiring the categorizing of information such as the Wisconsin Card Sorting and the Goldstein-Scheerer Colour-Forms tests. Deficits were also reported in similarities, block-design, and picture arrangement tests. It should be stressed, however, that

TABLE 13. Patient Evaluation: Results of Objective Tests Following Thalamic Operations

Reference #	Behavior Evaluation	Psychiatric Symptoms	Personality Tests	Specific Psychiatric Scales	Abstract Thinking	Intelligence	Learning and Memory	Neurology and Psycho-neurology	Motor Performance	Language
	Test Categories[1]									
224						+				
263			+(↓Hypomania)							
109			+(↓Neuroticism) NC(Introversion Neuroticism-diff. test)			+(↑verbal)				
262			−(↓color scores in Rorschach)		−(Block-designs, Similarities, Trail making)		+(learning of associations −(memory for designs)	−(reproducing figures)		
468						−(IQ, ST)				
594							NC(face recognition)	−(face matching)		−(token test)
597							NC(face recognition)	−(face matching)		−(token test)
16	+(Behavior Evaluation Rating Scale	+(↓Hysteria)	+(↓Hypochondriasis)							
18	+(↓aggression, patho-affect) hyperkinesia)					NC				
22	+(↓aggression, patho-affect) hyperkinesia)					NC				−(word fluency)
110			+(↓Introversion)	+(↓Depression)		−(↓1pt., NC others)				

[1]See Appendix 6 for specific tests included in each category.

NS = Not significant

NC = No change

↓ = Direction of arrow indicates increase or decrease of characteristic in parentheses.

\+ = improvement

\- = deficit

ST = short term

TABLE 14. Patient Evaluation: Results of Objective Tests Following Amygdala Operations

	Test Categories[1]									
Reference #	Behavior Evaluation	Psychiatric Symptoms	Personality Tests	Specific Psychiatric Scales	Abstract Thinking	Intelligence	Learning and Memory	Neurology and Psychoneurology	Motor Performance	Language
243	+		+(↓Emotional lability, Submissiveness, Tenderminded-ness)			NC				
575							−(↓memory)			
244	+		+(↓Shyness, Suspiciousness)	?(↑Intro-punitiveness)		NC				
42						NC				
559		−(↓Impulse Control, ↑Negativism, Belligerence, Grandiosity)				−(NS)		NC		
245	+	+	+							
71						−(↓verbal) +(↑performance)				
288						NC				
400	+(↓hyperkinesis)					+				
560						NC				
509				+(↓Depression)						
381						+				
224						+				
74						+				
575							−(Meyer Learning Test)			

[1]See Appendix 6 for specific tests included in each category.

NS = Not significant

NC = No change

↑ = Direction of arrow indicates increase or decrease of characteristic in parentheses.

\+ = improvement

\- = deficit

ST = short term

TABLE 15. Patient Evaluation: Results of Objective Tests Following Limbic Leucotomies

Test Categories[1]

Reference #	Behavior Evaluation	Psychiatric Symptoms	Personality Tests	Specific Psychiatric Scales	Abstract Thinking	Intelligence	Learning and Memory	Neurology and Psycho-neurology	Motor Performance	Language
285			+(↓Neuroticism, Obsessionalism, Phobic, Hysteric, Somatic; ↑Extroversion)	+(↓Depression, Anxiety)		+				
283			+(↓Neuroticism, Obsessionalism, Phobic, Hysteric, Somatic; ↑Extroversion)	+(↓Depression, Anxiety)	+(Block-design, Picture Arrangement)	+				
279			+(↓Neuroticism, Obsessionalism, Phobic, Hysteric, Somatic; ↑Extroversion)	+(↓Depression, Anxiety)		+				
280			+(↓Neuroticism, Obsessionalism, Phobic, Hysteric, Somatic; ↑Extroversion)	+(↓Depression, Anxiety)						
389			+(↓Neuroticism, Obsessionalism)	+(↓Depression)		+				
286			+(↓Neuroticism, Obsessionalism, Phobic, Hysteric, Somatic; ↑Extroversion)	+(↓Depression, Anxiety)	+(Block-design)	+(↑performance, full-scale)				

[1]See Appendix 6 for specific tests included in each category.

NS = Not significant

NC = No change

↑ = Direction of arrow indicates increase or decrease of characteristic in parentheses.

\+ = improvement

\- = deficit

ST = short term

TABLE 16. Patient Evaluation: Results of Objective Tests Following Cingulotomies

Test Categories[1]

Reference #	Behavior Evaluation	Psychiatric Symptoms	Personality Tests	Specific Psychiatric Scales	Abstract Thinking	Intelligence	Learning and Memory	Neurology and Psycho-neurology	Motor Performance	Language
187			NC(MMPI,EPI)			NC				
533			+(↑Extraversion; ↓Neuroticism)	+(↓Depression, Anxiety)		+(↑IQ including memory)				
595			+(↑Extraversion) NC(Rorschach)			NC			+(Purdue Pegboard)	
313			−(↓imagination in Holtzman Inkblot) NC(Neuroticism)					NC(attention, reaction time)	+(Purdue Pegboard)	
110			+(3 measures of ↓Neuroticism; ↓Introversion) −(1 measure of ↑Neuroticism; ↑Introversion)			NC				−(↓fluency NS)
216			NC(Introversion, Defensiveness, Neuroticism)		+(Hooper Visual Organization)	+			+(Bourdon-Wiersma)	
312							−(↓visual retention & comprehension)		+(↑psycho-motor speed)	
386			NC(Rorschach)			+				
32			+(↑self-sentiment, self-sufficiency, Social assertive-ness, Extraversion, Dominance, Surgency, Tough-mindedness, ↓Neuroticism Superego, Pugnacity) ?(↑Sexuality)	+(↓Anxiety, Tension)	+(Similari-ties, Block-Design)	+	−(Digit span NS)	+(↑vigilance)		
46						+(memory)		+(Bender-Gestalt)		
365			+(↓schizophrenic)	+(↓Depression, Anxiety, Hostility)		+				
329	+									
382				+(↓Depression, Anxiety, Hostility)		+		+(Bender-Gestalt)		

CONTINUED

TABLE 16 (continued). Patient Evaluation: Results of Objective Tests Following Cingulotomies

Reference #	Behavior Evaluation	Psychiatric Symptoms	Personality Tests	Specific Psychiatric Scales	Abstract Thinking	Intelligence	Learning and Memory	Neurology and Psycho-neurology	Motor Performance	Language
				Test Categories[1]						
256						NC				
161					−(Porteus maze, 2 patients)		NC(Digit-span, Digit-Symbol Substitution)		−(Tapping test)	
575							NC(Meyer Learning Test)			
388			+(↓Neuroticism, Obsessionalism, Phobic, Hysteric, Somatic; ↑Extraversion)	+(↓Depression, Anxiety)	+(Block-design, Picture arrangement, Object assembly)	+(↑verbal, performance, information, arithmetic)	+(Digit-Symbol Substitution)			
286			+(↓Neuroticism, Obsessionalism, Phobic, Hysteric, Somatic; ↑Extraversion)	+(↓Depression, Anxiety)	+(Block-design)	+(↑performance, full-scale)				
283			+(↓Neuroticism, Obsessionalism, Phobic, Hysteric, Somatic; ↑Extraversion)	+(↓Depression, Anxiety)	+(Block-design, Picture arrangement)	+				
33			+(↓Tenderminded-ness, Super-Ego, Pugnacity; ↑Assertiveness, Self-realism, Mating, Self-sentiment, Dominance)	+(↓Anxiety)	+(Block-design, similarities) −(Picture arrangement)	+	+(Digit-span, Digit-Symbol Substitution)	+(CFF, time estimates)	+(Form Board Speed)	+(↑fluency)

[1]See Appendix 6 for specific tests included in each category.

NS = Not significant

NC = No change

↑ = Direction of arrow indicates increase or decrease of characteristic in parentheses.

\+ = improvement

\- = deficit

ST = short term

TABLE 17. Patient Evaluation: Results of Objective Tests Following Frontal Operations

	Test Categories[1]									
Reference #	Behavior Evaluation	Psychiatric Symptoms	Personality Tests	Specific Psychiatric Scales	Abstract Thinking	Intelligence	Learning and Memory	Neurology and Psychoneurology	Motor Performance	Language
109			+(↓Neuroticism, Introversion)			+				
559						−(1pt., NC others)				
241			+(Rorschach, MMPI)			+(1pt.)				
187			NC(MMPI, EPI)			NC				
505			NC(Rorschach, TAT, Sentence-Completion) ?(↑ fantasy formation)			+		NC(Halstead-Reitan-Wepman)		
176		+(Miller Scale)								
314			+(↓Neuroticism) −(↓imagination, NS)			+(NS)	+(↑inkblot recognition)		+	
287				+(↓Anxiety, Depression)						
198				+(↓Anxiety, Depression)						
122						+				
613						NC				
147					−(Wisconsin card-sorting)	+				
533			+(↑Extraversion; ↓Neuroticism)	+(↓Anxiety, Depression)		+(↑ including memory)				
602		+(↓neurotic features)	+(↓Introversion) −(↓Ego-Strength)	+(↓Depression)	−(Goldstein-Scheerer, Colour-Forms)					
595			+(↓Neuroticism) NC(Rorschach)			NC	+(↑ inkblot recognition)			
348						−(↓verbal)				
313			+(↓Neuroticism)			+(Culture-Free)	+(↑ memory)	NC(attention, reaction time)	+(Purdue Pegboard)	

CONTINUED

TABLE 17 (continued). Patient Evaluation: Results of Objective Tests Following Frontal Operations

Reference #	Test Categories[1]									
	Behavior Evaluation	Psychiatric Symptoms	Personality Tests	Specific Psychiatric Scales	Abstract Thinking	Intelligence	Learning and Memory	Neurology and Psycho-neurology	Motor Performance	Language
85			+(↓Neuroticism; ↑Extroversion)	+(↓Depression, Anxiety)						
265						NC(general)	NC(memory)			
616						NC +(↑performance)		NC(Raven's Progressive Matrices)		NC(Mill Hill Vocabulary)

[1]See Appendix 6 for specific tests included in each category.

NS = Not significant

NC = No change

↕ = Direction of arrow indicates increase or decrease of characteristic in parentheses.

\+ = *improvement*

\- = deficit

ST = short term

TABLE 18. Patient Evaluation: Results of Objective Tests Following Other Psychosurgical Operations

Test Categories[1]

Target Site & Reference #	Behavior Evaluation	Psychiatric Symptoms	Personality Tests	Specific Psychiatric Scales	Abstract Thinking	Intelligence	Learning and Memory	Neurology and Psychoneurology	Motor Performance	Language
HYPOTHALAMUS										
42						NC				
494						NC				
496	+		NC(Rorschach)			NC		NC(Bender-Gestalt)		
487						NC				
FIELD OF FOREL										
14						NC				
INTERNAL CAPSULE										
65			+(↓Neuroticism, Obsessionalism, Introversion; ↑Self-Control)	+(↓Anxiety, Depression)		NC				
MULTIPLE TARGETS										
33			+(↓Tendermindedness, Super-Ego, Pugnacity; ↑Assertiveness, Self-realism, Mating, Self-sentiment, Dominance)	+(↓Anxiety)	+(Similarities, Block-design) −(Picture Arrangement, Mazes, Lattice Test, Gestalt Completion)	+	+(Digit-Span, Digit-Symbol Substitution)	+(CFF, time estimates)	+(Form Board Speed)	+(↑fluency)
74						+				
187			NC(MMPI, EPI)			NC				

[1] See Appendix 6 for specific tests included in each category.

NS = Not significant

NC = No change

↑ = Direction of arrow indicates increase or decrease of characteristic in parentheses.

\+ = improvement

\- = deficit

ST = short term

these deficits are not consistently found. Also, it is not uncommon for the deficits that are detected by objective tests to be relatively short lasting. For example, in the report, "A Study of Cingulotomy in Man" (Teuber, H.L., Corkin, S. & Twitchell, T.E., submitted to the National Commission, June 11, 1976), the deficits in abstract thinking and in some perceptual tasks (embedded figures) that were found during the first few months after surgery could not be detected in patients tested at a later period.

Following thalamic operations (Table 13) deficits were seen in language tests, in ability to deal with symbols ("token" tests and word fluency tests) and in the impaired performance evident on psychological tests thought to be sensitive to brain damage (three studies reporting deficits either in reproducing figures or in matching faces). Although the evidence is not sufficient, there appears to be a greater probability of deficits to be found on objective tests following thalamic operations than after other types of psychosurgery. Also noteworthy were reports in two separate articles of learning and memory deficits following amygdalectomies (244, 575). None of these deficits are consistently found. At least for the present, therefore, it is necessary to conclude that in spite of all the methodological advantages of objective testing, no one has developed a battery of tests that reveals consistent changes in intellectual capacities following any of the psychosurgical procedures.

B. Results Reported by Neurosurgeons and Psychiatrists

As discussed above, the results of psychosurgery are most commonly reported in broad categories that are said to reflect the changes in the patient's overall adjustment. We have summarized these results in Table 19 from articles published in the United States after 1970. Although various authors use 3, 4, or 5-point scales, it was found possible to group all of these results on the following 4-point scale:

TABLE 19. Neurosurgeons' Estimates of Outcome of Psychosurgical Procedures (U.S.A)[1]

Diagnostic Labels	Total # of Patients	Site of Brain Operation: Frontal Lobe Procedure	Cingulum	Amygdala	Thalamus	Hypothalamus	Multiple Target Sites
Aggression[2]	55			14(2) I= 7.1% II=21.4% III=71.4%	18(1) I=16.7% II=50.0% III= 5.5% III-IV=27.8%	4(1) II=100%	19(1) II=84.2% III=15.8%
Neurotic Depression	198	24(3) I=45.8% II=50.0% III= 4.2%	174(2) I=14.7% II=57.6% III=24.1% IV= 3.6%				
Psychotic Depression	70	1(1) I=100%	69(3) I=88.9% II= 3.2% III= 5.2% III-IV= 2.7%				
Fear & Anxiety	385	314(3) I=16.6% II=73.2% III=10.2%	71(2) I=91.3% II= 3.3% III= 2.5% III-IV= 2.9%				
Obsessive-Compulsive Neurosis	159	67(2) I=34.4% II=55.2% III=10.4%	89(3) I=62.8% II=24.3% III= 9.4% III-IV= 3.5%				3(1) I=66.7% IV=33.3%
Schizo-Affective Disorders	32	26(1) I=38.5% II=53.8% III= 7.7%	6(2) I=66.7% III=16.7% IV=16.7%				
Schizophrenia and Other Psychoses	233	126(3) I= 5.5% II=51.6% I-II=11.9% III=19.0% IV=11.9%	56(2) I=33.9% II=32.1% III=33.9%	1(1) I=100%			50(1) I=26.0% II=60.0% III=12.0% IV= 2.0%
Drug Addiction and Alcoholism	19	1(1) II=100%	18(2) I=50.0% II=16.7% III=11.1% IV=22.2%				
Psychopathic Behavior	17				17(1) I=41.2% II=41.2% III=17.6%		
"Emotional Illness"	8						8(1) I=87.5% II=12.5%
"Agitated States of Aged"	5	5(1) I=20.0% II=80.0%					
Involutional Melancholia	10		10(2) I=90.0% II=10.0%				
Epilepsy with Psychiatric Disorders	48			48(3) I=10.4% II=39.6% III=43.8% IV= 6.2%			

1 Information obtained from articles published after 1970. In the vast majority of instances, results of surgery were summarized by neurosurgeons and/or associated psychiatrists and are based on *subjective (or poorly defined) criteria.*

First Arabic number refers to number of patients; the figure in parentheses is the number of independent groups reporting results. Roman numbers indicate the judgment of the success of the operation: *I= Excellent results, II= Significant improvement, III= No significant change, IV= Worse.*

2 Includes 14 cases of hyperactivity and 2 cases of body rocking (*rhythmia*).

I. Excellent Results

II. Significant Improvement

III. No Significant Change

IV. Worse

The results are described in Table 19 separately for the different sites of brain operations and different diagnostic labels. The different psychosurgical operations and the great variety of diagnostic labels have been collapsed into major groupings as previously explained.

The overall results of the summary ratings by neurosurgeons and psychiatrists appear to be very favorable, especially for the frontal lobe and cingulum operations. Combining ratings I and II, it is possible to obtain an estimate of the percentage of patients that were judged to have improved significantly. It can be seen that following either frontal lobe or cingulum operations, over 85% of the patients received a rating of I or II in most diagnostic categories (Table 19). Lower success rates were reported for patients diagnosed as schizophrenic (or psychotic) and for those addicted to drugs. There was a slight trend for frontal lobe operations to be reported as more successful than cingulotomies. This was most evident in the neurotic depression diagnostic category, where 96% of the patients received a rating of I or II following a frontal lobe operation, but only 72% were assigned these ratings after a cingulotomy. Considering that different persons assigned the ratings and the number of depressed patients receiving frontal lobe and cingulate operations was not equal, these results should not be over-interpreted. They may, however, suggest a trend to be explored further.

Although the results following other psychosurgical procedures involve many fewer patients, some trends should be noted. Amygdalectomies for aggressive patients had a relatively low success rate as only 28% of the patients were judged to have improved significantly. Fifty percent of epileptic patients with psychiatric disorders were judged to have improved significantly. This latter figure is clearly below the success rate claimed for other procedures and diagnostic categories.

There will clearly be a difference of opinion about how much significance should be attached to these overall favorable ratings of the direction of change following psychosurgery. Those opposed to psychosurgery are likely to discount these results entirely on the basis of the subjectivity of the ratings and the fact that the neurosurgeons and psychiatrists responsible for the patients' treatment have assigned the ratings in most cases. Moreover, it has been argued that overall ratings give too much weight to the alleviation of outstanding symptoms, particularly those that are troublesome to others, and give much less weight to the quality of life that remains possible. Such criticisms cannot be dismissed out of hand, but they often are overstated. Considering the fact that this type of criticism has frequently been raised, it is not likely that many neurosurgeons would rate their results as excellent simply on the basis of the elimination of troublesome behavior without considering other aspects of the patients' overall adjustment. It would take overt deceit, not self-deception, to assign a rating of excellent to a patient who spends the days sitting passively and unresponsively at home even if no longer a burden to anyone. In some instances the criteria for an "excellent result" seems to have been defined quite broadly, if not operationally, and includes such factors as the quality of the adjustment to the family, work and social situations and whether or not the patients appear to display any loss of initiative.

Table 20 presents similar data for the outcome of the more recent brain operations for pain. The majority of the operations were anterior cingulotomies. The vast majority (over 90%) of the frontal lobe procedures were performed by one neurosurgeon who used an ultrasonic technique. The outcome ratings are

TABLE 20. Neurosurgeons' Estimates of Outcome of Psychosurgical Procedures for Pain (U.S.A.)[1]

Follow-up Duration	Site of Brain Operation: Frontal Lobe Procedure	Cingulum	Thalamus	Multiple Target Sites	Midbrain	Stimulation	Cortex
More than 1 year	14(2) I=100%	38(5) I=37.4% II=54.6% III= 8.0%	8(2) I=100%	14(2) I=48.9% II=43.6% III= 7.5%	9(2) I=100%)	6(2) I=66.7% II=33.3%	2(1) I=100%
Less than 1 year[2]	101(3) I=15.0% II=74.9% III=10.1%	152(7) I=21.3% II=45.9% III=32.8%	80(3) I=21.3% II=63.7% III=15.0%	11(2) I=63.6% II=36.4%	35(2) I=97.1% II= 2.9%	32(3) I=40.6% II=28.1% III=31.3%	

[1]Information obtained from articles published after 1970. In the vast majority of instances, results of surgery were summarized by neurosurgeons and/or associated psychiatrists and are based on subjective (or poorly defined) criteria.

First Arabic number refers to number of patients; the figure in parentheses is the number of independent groups reporting results. Roman numbers indicate the judgement of the success of the operation: I=Excellent Results; II=Significant Improvement; III=No Significant Change; IV=Worse.

[2]In some instances follow-up duration had to be estimated.

generally very favorable with more than 80% of the patients rated as having improved significantly even when examined more than one year postoperatively.

C. Postoperative Complications

All published reports of physical and emotional complications of different psychosurgical procedures performed after 1965 have been collated in Appendix 9. The intellectual deficits produced by the surgery are generally presented in terms of the results of objective tests and have, therefore, been summarized in Tables 13-18. Appendix 9a summarizes the physical and emotional complications of the more recent psychosurgery (that performed after 1970); Appendix 9b presents comparable data from operations after 1965.

The physical complications of the surgery that are reported in the literature include hemorrhages and infections, complications probably unrelated to the specific operation. Of more interest are the physical complications such as seizures, weight changes, paralysis, dyskinesias, loss of smell, bladder or bowel incontinence and endocrine changes (including irregularities in menstrual cycle), that may be the result of surgical destruction of a specific brain structure.

Emotional and behavioral complications are described primarily by such terms as lethargy (loss of motivation and/or affect), generalized or specific disinhibition (volubility, lowered personal standards, carelessness, immature behavior 3 shoplifting, extravagant behavior, irritability, aggression), increases or decreases in sexuality, and inability to work. Sometimes the phrase "frontal lobe syndrome" is used to refer to a constellation Of post-operative symptoms which often include either lethargy or disinhibited behavior in addition to seizures, incontinence, and some loss in capacity for abstract thinking. In the following discussion and in Appendix 9, mortality rate is based Only on deaths clearly attributable to the direct effects of the operation as it was often not possible to determine whether some of the postoperative deaths (including those resulting from suicides) were the direct, or even the indirect, result of psychosurgery.

The complications summarized in Appendix 9 include only those that persisted for more than two weeks after surgery. However, many of the complications were not regarded by the authors as important, primarily because they were viewed as "transient;" their duration often not exceeding a period of several months. It is also important to appreciate that the frequency of occurrence of complications tabulated in Appendix 9 cannot be considered to be representative as the only data listed are those that included descriptions of complications. Reports in the psychosurgical literature that did not mention any complications and those that explicitly stated there were none, were not listed in Appendix 9. Moreover, the incidence of complications following psychosurgery that is not reported in the published literature is, of course, unavailable. Even though the information given in Appendix 9 may not be useful for deriving accurate estimates of the probability of occurrence of various complications, it was considered important to compile a listing of complications that do occur.

Except for statements from those extremely opposed to psychosurgery, it is generally agreed that the incidence of complications following psychosurgery has been significantly reduced since 1965. The most common physical complication of psychosurgery had been the occurrence of epileptic seizures. Estimates of the incidence of postoperative seizures for surgery performed during the 1945-1965 period range from 10% to 50%. Summaries of postoperative seizures after 1965 generally indicate an incidence of approximately 2% for surgery performed with the aid of stereotaxic instruments (198). Some reports of the larger patient populations give figures as low as 0% (389), 0.5% (548) and 1.0% (295). The incidence of seizures following the more recent non-stereotaxic surgery, however, may be as high as 10% (505). The comparison of the incidence of seizures between the "older" and "newer" psychosurgery is somewhat confounded by the tendency of several neurosurgeons to administer anti-convulsant drugs preventively following surgery, but in spite of this practice, there seems to be convincing evidence that the occurrence of post-operative seizures has significantly declined. Moreover, bladder and bowel incontinence, which were commonly observed after the older prefrontal lobotomy procedure, are rarely reported in the current literature.

The most common emotional complication reported to occur after current psychosurgical procedures is either some evidence of impulsiveness (and other evidence of disinhibition) or lethargy. The incidence of these emotional complications is about 5-10%, but it is usually described as "slight" and "transient." In one recent report of thalamic surgery for intractable pain, the incidence of postoperative lethargy or disinhibited behavior, however, was approximately 50% (474).

The incidence of mortality attributable to psychosurgery has been approximately 5% during the early period of these operations. Current estimates of postoperative deaths following stereotaxic psychosurgery are close to zero (282). For example, in summaries of large patient populations that had stereotaxic frontal or cingulum psychosurgical procedures, the mortality rate was listed as 0% for 345 operations (46), 0% for 204 operations (94) and 0.2% for 660 operations (295). Higher figures (3.7 to 4.5%) have been given, however, for stereotaxic operations of other brain regions and for non-stereotaxic procedures (37, 433, 505). Nevertheless, a search through all of the "data articles" on psychosurgery performed since 1970 uncovered only 12 deaths attributable to the surgery and even this figure includes a few cases where it was not completely clear that the surgery was the cause of death.

In general, data in the published literature suggest that the incidence of all types of complications has significantly declined over the years, but the incidence may vary greatly as a function of brain site and surgical procedure. There appears to be a greater likelihood of motor complications (dyskinesias or partial paralysis) after thalamic operations and (as might be anticipated) a greater probability of endocrine disorders after hypothalamic operations. Also, the incidence of physical and emotional complications following stereotaxic procedures is lower than following so-called "open" operations. Dr. J. Smith of Sydney, Australia, has attempted to review the papers published in English on modified frontal lobe lesions performed between 1960 to 1974. He concluded that:

> "Operative mortality has been reduced to 0.4% with open operations and 0.2% with stereotactic procedures. Chronic epilepsy complicated approximately 0.7% with open operations and 0.2% with stereotactic approaches." (554)

The technique used to ablate brain tissue (see Section IV) may also be a very major variable in determining the incidence of adverse side effects. For example, the frequency of complications following anterior cingulotomy was very low after radio frequency destruction of tissue (46), but after attempted destruction of the same brain region using a "suction technique" the following complications were described:

> "One half of our patients had bladder and bowel incontinence which recovered before discharge. Three patients had major, generalized seizures postoperatively without a previous history of convulsions. All were easily controlled on low doses of anticonvulsants. Unusual behavior was observed in several patients. This included flattened affect (57%), confusion (35%), uninhibited facetious speech (30%), diminished attention span (22%), hallucinations (13%), and automatisms (8.7%). Except for flattened affect all other mental abnormalities were gone by the time of discharge." (617)

Lastly, it must be re-emphasized that the results presented are representative of only the published literature. There is a very realistic possibility that the incidence of complications following operations by those performing only one or two psychosurgical procedures a year--a group that usually does not publish their results (cf., pages 28-29)--may be quite different.

VIII. ALTERNATIVE TREATMENTS

Even among its strongest advocates, there is general agreement that psychosurgery should be performed only on patients proven to be intractable to other treatments. In spite of this agreement, it is clear that there can be large differences in the criteria used to establish the intractability of a psychiatric disorder. These differences are highlighted by the response of some neurosurgeons to the designation of psychosurgery as a treatment of "last resort." Their response is that no surgery should be performed if effective non-surgical alternatives are available, and therefore statements about psychosurgery being a "last resort" are misleading, if it is concluded that it conveys a special meaning for this field. Moreover, because many psychiatric disorders are believed to be progressive, it is often stressed that there is a danger in postponing surgery in order to exhaust all alternative treatments--especially those considered to have a low probability of success. Lastly, the expense of a very thorough exploration of alternatives can be prohibitive. There can be no doubt that there is much room for interpretation in the phrase "last resort."

Obviously, even among those who agree on the same general principle, there is much of importance that can differ in practice. Many factors can contribute to these differences in practice. One of the factors that should be stressed is that alternative treatments can not be explored if they are not known. An example of this point can be illustrated by some recent developments in behavior therapy occurring in England. Several reports (247, 248, 362, 450, 451) have appeared which indicate considerable success with the type of obsessive-compulsive and phobic patients that appear to be similar to those often described as among the most suitable candidates for psychosurgery (see pages 27-28). Some of the patients have been described as follows:

> "Patient 4, aged 38, feared contamination by germs, resulting in washing and cleaning rituals. Her child was restrained in one room which was kept 'germ free.' Doors were opened with feet to avoid contaminating her hands (20 years duration)." (248)

"Patient 5, aged 22, had pervasive checking rituals (10 years duration) which occurred 50-100 times each day, especially when he had doubts about the tidiness of his room, contents of a letter, etc. Each check was associated with a distinctive motor movement. His doubts and checks made him excessively slow and finally led to his unemployment." (451)

The above patients and many others have been treated with behavior therapy at the Institute of Psychiatry (The Maudsley Hospital, London). The techniques used combine "modelling" and "flooding." Patients are repeatedly exposed ("flooded") to the situations and stimuli that are most stressful to them. Some of the exposure involves viewing former patients ("models"), who have overcome their phobic reactions. According to those administering this treatment, they have achieved significant improvement in 75% of the very severely obsessional patients and have concluded that psychosurgery is frequently performed unnecessarily because of "ignorance about the new developments" (S. Rachman, personal communication, May 10, 1976).

It is likely that some neurosurgeons would argue that the patients being treated successfully by behavior therapy are not as severely disturbed as the psychosurgical patients. They would argue that psychosurgery is performed only on those 20-25% of the patients that do not respond to behavior therapy. This may or may not be true. In any case, it is an empirical question. What is clear, however, is that the patients being treated with behavior therapy are failures of psychotherapy and it is likely that if they had been treated by psychiatrists, who are both unaware of an alternative and who are favorably disposed toward psychosurgery, the patients would have been referred for surgery. The important issue is that ways must be found to encourage a maximum input of new ideas that can influence the thinking about alternatives to psychosurgery. Properly constituted review committees may serve a useful purpose here (see pages 92-94).

IX. ETHICAL ISSUES

Most of the ethical issues discussed with reference to psychosurgery concern problems that are common to all controversial medical procedures. It is not only psychosurgery that generates discussion about informed consent, conflict between research goals and patient protection, the adequacy of review procedures, and other ethical issues. It is clearly beyond the scope of this report to deal with them all. We will present instead a brief discussion of those issues which have been given special emphasis in psychosurgery, even though they may not be restricted to this field.

A. The concern-that members of minority groups, the indigent, and women are overly represented among psychosurgical patients.

It may provide some clarification at the outset to note that the great majority of psychosurgical patients are referred by psychiatrists in private practice. This fact alone would indicate that the patients are not primarily from the lower socio-economic class and that their demographic characteristics are more typical of those of the "middle class." Although it is not possible to obtain reliable statistics on this question from the literature, the author could find no information based either on the available descriptions of the patients as presented in the literature or on the institutional settings where surgery is customarily performed that would conflict with the above statement. Although the demographic information on the psychosurgical patient population collected by Dr. John Donnelly has not yet been fully analyzed (see page 24), his impressions of the data are consistent with the view expressed above (personal communication, 1976).

In an attempt to investigate the charge that black persons may be the target of psychosurgery (77, 362), the author corresponded with those neurosurgeons who have accumulated the largest population of psychosurgical patients. In addition, the psychosurgical literature was examined in order to determine the patients' race, if specified. The results of the correspondence (see Appendix 8a-f) indicate that based on relative population, the incidence of psychosurgery performed on blacks is very significantly below that of the white population. This conclusion is also consistent with the views expressed by two black neurosurgeons (cf., Hicks, N. "2 black neurosurgeons defend behavior-altering operations." New York Times, January 8, 1976). The same conclusions appear to apply to Puerto Ricans, Mexican-Americans, and Oriental-Americans. The information that can be collected from the literature is inadequate as race was frequently not stated. Where race was mentioned the most common statement was that the patients were all Caucasian. One newspaper article that referred to 13 psychosurgical operations performed between 1968 and 1972 on state patients in Michigan identified two of the patients as black (107). No other data consistent with this report could be located in the scientific literature or news media.

The question of sex-ratio among the psychosurgical population is more complicated. An analysis of all of the U.S. articles published after 1970 was undertaken in order to estimate the sex-ratio of the patients. Where it could be determined, patients obviously described several times in different Publications were counted only once. The data were divided according to diagnostic category, collecting together the "aggressive" (violent, assaultive, or hyperkinetic) patients in one group and all others in a second group. The majority of the "others" were anxious, depressive, obsessive and phobic patients. Epileptic patients and those suffering from pain were excluded from this analysis.

The results of the sex-ratio analysis revealed that 59% of the patients in the "other" diagnostic group were female, while 61% of "aggressive" patient groups were male. In total, a greater percentage (56%) of the psychosurgical patients were female, because the "other" category has approximately nine times more patients than does the "aggressive" category. These results do not differ significantly from the sex ratio distribution in these diagnostic categories and therefore do not support the belief that females are being preferentially selected for psychosurgery. It is, of course, possible to develop a more complex argument based on the belief that sex discrimination is responsible for the greater number of females suffering from psychiatric disorders, but an examination of this possibility falls well outside the scope of the present report.

B. The concern that psychosurgery will alter personality.

The concern here appears to take two conflicting points of view. While no one expects a "Dr. Jekyll W. Hyde" transformation to take place after surgery, there has been considerable concern expressed about the possibility that patients may become either intellectually and emotionally unresponsive ("vegetables") or, at the other end of the continuum, they may become impulsive, irresponsible, and perhaps amoral. There was certainly evidence that both of these outcomes did occur following the older lobotomy operations. The frequency of occurrence is a matter of dispute, but the question has little relevance to the probability of such results being produced by the psychosurgical procedures in use today. The analysis of the postoperative outcome presented in Section VII (Part 2) indicates that there may be some "blunting of affect" and irritability (or other indices of disinhibition) that is reported to follow psychosurgery, but these results are relatively infrequent and characterized as "mild" and "transient."

C. The concern over psychosurgery on children.

A great amount of heated controversy has been directed toward the issue of psychosurgery performed on children. Questions about how to obtain "informed consent" for operations on children.. are complex and are not peculiar to psychosurgery. However, psychosurgery on children does raise special problems because of the growing literature suggesting that brain damage may have very different consequences for children and adults. There are many reasons why this is true. Some of the reasons involve the evidence that certain brain structures subserve different functions in the young and the adult. Also relevant is the fact that the young child is acquiring information and problem solving strategies at rates that are very much accelerated compared to those of the adult. In any case, it has been demonstrated repeatedly that early brain damage has much greater consequences for IQ than late brain damage. All of these arguments justify the appropriateness of the special concern over the issue of psychosurgery on children. (Note: None of the above statements contradict the fact that there are also demonstrations in regard to certain functions such as speech that after selective brain damage the very young child may display more "plasticity" and better recovery of capacities than the adult.)

In addition to the above considerations, the developmental status Of children raises another issue in regard to psychosurgery. Although it may be possible to justify statements about the persistence of a psychiatric problem in adults, it is much more difficult to present convincing evidence that this is the case in a child. There are a number of psychiatric and organic problems observed in children that are attenuated or even eliminated later on, particularly around puberty. The so-called "hyperkinetic syndrome" is a case in point. Any consideration of psychosurgery on children has to be viewed together with some estimate of the possibility of "spontaneous improvement" with age.

Other than raising the above issues, the contribution to the resolution of this problem is restricted to a presentation of data on the incidence of psychosurgery on children. The literature published after 1970 was analyzed in order to determine the incidence of psychosurgery performed on children. After all duplications were eliminated (as far as could be determined), there was reference to 156 operations on children under 15 performed throughout the world. Of these, 17 were performed in the United States. An analysis of the dates of surgery (as far as could be determined) revealed that of the 17 U.S. psychosurgical procedures performed on children under 15, only 7 were performed after 1970. Moreover, 2 of the 7 patients had epilepsy in addition to behavior disorders. A comparable analysis revealed that there were 11 U.S. operations on children between the ages of 15 and 20 mentioned in the literature published after 1970. It has been concluded, therefore, that while the problem is real, the number of children involved is considerably smaller than the impression given by those who repeatedly cite a few older and particularly dramatic cases.

D. The concern over psychosurgery in prisons or other institutions where people are committed involuntarily.

The issue of psychosurgery on prisoners has also generated a heated controversy. In spite of all the charges that have been made, there is almost no data available on the incidence of psychosurgery in prisons. It has proven impossible to determine from the published literature whether any psychosurgery has been performed on persons in U.S. prisons. (There have been operations performed on imprisoned sexual offenders in Germany (141, 142).) The charge has been repeatedly raised that there were three inmates of Vacaville prison in California that received psychosurgery, but this charge has been countered by others who claim that these inmates had demonstrable evidence of brain pathology and therefore the operations should not be considered psychosurgery. No other charges of psychosurgery on prisoners appears to have been made. It seems clear, on the other hand, that there has been psychosurgery performed on patients committed in state mental institutions (107). Since the great majority of psychosurgery is performed in private, general hospitals, the incidence of such operations in state hospitals appears to be quite low, but no data on this topic can be obtained from the published literature.

It is evident that even among neurosurgeons who perform psychosurgery there is no agreement on whether these operations should be performed on prison inmates. One neurosurgeon has argued that prisoners should not be deprived of psychosurgery which he describes as a humane and tax-saving alternative to a life of confinement (see Appendix 8b). Most neurosurgeons, however, seem to have concluded that these operations should not be done on prisoners (310, 358).

There are few people who would consider it appropriate to perform psychosurgery unless the patients have given their "informed consent" under conditions where the external duress is minimal. Moreover, almost everyone agrees that psychosurgery should be undertaken only after all reasonable alternative treatments have been exhausted. Lastly, many neurosurgeons and psychiatrists have argued that the effectiveness of psychosurgery is very much dependent on the postoperative support the patient receives from his or her family. It seems evident that it is very doubtful that all three of the above conditions can be met with a prison population. For this reason, in addition to concern about the danger of establishing a precedent of solving social problems by medical interventions, it is recommended that psychosurgery not be performed on prisoners.

E. The question of review procedures

Many persons have expressed concern about the adequacy of the protection afforded patients by review boards (e.g., 47, 48, 49). It is evident that review panels have not always been effective and this fact has led to suggestions that medical students have to be sensitized to ethical problems, that the representation on review panels be broadened, as well as many other recommendations. This issue clearly extends beyond questions about psychosurgery.

A major question about review panels and psychosurgery concerns the question of what is usually called the "experimental" nature of these procedures. The designation of a medical procedure as "experimental" will greatly influence the review procedure. The word "experimental" in this context is not meant to refer to research in contrast to therapy, but rather to the degree of general acceptability in the medical community of a given treatment. The criteria used by some physicians can be very "practical." For example, the fact that Blue Cross-Blue Shield medical insurance covers the expense of some psychosurgical operations has been offered as an argument that these procedures are not "experimental." Others have argued that the proven effectiveness of these procedures should remove them from the "experimental" category, while those opposed have claimed that there is sufficient uncertainty about the outcome to justify the label "experimental."

Some clarity can be gained by appreciating that psychosurgery is not one procedure. Many different operations as well as psychiatric problems are involved. Some of these procedures such as anterior cingulotomy and a variety of bimedial frontal operations have much greater acceptability than other procedures. (Of interest here is a discussion in Lancet that followed the publication of reports of hypothalamic surgery on obese patients (448). When a reader asked how it was possible to obtain a review panel's approval of such a questionable procedure, the author responded that it was not necessary as there are no such panels in Denmark.) Similarly, the suitability of psychosurgery for some types of phobic, obsessive-compulsive, and depressed patients is much more favorably viewed than psychosurgery for violent patients who do not have demonstrable brain damage. The criteria which should be used to establish the acceptability of a treatment procedure and consequently the amount of scrutiny it should undergo are difficult to establish.

It would seem that there are at least two very important functions a review procedure can serve with special regard to psychosurgery. Since the treatment methods available for psychiatric patients are constantly changing, a review panel can be useful in informing all concerned about new therapeutic approaches that might provide practical alternatives to psychosurgery. Neuro-surgeons are not likely to be the first to learn about the new attempts to apply, for example, behavior therapies to psychiatric problems (see Section VIII for a discussion of alternative treatments). A review panel that contains appropriately selected members of the neuroscience and neuropsychological communities may provide a very useful service here.

The second function of the review procedure in psychosurgery is somewhat related to the above point. It is clear that psychiatrists differ greatly in their willingness to refer patients for psychosurgery and it is likely, therefore, that attitudes toward the exploration of alternative treatments will vary greatly (see discussion on pages 38-39). In most instances, neuro-surgeons have their own criteria also, but here too there are large individual differences. A review panel can be very helpful in establishing that all patients considered as potential candidates for psychosurgery have met some minimal established criteria which assures the thoroughness of exploration of alternative treatments.

X. CONCLUSIONS AND RECOMMENDATIONS

A survey of all of the psychosurgical literature published in English between 1971 and the present was undertaken in order to summarize current practices in this field. Data obtained from several questionnaire surveys undertaken by the author and others was used to supplement information obtained from the literature. Emphasis was placed on establishing: 1) the amount of psychosurgery performed; 2) the characteristics of the patient population; 3) the variety of psychosurgical techniques currently being used; and 4) the outcome of the operations. In addition, the report contains discussions and comments on questions related to the exploration of alternative treatments prior to psychosurgery, the rationale for these operations, ethical issues raised by the practice of psychosurgery, the scientific merit of the psychosurgical literature, and a brief account of the history of psychosurgery and the evolution of the surgical procedures. The main conclusions and the section of the report treating each topic is listed below.

1) Approximately 140 neurosurgeons in the U.S.A. performed between 400 and 500 psychosurgical operations per year during 1971, 1972, and 1973. There are indications that the annual rate of this surgery decreased after 1973. After adjustments for differences in populations, it was estimated that psychosurgery is performed in the United Kingdom at approximately twice the rate, and in Australia about three times the rate of that of the U.S.A. Estimates of psychosurgery in other countries around the world are provided (see pages 24-36).

2) The most common patient receiving psychosurgery is described as having severe disturbances of mood and emotion that have persisted for long periods of time without any lasting relief from any other type of therapy. Diagnostically, these patients include those that are severely depressed, obsessive-compulsive, phobic, and hypochondriacal. The literature also indicates that the best post-operative results are obtained with these patients. A number of patients suffering from intractable pain are also reported to receive benefits from psychosurgery. In addition, there are lesser numbers of patients in different diagnostic categories that receive psychosurgery either in the U.S.A. or abroad. There is much more controversy about the effectiveness of psychosurgery (even among those in favor of these operations) for schizophrenics, violent patients, sexual offenders and other disorders (see pages 37-49).

3) The published evidence on the outcome of psychosurgery indicates that between 60-90% (depending on diagnostic category and surgery) of the patients experience a significant reduction of their most troublesome symptoms. The risk of permanent adverse intellectual, emotional, and physical side effects is reported as minimal. The latter finding stands in sharp contrast to the results from the older lobotomy operations (see pages 50-84).

4) The apparent marked decrease in the postoperative complications of psychosurgery is attributable to the improvement in techniques over the past 35 years. Psychosurgical operations have evolved from crude procedures for destroying poorly defined regions of the frontal lobes to much more precise techniques that make it possible to destroy relatively specific targets in the brain (see pages 18-23). Current evidence suggests that the incidence of postoperative complications following non-stereotaxic ("free-hand") operations may be greater than average (see pages 80-84).

5) There is no reliable evidence that any minority group, women, or members of a particular socio-economic class are preferentially selected for psychosurgery (see pages 87-89). Psychosurgery on children presents a number of special scientific and ethical problems. Analysis of the published data revealed that after 1970 there were less than 7 cases of psychosurgery performed on children under 15 and 11 cases on children between 15 and 20 in the U.S. (see pages 89-91).

6) The published literature in the field of psychosurgery was judged to be quite low in scientific merit. Very few articles contain adequate information on patients, adequate experimental controls, or report the use of reliable test instruments. Because of the above considerations, the possibility that such factors as a patient-selection bias, the patients' anticipation of favorable results (the "placebo effect"), and improved postoperative care and treatment can account for a substantial amount of the reported success of psychosurgery cannot be ruled out (see pages 50-66).

7) The rationale supporting psychosurgery that is based on physiological explanations of brain mechanisms has not advanced very much during the past 30 years. The most convincing arguments supporting psychosurgery are based on evidence that the operations are successful and other treatments are not (see pages 9-17).

8) The following recommendations are offered:

a) Psychosurgery should not be performed on prisoners (see pages 91-92).

b) Improvement in information communication in the field of psychosurgery is badly needed. Some of the problems discussed were the large number of neurosurgeons that do not describe the results of their surgery at all or in a reliable form, the use of poorly defined diagnostic categories instead of more objective descriptions of symptoms and the use of subjective criteria to demonstrate postoperative changes (see pages 40-41 and 50-62).

c) Review procedures should be expanded to include the function of exploring alternative treatments (see pages 85-86; 92-94).

d) It is important to make more distinctions in the field of psychosurgery. The evidence supporting the effectiveness of different operations varies greatly. Similarly, the acceptability of psychosurgery as an effective treatment for different psychiatric disorders varies greatly.

e) The possibility of undertaking controlled experiments in psychosurgery that are consistent with appropriate ethical standards should be explored. Such control studies are being proposed or actually underway in other countries (see references 310, 482).

XI. BIBLIOGRAPHY OF ARTICLES ON PSYCHOSURGERY (1971-1976)

The following list of references were obtained from an extensive library search for articles on psychosurgery and related scientific, ethical, and social issues published in English between 1971 and 1976. Articles on brain ablations to alleviate intractable pain were also included, but articles restricted to spinal cord or peripheral nervous system procedures for pain were omitted. Also excluded from this bibliography were articles on brain operations for movement disorders or epilepsy unless accompanied by psychiatric disturbances that were judged to be of major concern to the authors. Articles describing the use of electrical stimulation via implanted brain electrodes for the purpose of treating either psychiatric disorders or intractable pain have been included as were articles describing new technical developments for modifying brain functioning that might be used in the future for these therapeutic purposes. Several articles that appeared prior to 1971 were included if they were cited in the accompanying report.

The core references for this bibliography were obtained from a National Library of Medicine (NLM) MEDLARS search. Ms. Charlotte Kenton of the NLM was most helpful in designing the search matrix for generating this core list of references. This original list was considerably expanded by adding all relevant references cited in articles as they were read and coded.

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XII. APPENDICES

APPENDIX 1

QUESTIONNAIRE

Respondent:

Name

Address

Questions:

1. What is your estimate of the number of patients in your country who have undergone a psychosurgical operation during the following years?

    1973

    1974

    1975

2. What is your estimate of the number of patients in your country in which brain stimulation was used to alleviate psychiatric disorders during the following years?

    1973

    1974

    1975

3. What is your estimate of the number of patients in your country who have undergone brain operations to alleviate pain in the following years?

    1973

    1974

    1975

4. What is your estimate of the number of patients in your country in which direct brain stimulation was used to alleviate pain in the following years?

    1973

    1974

    1975

5. What is your estimate of the number of neurosurgeons in your country who currently perform the following brain operations?

   a. Psychosurgery

   b. Brain operations to alleviate pain

6. Which three neurosurgeons in your opinion are currently doing the greatest number of psychosurgery procedures in your country?

   a. Name:
      Institutional Affiliation:

   b. Name:
      Institutional Affiliation:

   C. Name:
      Institutional Affiliation:

APPENDIX 2

TASK FORCE ON PSYCHOSURGERY
AMERICAN PSYCHIATRIC ASSOCIATION

1. Have you performed any neurosurgical procedures for treatment of psychiatric patients in the period January 1, 1971 to September 30, 1973? Yes ________ No ________

(If none, please indicate and return the questionnaire)

. . .

2. If yes, how many in: 1973 ________
1972 ________
1971 ________

3. Number of procedures performed?

	1973	1972	1971
(1) Orbital Undercutting	____	____	____
(2) Cingulotomy	____	____	____
(3) Bimedial Leucotomy	____	____	____
(4) Amygdalotomy	____	____	____
(5) Thalamotomy	____	____	____
(6) Posterior Hypothalamotomy	____	____	____
(7) Standard Lobotomy	____	____	____
(8) Other	____	____	____

4. What techniques have you used?

(1) Surgical (Scalpel)	____	____	____
(2) Stereotaxis	____	____	____
(3) Isotopes	____	____	____
(4) Radio Frequency Current	____	____	____
(5) Other	____	____	____

5. For which conditions have the procedures been used?

(1) Intractable pain ________
(2) Tension and anxiety states ________
(3) Phobias ________
(4) Depression ________
(5) Obsessive Compulsive states ________
(6) Paranoid states ________
(7) Schizophrenic states ________
(8) Behavior problems
(e.g., repeated violent behavior) ________
(9) Sexual psychopathology ________
(10) Hysterical Syndromes ________
(11) Other ________

. . .

Return to Dr. John Donnelly
Institute of Living
200 Retreat Avenue
Hartford, Connecticut 06106

Signature ______________________
(optional)

APPENDIX 3

Report of Visit to the Institute of Neurology, Madras (Dr. Ramamurthai, Dr. Balasubramaniam, and Dr. Kanaka), November 30 - December 1, 1975.

The Neurological Institute of Madras is located downtown in the Madras General Hospital, a 1,500-bed facility, with a current census of 3,000+ patients and serving more than 5,000 outpatients a day. The Neurological Institute houses research laboratories and wards for neurological-neurosurgical patients of all ages, as well as ancillary services such as neuroradiology, electro-encephalography, occupational and rehabilitation therapies. In addition to their well known stereotactic work, Dr. Ramamurthai and a staff of two senior and four junior neurosurgeons have 108 inpatient adult and pediatric surgical beds, all of which are full, plus half again as many patients on mats on the floor. The regular neurosurgical service is at least half acute and subacute neurosurgical emergencies, including skull fractures, obstructive meningitis (mostly tubercular), Grade IV meningiomas, acoustic neuromas, astrocytomas. There is thus an enormous volume of daily work which Drs. Balasubramaniam and Kanaka carry on in addition to their principal responsibility for design and execution of psychosurgical procedures. Without secretarial or research assistance, and with a part-time psychologist borrowed from another service who works with their cases out of interest when he is able, without special EEG facilities (access only to the routine laboratory), preoperative studies, controls, documentation and follow-up must be judged a considerable undertaking. My hosts were extraordinarily hospitable and displayed candor and openness with respect to access to files and records insofar as these were available.

Approximately half of the patients with psychiatric disorders, including behavior disorders referred to this group, come from the Madras Mental Hospital, on the staff of which Dr. Balasubramaniam is a regular weekly consultant. These patients are referred to the Neurological Institute, Neurosurgery Service, by the psychiatrists following a more or less lengthy stay and treatment by conventional psychiatric techniques. They are presented to Dr. B. on his regular visits and if accepted for surgery by him, are reviewed by the neurosurgical staff prior to selecting a procedure. Following the definitive surgery, they are referred back to the psychiatric hospital. Responsibility for subsequent follow-up, as well as preoperative work-up and treatment, is thus not in the hands of the neurosurgeons in this half of cases, but is solely dependent upon the psychiatrist's evaluation. The other half of the patients who have been operated in this unit since 1964 are referred directly to the neurosurgeons by other physicians, from their own neurosurgical outpatient clinic, very frequently by successfully operated patients who send in friends, and by other word of mouth referrals. Among the latter group, the quality of the work-up depends on the neurosurgeon's estimate of the situation. "If the behavior disorders are real emergencies, we don't send them on to 2 psychiatrist and if we think they won't benefit from drug treatment or won't follow through on taking it, we go ahead with surgery." Not only is there no specific series of preoperative requirements, but follow-up must depend largely on empirical judgment.

Psychosurgery here falls into three main groups: Addictions, behavior disorders, and psychoses.

Addiction

Sixty-five cases have been operated which meet the criteria of psychological and physical dependence on narcotics (largely pethidine and morphine) or alcohol. Cingulotomy is the surgical procedure for these patients. The lesion is accomplished at the level of the foramen of Monro. Some of these cases are referred from the psychiatrist following psychotherapy. Most have had a trial of some tranquilizer or diazepam. Some cases are judged unsatisfactory for psychiatric treatment and are directly referred. All have a history of addiction of several to many years' duration. A former addict's article in a popular journal following his own successful operation caused many self-referrals by readers. The drug addicts are divided into two groups by Dr. B.: (1) Psychopaths without much drive for cure; these are not much helped by surgery. (2) Adventitious addicts: These are individuals who have become addicted in the course of treatment for pain or who are physicians, dentists, and nurses. They have a strong drive to discontinue drugs, but fail to give up drug abuse by themselves or following psychotherapy. These patients have a much better result from surgery. Of the total of 60 addicts treated by cingulotomy to date, 60-80% have been totally relieved of addiction to morphine or pethidine and 60% have had good results from withdrawal from alcohol. By good results, this team means no further use of alcohol or narcotics during the follow-ups of three months to seven years. Even one dose of the drug is considered a failure. If a failure occurs, it is always during the first three to six months. There is no significant fall-off in results after the first year. The surgeons have followed "100%" of their addicts by either letter, word of mouth, or visit. The exact number followed in each way is not available.

The choice of cingulotomy for these patients is based on experimental work of Ward and Foltz in the late 40's which demonstrated absence of withdrawal symptoms in addicted monkeys following cingulotomy. The remarkable thing about the operation is that patients have few or no withdrawal symptoms following the operation even though drugs are stopped abruptly and they may have made many frequent attempts to stop the drug habit previously and failed due to serious withdrawal symptoms. There is a moderate euphoria in the majority of patients during the first postoperative week. Among patients who have relapsed following surgery, this is usually attributed to "circumstances," i.e., doctors who resume administration of medication to their patients in order to readdict them and thus to obtain money, rather than a rekindling of desire for narcotics. Psychopaths, in general, do badly, however. Also, new psychological stress may cause new addiction.

I saw three of these patients personally:

Case One. A 59-year-old ex-clerk, voluble, intelligent. Bilateral cingulotomy two days ago. Previous habit of 10-15 ampules pethidine daily. Unable to work. Addicted 15 years. Only activities spent in obtaining drugs illicitly. Following operation two days ago, no withdrawal symptoms, has no desire for drug today. Physical findings unremarkable. Alert and cooperative. The patient relates that he has tried to quit the drug habit many times in the past but could not stand it. He has not had more than ten drug-free days in the past year and those occurred only under the duress of unobtainability. Following the operation two days ago he has absolutely no craving, presents no neurological or affective deficits, is bright, alert, voluble, intelligent and looking forward to going back to work. Be has a mild headache tonight and is still in surgical bandages.

Case Two. A 40-year-old auto mechanic, five children, seven days post-operative bilateral cingulotomy. This man had a 4,000 mg. a day pethidine habit. He has been unable to work regularly for a number of years. He was ready to commit suicide by throwing himself under a train. Now he feels he "would like to get on the train and go to work." The patient is distinctly euphoric, smiling, bowing, offering me repeated "namastes" (Indian form of greeting with folded hands). He comes up to the office next day in order to get my address and to thank me for my visit. He had no withdrawal symptoms other than mild leg cramps on the first postoperative day. He has no craving for drug. His preoperative work-up does not include a psychiatric history or psychological testing.

Case Three. This is the only long postoperative follow-up I personally examined. Unable to come in the evening before because he was involved in a rehearsal with a dramatic company, this 51-year-old accountant was operated on four years ago after hearing about the Madras operation for addiction via the drug grapevine. An addict himself for ten years, he received psychotherapy from a psychiatrist for one to two months prior to surgery. He had never undergone a formal detoxification or prolonged psychotherapy program. Following surgery four years ago, his previous 15-16 ampules (1500-1600 mg.) pethidine habit was abruptly discontinued. He had no withdrawal symptoms, although he has taken no medication from the date of his surgery. He works full-time as an accountant, something he was unable to do prior to surgery. He tells me there have been no side effects of any kind from the surgery, sexual, emotional, or intellectual. He has more friends than before. His judgment has been good. Indeed, on examination, the patient appears to be an extremely intelligent, alert, and cooperative individual who, after I asked him a number of standard questions, asked me "Why won't you let Americans have this kind of treatment?".

Author of an article which appeared in the popular Indian press several years ago, this patient has brought in a dozen or more patients like himself for treatment, most of whom are reportedly successes postoperatively. He has unsuccessfully submitted a story of his cure to the Reader's Digest in the U.S. for publication, but was turned down. He has nothing but praise for the surgery and I can detect no evidence of intellectual or affective dysfunction. There is no euphoria.

In the past year, routine psychological tests have been started pre- and postoperatively in this group of addicts. Thirteen patients have been tested pre- and postoperatively to date, but the data are not available on a form that one can easily make pre- and postoperative comparisons. Of necessity, the preoperative test is done while the patients are still on a variable amount of narcotic as they cannot be withdrawn completely and still take the test. All patients are, however, reduced in their narcotic intake preoperatively and suffer a certain amount of anxiety and withdrawal symptoms during the preoperative psychological assessment. In contrast, postoperatively they are drug-free. However, the postoperative assessment is made one week to one month following surgery. Psychological tests done are the Ramilung Aswama version of the Wechsler Adult Intelligence Scale (WAIS) performance subtests standardized for India, Koh's blocks, Bender-Gestalt, digit span, tachistoscope, Ishihara's color blindness test and the Wechsler memory scale. These are carried out by a young psychologist who has not performed statistical analyses on the laboriously garnered results. His conclusions are that there are modest decreases in concentration and perception in three or four of the thirteen patients and some improvement in several others. The data have not been broken down to permit one to determine whether patients showing modest decrease in intellectual performance are those tested early (i.e., one week) or relatively late (one month). Thus, the results are not very satisfactory for judging cognitive changes due to these time and drug contaminating factors. In addition, only thirteen patients have been studied with pre- and postoperative testing. No drugs were used during withdrawal except in the rarest cases. Regular family reports on pre- and postoperative status are not formally recorded or obtained, although it is stated that informal follow-up is available on all patients. Controls of a sort on surgery of addict cases have been achieved by doing a two-stage operation on six patients of the series. However, these are all Dr. B.'s private patients, done in a different hospital where a two-stage operation is necessary because of apparatus constraints. He tells these patients when they wake up following the burr holes (stage one) that their surgery has been done. Drugs are then stopped and withdrawal symptoms regularly follow. On the following day, a lesion is made, following which drugs may be withdrawn with impunity. The patients' families are kept informed of the true state of affairs.

Hyperactive and Behavior Disorders

Two-hundred and eighty patients from 2-45 years have been subjected to bilateral amygdalotomy accomplished by either diathermy (70 cases) or myodil wax injection (0.5 cc. warm wax in the center of each amygdala). Diathermy requires eight or nine lesions to be made to achieve an effect equal to that accomplished by the wax. There have been eleven surgical mortalities and a 10% dropout rate from follow-up in the two to eleven year postoperative period. Seventy patients who failed to achieve adequate results with amygdalotomy have subsequently been subjected to a unilateral hypothalamotomy which in a "few" cases has been followed by a second operation on the opposite side of the hypothalamus. Ten cases have had a medial thalamotomy. Symptoms of this group of patients are aggressivity, violence, difficult to control even in a mental hospital. Fifty percent of the series are referred directly from the mental hospital where the preoperative work-up is in the hands of the psychiatrist, as is the postoperative follow-up. There is no regular protocol. Drugs used prior to surgery usually, but not routinely, include phenothiazines, diazepam and in some cases, anticonvulsants or amphetamines. None of the patients improved on these therapies sufficiently to lead normal lives. Dr. B. has the impression that the best results are obtained from a medial ventral lesion, particularly lesions which interrupt the ventral pathway from amygdala to hypothalamus. Although the surgeons receive drug failure cases from the mental hospital or cases referred from the outside sources, in recent years "being surgically minded I have a tendency to go right ahead with surgery and not bother with drugs. I count on the chances of cure at 70% immediately following surgery and when I tell the parents or patients this, most of them want to take this route."

Morbidity to date has included postoperative obesity in one patient, two immediate postoperative pulmonary edemas and one hemiplegia. In general, patients with epilepsy, particularly post-traumatic epilepsy and behavior disorders, do the best with the amygdalotomy. Improvement occurs in both the fits and the behavior disorder, although not necessarily the two together. Convulsions may improve, but not behavior and vice versa. It was not possible for me to get an accurate idea of the number of patients with seizures actually totally remitted, but again he gives me the 60-70% figure. In general, patients who have postencephalitic behavior disorders and those with severe global brain damage due to hypoxia at birth or thereafter do much less well. Unimportant for prognosis are initial I.Q., EEG findings (including operative recordings directly from the amygdala), sex, age and duration of disturbance. Cautery, loop and wax all appear to accomplish the same end if the lesion is similar in size and location (equivalent to a 5 mm. bolus of myodil and wax). Improvement always takes place within one month and if relapse will occur, it will be within the first year. There is no intellectual deficit, Kluver-Bucy syndrome, change in sexual potency or other complaint. Although approximately half of these persons have been severely retarded, the other half have not. No intellectual disturbances are recorded. Psychological tests pre- and postoperatively have not been done on many members of this group, again due to the lack of psychological consultation availability. However, the mental hospital staff has done pre- and postoperative assessments which, unfortunately, are not available in this unit nor did I have time to obtain the mental hospital data since my visit coincided with a week-long psychiatric congress here. Two patients were seen from this series.

Case One: An eight-year-old girl, bright-eyed, intelligent, responsive, brought in by her mother. Normal to the age of four, she sustained a severe head injury followed by prolonged unconsciousness at that time. No fits occurred then or subsequently. Several weeks following the head injury, she developed progressive aggressiveness, biting behavior, hitting, running off. I was unable to obtain her preoperative records despite an extensive search by the staff. Preoperative drugs and work-up were thus inaccessible, but one has the impression that these need not be extensive before surgery is decided upon. Postoperatively, her behavior has been normal, she has done well in school; there are no complaints of any kind. On examination, this is an adorable, bright-eyed, spontaneous child who shows no neurological, intellectual or affective deficits and is extremely responsive, warm and friendly. A film was taken of the child and her mother.

Case Two: This is a severely damaged 16-year-old boy, born with the cord around his neck, with marked hypoxic encephalopathy. A severe lifelong behavior disorder characterized by marked restlessness supervened. Three years ago he dropped his sister in a well, was placed in a mental hospital where he was "like an animal." His speech was confined to grunts. He had to be continually restrained because of obsessive tendencies to attack or break anything made of glass. At the age of 12, in 1973, an amygdalotomy was performed bilaterally. This stopped aggressive behavior, but he continued to break glass. One year later, a bilateral cingulotomy was done. There was improvement in reasoning ability and speed of response, allowing testing with the Binet which demonstrated an I.Q. of 45. Glass breaking continued and he had to be restrained. Two months later, a unilateral hypothalamotomy was done, resulting in a hemiparesis on the left side, but the glass breaking was stopped. He can now be kept on the ward without being tied up and is a "lovable" sort of ward pet, talks, obeys simple commands, walks with a marked dystonia and modest hemiplegia. On examination, he is clearly diffusely damaged, talks with a marked speech impediment, grimaces, and is able only to answer simple questions and follow simple commands. He states he will never break glass again and shows a good sense of humor. He is clearly psychotic, as well as motorically and intellectually disturbed, goes about muttering to himself, making contorted facial movements.

As noted, these patients are referred from the psychiatrist with no specific requirements for work-up, treatment, or number of treatments prior to surgery. No secretarial help is one reason given for this irregular work-up.

Another is their reliance on the summary sent from the referring psychiatrist. The surgeons believe that psychological tests may be done on about half the patients referred from the mental hospital. No defined protocol of presurgical drugs has been utilized. A routine urine screen of amino acids has been done on a number, but one senses not all, of these patients.

"If real emergencies, we don't send them on to a psychiatrist if we think they won't benefit from drug treatment or won't take the drug regularly."

The surgical team considers drug treatment to be a long, drawn-out and expensive procedure, while with surgery "we have results in a few hours without significant handicap." Dr. B. has in the past year developed a behavioral check list to be used by parents or friends of the child pre- and postoperatively. Unfortunately, the check lists are not identical pre- and postoperatively and may often be filled out by a casual acquaintance who is literate rather than a family member. They have just started doing psychological tests pre- and postoperatively on these children and these include Binet (Comprehensive Indian version), Knox Cubes, Seguin form board, TAT, Rorschach. The latter two have been done only on a few patients because of the difficulty with educational level and lack of cooperation on the part of many of the severely disturbed patients.

Major Psychoses: Basal Frontal Tractotomy (Knight).

The orbito-medial tractotomy is the procedure of choice for depression and suicidal tendencies, including schizophrenia. A total of 23 patients with schizophrenia or depression have had this treatment, plus 14 "hypomanics." All were referred from the Madras Mental Hospital. One patient examined: A 30-year-old male who, in 1963, had onset of loss of concentration and disturbing thoughts, spent the subsequent ten years in and out of mental hospitals taking a variety of antipsychotic drugs and several courses of electroshock therapy. Disturbing thoughts, auditory hallucinations, and inability to concentrate prevented gainful employment. His symptoms were not relieved by the treatments administered. In 1973, a unilateral orbito-medial leucotomy was carried out by stereotactic method with good relief for the following three years, including abolition of auditory hallucinations. Two months ago the patient noted onset of depression, loss of concentration, and feared his illness was returning. He was placed on Stelazine, 5 mg. b.i.d., one month ago with moderate to mild relief, but still is not sleeping well and has marked inability to concentrate. On examination, he demonstrates flat affect, moderate anxiety, readily relates auditory hallucinations, disturbing thoughts and loss of concentration. There are no evident neurological signs. Dr. B. would go on to surgery immediately on this young man rather than increase his drug therapy or try other drug modalities. His reason for this is that there should be 70% remission following a basal medial leucotomy on the second side and no significant morbidity is anticipated.

Case Two: A 22-year-old female diagnosed paranoid schizophrenia or hypomania. Referred to the mental hospital because of frequent attacks on her husband, who is said to have looked as though he had been "mauled by a bear." Hypersexual, obscene talk, thought disorder, affect disturbance. On examination, this is a nice, meek-looking, rather attractive young woman, seated on a mat on the floor in a ward of 30 or 40 patients. There is a past history of ill treatment by stepfather and father. She was treated for the above mental disorder with ECT and chlorpromazine prior to the "innominotomy" procedure two years ago. She has had no EEG studies, but is now referred from the mental hospital for enlargement of the initial orbito-medial lesion. The latter will be placed just inferior to substantia innominata, 10 mm. from the midline, beneath the head of the caudate nucleus.

The old records, including psychological and psychiatric assessments, treatments and a clear description of her repeated bouts of excited behavior, are not available since they are in her records at the mental hospital.

Dr. Balasubramaniam finds that interruption of the orbito-medial fibers just anterior to substantia innominata gives relief in schizophrenia and has an excellent prognosis, especially if done early in the illness. He feels that such patients should be referred to him for surgery after six months of treatment without improvement on conventional therapies.

Neurosurgical ward rounds December 1, 1975. This incredibly crowded service of 108 beds, nearly all of which contain acute neurosurgical emergencies or major pre- and postoperative problems, is relatively clean and well organized. Beside nearly every bed is a mat containing another patient on the floor. In the pediatric ward, mothers lie on the floor nursing their hydrocephalic or otherwise ill children, while sparrows hop about between them. Nurses in spotless white and tall starched caps roam through this melee as at home as we are in our own rather more sumptuous facilities. The intensive care and recovery room facilities are spotless and appear well staffed. Following ward rounds, I sat down with Drs. B. and K. for an examination of EEG records. Their facilities, an 8-channel Model 8 machine and a single bipolar concentric electrode, which they place at the lesion site for their amygdalotomies or hypothalamotomies, do not permit extensive intracranial recordings. Their current procedure is to place four scalp leads on each side, sink the depth electrode to 40 mm. above the calculated target, record, sink again, re-record, and attempt to recognize the transition from white matter to amygdala by EEG. Actual amygdala spindles have been identified in only 20 of the cases studied. Two or three records examined demonstrate clear-cut spike wave activity in the amygdala, most do not. Records are technically satisfactory for the most part. As noted above, EEG findings from these acute recordings have no bearing on outcome. No chronic recordings can be done at the present time. Dr. B. sees the amygdala as the superior tier of an amygdala-hypothalamic projection system. If the amygdalotomy is unsuccessful, he goes on to make a hypothalamic lesion unilaterally. Because the amygdala EEG findings are not often specific enough for recognition of the target site, they rely on production of apnea by electrical stimulation for recognition of the amygdala. Apnea, pupillary dilatation, and cardiac acceleration are obtained from stimulation of hypothalamic target site. I inspected the stimulating equipment, which consists of either a Grass stimulator or homemade step-down transformer. They usually use the latter set at 10 volts which, with tissue resistances of 1-10,000 ohms means they are stimulating at 1-10 milliamps.

Both Investigators are relatively unknowledgeable about current characteristics, EEG and after-discharges; indeed, they have not been recording the EEG following stimulation. They are eager to have someone come to work with them and assist in recording and stimulating techniques that will permit them to more carefully define parameters and results and to utilize depth recordings chronically.

Summary

The above data speak for themselves. Sandwiched in between an extremely busy and urgent neurosurgical service that serves a city of three-million people, the dedication of these investigators and their sincerity cannot be doubted. Controls, adequate subject protection, preoperative testing, drug therapy, length of follow-up, identification of clinical problems from a diagnostic point of view, all leave a great deal to be desired. The operations for addiction, a known hard core group, seem very successful in the three patients whom I examined. Since addiction often is an intractable disorder, their results appear most worthy of attention and follow-up. Deficits seem negligible if one is to assess the situation by the patients' work records or by the few psychological tests done to date. I was particularly impressed that some of these patients are working as doctors and dentists without apparent handicap. Postoperative euphoria is said to be a transient finding in the cases in which it occurred. The behavior disorder group is unfortunately misnamed as these are mostly, but probably not entirely, extremely severe behavioral disorders who pose a danger to themselves and others, often requiring full restraints or constant care. By our standards, these patients had not had adequate treatment trials by other means nor systematic follow-ups. Those who come in again are seen and examined. Those who do not are followed by word of mouth or letter.

The smallest series of cases are those of orbito-medial tractotomy for schizophrenia. These are impossible for me to judge as the full records are in the hands of the mental hospital personnel. The fact that they continue to refer patients to this service suggests that patients obtain some relief. However, presurgical treatment is far from adequate by our standards. Of the two patients who I saw, one was rather typical of a chronic schizophrenia, but was grossly undertreated by American standards of medication. The second patient, although allegedly aggressive and hyperactive, has had no EEG studies for such possibilities as a temporal lobe epilepsy and no thorough going trial on medications.

Adequate assessment of these neurosurgical interventions for psychological disturbances would require at least one to two weeks of pre- and postoperative record examinations of all patients, as well as thorough going discussions with the psychiatrists. I hope to have an opportunity to do that in the future.

JRS:mpi:mrm

APPENDIX 4. Articles Analyzed to Study Relationship of Diagnostic Labels to Site of Brain Operation (U.S.A.)[1]

Diagnostic Labels	Total # of Patients	Site of Brain Operation: Frontal Lobe Procedure	Cingulum	Amygdala	Thalamus	Hypothalamus	Multiple Target Sites	Midbrain	Brain Stimulation
Aggression	35			527(12)		69(4)	125(19)		
Neurotic Depression	136	505(4)* 227(1) 620(4)	46(100) 365,382(27)						
Psychotic Depression	11		365(4) 329(7)						
Fear & Anxiety	4	505(3)*	382(1)						
Obsessive-Compulsive Neurosis	37	505(9)*	46(20) 382(5)				463(3)		
Schizo-Affective Disorders	7	505(7)*							
Schizophrenia and Other Psychoses	80		365,382(29) 329(3)				125(47)		231(1)
Drug Addiction and Alcoholism	14	620(1)	365,382(13)						
Pain	379	470(13) 620(4)	256(68) 99(32) 161(9) 365,382(4) 598(16) 512(2) 427(20) 513(3)		468(2) 464(45) 579(17) 262(30)* 598(25) 16(1)		99(11) 463(1)	403(8)	254(11) 465(5) 466(8) 3(1) 4(7)
Psychopathic Behavior	6				18(6)				
"Emotional Illness"	9		365(1)				463(8)		
"Agitated States of Aged"	2	505(2)							
Involutional Melancholia	1		329(1)						
Epilepsy with Psychiatric Disorders	45			362(11) 71(2) 527(32)					

[1]First number refers to article number in bibliography; figure in parentheses indicates the number of patients. These 38 articles contained the data presented in Table 6 in the text.

*Number of patients had to be estimated.

APPENDIX 5. Articles Analyzed to Study Relationship of Diagnostic Labels to Site of Brain Operation (United Kingdom)[1]

Diagnostic Labels	Total # of Patients	Site of Brain Operation: Frontal Lobe Procedure	Cingulum	Limbic Leucotomies	Amygdala	Multiple Target Sites	Subthalamus (Field of Forel)
Aggression inc. self-mutilation	12		575(2)*		575(3)* 245(5)	438(2)	
Depression	201	186(1) 52(5) 87(24) 438(15) 198(124)	294(2)	389(9) 462(19)	158(2)		
Fear & Anxiety	82	52(2) 129(8)* 577(13) 198(35)	294(1)	389(15) 462(8)			
Obsessive-Compulsive Neurosis	96	438(1) 52(1) 87(24) 616(1) 198(23)	294(5)	389(27) 129(10)* 462(4)			
Anorexia Nervosa	13	128(4) 438(7)		389(2)			
Psychopathic Behavior	13	198(7)		389(6)			
Schizophrenia and other Psychoses	13	198(6)		389(7)			
Drug Addiction and Alcoholism	13	198(13)					
Epilepsy with Psychiatric Disorders	36		575(3)*		243(10) 575(7)* 245(13)		14(3)

[1]First number refers to article number in bibliography; figure in parentheses indicates the number of patients. These 16 articles contain the data presented in Table 7 in the text.

*Number of patients had to be estimated.

APPENDIX 6

LIST OF OBJECTIVE TESTS

The following list represents the objective tests cited in the 153 articles reporting post-operative evaluation on psychosurgical patients. The tests have been grouped in categories reflecting the types of abilities they are generally thought to be measuring. Some of the tests, however, have been used for multiple purposes. Several tests cited appear to be idiosyncratic to one group of investigators and no information has been published pertaining to their reliability and validity. In addition, five papers mentioned the use of "psychometric evaluation" without specifying the particular tests used. These "tests" could not be included. Moreover, "standard neurological examinations" were probably given to most patients even though this fact was usually not indicated in the article. The number(s) in parentheses refer to the articles in the bibliography citing the use of these tests.

I. Behavior Evaluation

Adaptive Behavior Scale (244,245)
Behavior Evaluation Rating Scale (16)
Hargreaves Nursing Rating Scale (243,244,245)
Katz Behavior Inventory (329)
Problem-Severity Index (Andy) (18,22,216,329)

II. Psychiatric Symptoms Evaluation

Amsterdam Biographical Questionnaire (216)
Brief Psychiatric Rating Scale (241,329,509)
Cornell Health Questionnaire (283,388,389)
Jorgenson's Common Neurotic Features (602)
Miller Scale (176)
Spitzer Status Schedule (527)
Symptom-Sign Inventory (243,245)
Visual Analogue Scale (243,245)
Zuckerman and Luben's Multiple Affect Adjective Checklist (243)

III. Personality Tests (general)

Adjective Self-Inventory (365,382)
Cattell's 16-Factor Personality Questionnaire (32,33,35,243,244,245)
Draw-a-Person Test (365,382)
Eysenck Personality Inventory (EPI) (65,85,187,313,314,533,595)
Four-Picture Test (35)
Gottschalk Scales (243)
Guilford-Martin Inventory (35)
Holtzman Inkblot Test (313,595)
Maudsley Personality Inventory (MPI) (109,279,280,283,285, 286,287,388,389)
Middlesex Hospital Questionnaire (MHQ) (279,280,283,285,286,388,389)
Minnesota Multiphasic Personality Inventory (MMPI) (65,109,110,187,241, 263,288,365,382,602)
Motivation Analysis Test (32,33,35)
Personality and Personal Illness Questionnaire (245)
Repertory Grid Techniques (127,128)
Rorschach (16,18,241,262,314,365,382,386,496,505)
Sentence Completion (245,505)
Thematic Apperception Test (35,505)
Zulliger Inkblot Test (32,35)

IV. Specific Scales

Beck Depression Scale (82,85,279,280)
Hamilton Depression and Anxiety Scales (279,283,285,286,388,389,533)
Hostility and Direction of Hostility Questionnaire (243,244,245)
Hysteroid-Obsessoid Questionnaire (243,245)
Iowa Hostility Inventory (509)
Leyton Obsession Scale (87,283,388,389)
Self-Ratinq Depression Scale (509)
Taylor Manifest Anxiety Scale (82,85,87,279,280,283,285,286,287,380,388,389)
Wakefield Self-Assessment Depression Scale (82,85,87,380)
Scales of anxiety and/or neuroticism in MMPI, MPI, EPI, MHQ, and Cattell's 16-factor Personality Questionnaire

V. Abstract Thinking

Block-Design Test (224,254,262)
Colour-Forms Sorting Test (Weigl-Goldstein-Scheerer; Gelb-Goldstein) (602)
Digit Ordering (313,314,595)
Gibson Spiral Maze (244,245)
Goldstein and Scheerer Blocks (35,602)
Goldstein-Weigl Test (35)
Hooper Visual Organization Test (216)
Lattice Test (33)
Porteus Maze (161,243,245,602)
Street’s Test of Gestalt Completion (33)
Similarities (262)
Trail Making (262,329)
Wisconsin Card-Sorting Test (147)
Wechsler Intelligence Scale for Children (WISC) (33)

VI. Intelligence and Mental Ability (general)

Cattell-Cattell IQ Test (Culture-Fair IQ Test) (313,314,595)
Groninger Intelligence Test (216)
Halstead Tests of Mental Efficiency (35)
I.Q. (unspecified) (14,18,42,69,71,74,122,147,187,239,241,256,400,468, 487,494,496,527,533,559,560,616)
Stanford Binet (245,265)
Wechsler Adult Intelligence Scale (16,32,33,46,109,216,245,276,279,280, 283,285,286,288,312,382,388,389,505)
Wechsler-Bellevue Test Battery (35,65,110,348,365,381,386)

VII. Learning and Memory

Associate Learning Test (16)
Benton's Visual Retention Test (312)
Digit-Symbol Substitution Test (33,161)
Face Recognition (Milner) (244,245,594,596,597)
Graham-Kendall Memory for Designs (243,245,262)
Meyer Learning Test (575)
Wechsler Memory Scale (46,329,365,382,505)
Weingarten's Digit-Span (161,245,265,266)
William's New Word Learning Test and Delayed Recall Test (243,244,245)
Verbal Memory (170)
Word Association (161,216,262,329)
Go-No-Go Learning Task (148)
Two-Choice Discrimination Task (314)

VIII; Neurological and Psychoneurological Tests (including Perception tests)

Bender-Gestalt (16,18,35,46,262,329,365,382,496)
Cattell's Measure of Corticalertia (33)
Critical Flicker Frequency (32,33,35)
EEG (totals 38 articles)
Face Matching (Milner) (244,245,594,596,597)
Grassi Block Substitution Test (216)
Halstead-Reitan-Wepner (527)
Minnesota Thermal Discs (329)
Minor Drawing (245)
Necker Cube and Other Illusions (16,18,262)
Penrose Pattern Perception Test (35)
Phi Phenomenon (262)
Raven's Progressive Matrices (243,245,616)
Seashore Test (329)
Street’s Test of Gestalt Completion (33)
Temporal and Geographic Orientation Tests (329)
Test for Stereognosis (Sandpaper Designs) (329)
Tests of selective attention, reaction time (33,35,314,595)

IX. Motor Performance Tests

Bourdon Wiersma (216)
Halstead's Form Board Speed Test (33)
Kraepelin's and Burdon's Test (241)
Purdue Pegboard (312,313,314,595)
Pursuit Rotor (244,245)
Rey-Davis Pegboard Test (244)
Tapping Test (161,329)
Thurstone Bimanual Test (35)
Phepple Test of Motor Efficiency (35)

X. Language Tests

Achievement Tests (reading and spelling) (245,329)
Mill Hill Vocabulary (243,245,616)
Multilingual Aphasia Examination (329)
Sentence Repetition (243)
Token Test and Word Fluency Test (329,594,596,597)

APPENDIX 7

Robert G. Sheppard, M.D., Inc.
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Arcadia, California 91006
(213) 445-6196

May 10, 1976

Pierre Flor-Henry, M.D.
Alberta Hospital
Edmonton, Alberta, Canada

Dear Dr. Flor-Henry:

I have just had the pleasure of listening to a summary of your recent report on "Progress and Problems in Psychosurgery" as distributed by Abbott Laboratories for their countinuing educational program "Today In Psychiatry." It is my opinion that an important area of your report is inaccurate and can unfortunately be misleading.

I hope the following information will be welcomed and of assistance in furthering your interests of advancements in psychosurgery. I quote the questioned statement as presented on the tape, "Ironically, psycho-surgeons now know that their operations have no real effect on Schizophrenia, which was so often the target of surgery during the earlier years," There is, and has been, continuing advancement and refinement of surgical techniques which give a high percentage Of excellent results in Schizophrenia.

For your information I am taking the liberty of sending to you, under separate cover, one of the very important papers presented at the Fourth World Congress of Psychiatric Surgery in Madrid last September. The paper is entitled "Results of Multi-target Limbic Surgery in the Treatment of Schizophrenia and Aggressive States" by Aris Cox M.D. of Tulane University and M. Hunter Brown, M.D., senior neurosurgeon of Santa Monica Hospital, Santa Monica, California. This was but one of the presentations regarding Schizophrenia and target surgery. Forth coming in the near future will be full release in book form of the papers of the World Congress.

Robert G. Sheppard, M.D., Inc.
650 West Duarte Road, Suite 401
Arcadia, California 91006
(213) 445-6196

None of the patients in the aforementioned article were mine, but to date twelve of my patients, of which seven were clearly schizophrenic (predominately schizo-affective and paranoid types) have had six target limbic surgery with most promising results and prognoses.

You mention that psychiatric surgery has essentially stopped in the United States. It is unfortunately true that it has met with some considerable resistance in various political and medical circles but excellent work has continued in the field by M. Hunter Brown, M.D. in Santa Monica, California as well as a few other well qualified men in other parts of the U.S.A. Dr. Brown's cases number into the hundreds. I'm sure you would find it most profitable in communicating with Dr. Brown regarding his work.

If ever you are in this part of the United States and should you desire, I would like very much to meet with you and share information in an area in which we are both most obviously interested.

Most cordially yours,

R G Sheppard

Robert G. Sheppard, M.D.

RGS:ss

CC: 1) Roy R. Grinker, Sr., M.D.
Director
Institute for Psychosmatic and Psychiatric
Research and Training
Michael Reese Medical Center
Chicago, Illinois

✓ 2) M. Hunter Brown, M.D.
Santa Monica, California

3) Medical Director
Abbott Laboratories
North Chicago, Illinois

APPENDIX 8a.

M. HUNTER BROWN, M. D.
SUITE 640
2021 SANTA MONICA BOULEVARD
SANTA MONICA. CALIFORNIA 90404
TELEPHONE: 829-2286

December 8, 1975

Professor Elliot S. Valenstein
Neuroscience Laboratory Building
The University of Michigan
Ann Arbor, Michigan 48104

Dear Elliot:

On receipt of your letter I rechecked our own material combined with my best recollections of the joint survey with Doctor Ballantine for Professor Stone including a recent conversation with Tom in Madrid.

My best appraisal of the combined material at this time (slightly over 600 patients) is one black patient, now six Spanish-Americans (all my own including three of the six from Puerto Rico), and two Oriental-Americans of Doctor Ballantine. I suggest you update the accuracy of Tom's group by a phone call to 617) 726-2000.

My own experience covers a time period of 27 years, the first two cingulotomies having been done on November 17 and November 18, 1948. As I recall Tom's paper in Madrid, his own span is 13 years, but again, I think you should verify that at the proper source.

My single black patient was K.L., aged 14 years, with an I.Q. of 14! The diagnosis was childhood schizophrenia, post-autistic, with severe retardation and explosive violence of fearsome proportions. He had been confined since the age of 4 years at Camarillo State Hospital and had a six-target procedure at the request of their research group and UCLA. Believe me, Camarillo tried their best with every traditional psychiatric modality and a conservative estimate would be $150,000 expended by the State of California over this lo-year period. Despite this he continued to fracture other children's skulls, tear doors off the hinges, and took the administrator's office apart which required extensive redecorating.

K.L. has not required further hospitalization for 18 months and is now off all psychotropic medications. He is on behavior modification and special education at Fairview School in Costa Mesa. He goes home each weekend, seems much happier, can ride a bicycle, mow the lawn, and relate to a very fine family without physical aggressivity. Naturally the goal was restrictive as we do not anticipate a future Rhodes scholar, but within the framework of possible human and economic considerations it seems quite worthwhile.

Concerning the six patients of Spanish-American extraction, one was a six-target procedure, two were four-target procedures (cingulo-amygdalotomy), and three were single cingulum targets.

Please check with Doctor Ballantine on the question of two Orientals and if I am correct in this, I would suspect that they were cingulotomy alone, as I do not believe Tom has yet moved into multi-target neurosurgery. I believe you will find that my conclusion on discrimination in public policy is justified. As you mentioned, the issue is very emotional to members of the minority groups and hopefully it can become rational and scientific. In this vein I will give a two-hour lecture to the whole staff of Martin Luther King Hospital in Los Angeles on December 12th and intend to use outcome assessment data to keep matters on an even plane.

Best regards,

Hunter

M. Hunter Brown, M.D.

MHB/dk

CC: H. Thomas Ballantine, Jr., M.D.

APPENDIX 8b.

M. HUNTER BROWN, M. D.
SUITE 640
2021 SANTA MONICA BOULEVARD
SANTA MONICA, CALIFORNIA 90404
TELEPHONE: 829-2286

May 18, 1976

Charles U. Lowe
Executive Director, National Commission
for the Protection of Human Subjects
Westwood Building, Room 125
5333 Westbard Avenue
Bethesda, Maryland 20016

Dear Sir:

Thank you for the invitation to appear at a public hearing by the Commission on June 11, 1976. Regretfully, I am obligated to attend the annual meeting of the Society of Biological Psychiatry in San Francisco on June 10, 11, and 12, 1976; therefore I hope you will be kind enough to read this memorandum to members of the Commission as it represents my posture on a few current aspects of target surgery (usually termed "psychosurgery" in the lay media). These comments are based on 28 years of increasing activity in this field on several hundred patients. Since 1965 our major thrust has been directed to multi-target stereotactic treatment for schizophrenia and aggression.

I fully agree with an HEW memorandum distributed by Doctor Miriam Kelty at the recent Madrid Congress. This indicates that manipulations of the central nervous system for intractable pain which alter feeling and mood constitute "psychosurgery." This definition would include trigeminal neuralgia, phantom limb syndrome, and even such conditions as uterine cancer with frozen pelvis when the neoplasm has not metastasized to the central nervous system. Pain procedures such as cordotomy, mesencephalic tractotomy, thalamotomy, cingulotomy, RFG coagulation of the gasserian ganglion, etc., are psychosurgery. One of the commonest alterations of feeling encountered by physicians is relief of intractable pain and if this persists for months or years depression and drug addiction are frequent concomitants.

In another vein, I would like to call the Commission's attention to discrimination against minorities in this area. This does not result from case selection by the surgeon but is caused by economic realities in low income groups and From public policy in the several states. In February 1976 I pointed this out in a lecture at the Martin Luther King Memorial Hospital in Los Angeles. TWO years ago Doctor H. Thomas Ballantine, Jr., and I compiled some 600 cases for Professor Alan Stone of Harvard to evaluate the problem--at that time my own group included six Hispanic patients (three from Puerto Rico and three from southern California) and one black patient; Doctor Ballantine had carried out anterior cingulotomy on two Oriental-Americans. We were impressed that a total of nine minority patients out of 600 seemed disproportionate to the need.

I have a special concern for involuntary patients held in our state mental hospitals and state prisons. Often they cannot procure needed treatment and face an eternity behind walls and bars for the crime of illness. Much of their plight relates to semantics concerning informed consent and could be solved by a neutral ombudsman in each state. Excessively vigilant civil libertarians guarantee that the captive patient can spend the rest of his natural life in confinement with the comfort of knowing that no one took advantage of his legally manufactured incompetence to consent.

Finally, I should relay to the Commission my considered opinion that stereotactic target and multitarget treatment have the highest risk-benefit ratio of any procedure currently carried out in neurological surgery. Worldwide data entered at the recent International Congress indicate a mortality rate on the order of 1/10 of 1%, and current technology affords significant benefit or recovery in about 9 out of 10 of the worst psychiatric failures with no adverse side-effects and often with an increase in postoperative intelligence quotients. I concur with Doctor A. E. Walker's testimony at the Wayne County trial that these procedures in competent hands are not research or experimental but are subject, as in all branches of surgery, to continual refinement and progress.

I trust the Commission has available the collected papers from the Madrid Congress. I understand these recently have been supplied to Professor Elliot Valenstein prior to publication. Current outcome assessments under the direction of Doctors Mirsky and Orzack at Boston University should also provide useful data and bridge the information gap noted in the enclosed letter of Doctor Robert Sheppard. Hopefully, similar neutral ratings can be continued this fall in schizophrenia and aggression.

Sincerely yours,

M. Hunter Brown

M. Hunter Brown, M.D.

MHB/dk

Encl.

APPENDIX 8c.

Several of the more active participants in the psychosurgery controversy have implied that Dr. Orlando J. Andy of the University of Mississippi Medical Center has operated upon a high percentage of blacks (79). As far as could be determined, no evidence has been presented to support the charge. In a personal communication (February 27, 1973) to Dr. Valenstein, Dr. Andy wrote that, "Less than 5% of the patients I have operated upon are black." This figure is significantly below the percentage of blacks in the population of the state of Mississippi.

APPENDIX 8d.

HARVARD MEDICAL SCHOOL MASSACHUSETTS GENERAL HOSPITAL

H. THOMAS BALLANTINE, JR., M.D.
Neurological Surgery

Please reply to:

Massachusetts General Hospital
275 Charles Street
Boston, Massachusetts 02114
Tel. (617) 726-3416

December 9, 1975

Professor Elliot S. Valenstein
Neuroscience Laboratory Building
The University of Michigan
1103 East Huron
Ann Arbor, Michigan 48104

Dear Elliot:

Thank you for your letter of December 2, 1975. There is one correction I must make: the series that we reported in Madrid consisted of 238 patients, None of these were Blacks.

I thought you might be interested in copies of my entire correspondence with Professor Stone, and I an enclosing these. I am also enclosing copies of statements pertaining to some proposed "Psychosurgical" regulations promulgated in Massachusetts. These regulations were subsequently withdrawn as being "inappropriate." Finally, I am enclosing a copy of an article I wrote for "Prism Magazine" which you may find of interest.

I wish you every success in your endeavors.

Best wishes for a happy holiday season,

Sincerely yours,

Tom

H. Thomas Ballantine, Jr., M.D.

HTB,Jr.:nmd

P.S. On re-reading your letter to me, I find that you are asking not only for Blacks but for "minorities" who may have undergone this operation. My reply to Professor Alan Stone's similar request was as follows: "Not one of these patients was Black.

For your further information it would appear from a random sampling that Jew, Catholics and Protestants were about evenly distributed in the series. It is also of some interest that we have not performed this operation on Chinese, Japanese, East Indians or other of the Asiatic races. We have operated upon one individual who claimed to be part American Indian."

NEUROSURGICAL GROUP

WILLIAM BEECHER SCOVILLE, M. D.
BENJAMIN BRADFORD WHITCOMB, M. D.
REMBRANDT HARVEY DUNSMORE, M. D.
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CONNECTICUT

85 JEFFERSON STREET
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December 9, 1975

Elliot S. Valenstein
Professor of Psychology
The University of Michigan
Neuroscience Laboratory Building
1103 East Huron
Ann Arbor, Michigan 48104

Dear Dr. Valenstein:

Thank you for your letter dated December 2, 1975.

The only black person on whom I have performed psychosurgery was by invitation from Bermuda where it was done in 1965. The patient was referred by a neuro-psychiatrist. The early results were good and the family was appreciative. I have been unable to get a recent follow up but will try again. His diagnosis was pseudoneurotic schizophrenia strongly imbedded with obsession and a rigid personality.

With very best wishes,

Bill Scoville

William Beecher Scoville, M. D.

WBS/eg

APPENDIX 8f.

In an article (516) summarizing the results of amygdalectomies performed by Dr. Robert Heimburger (Indiana University School of Medicine) on 58 patients treated for intractable seizures and/or behavior disorders, it was stated that: "The sex ratio was nearly two to one, favoring males; all of the patients were Caucasian..."

In another article (374) reporting the results of cingulotomies performed by Dr. Glen Meyer and his associates (at the time all located at the University of Texas Medical School), it was reported that: "Of the 75 patients, 71 were Caucasian and 4 were Mexican-American. Thirty-three were male and 42 female."

APPENDIX 9a. Postoperative Complications Following Psychosurgery[1] Performed After 1970 As Reported in the Literature

OPERATION	REF #	COMPLICATION	FREQUENCY	APPROXIMATE DATES OF SURGERY
Frontal Lobe Procedure	64	seizures	1/17	1970-72
	533	seizure	2/40	1972-73
	122	nocturnal enuresis	1/8	1970's
	283	irregular menstrual cycle	some+/30	1970-72
	389	lethargy	some/66	early 1970's
	283	excessive tiredness	1/30	1970-72
	533	apathy	1/34	1972-73
	533	disinhibition	2/34	1972-73
	64	disinhibition	some/17	1970-72
	389	outspokenness	some/66	early 1970's
	273	outspokenness, disinhibition	1/11	1973-73
	273	aggression	1/11	1971-73
	389	impaired memory	some/66	early 1970's
Cingulotomies				
	513*	flattened affect	1/3	before 1974
	595	lethargy,lack of judgement	3/27	1970-73
	595	increased hallucinations and delusions	1/27	1970-73
Thalamotomies				
	464*	hemiparesis	2/45	1970-73
	309	abnormal bodily sensations	3/41	1970-74
	579	impaired memory	4/17	1970-73or74
	309	semantic aphasia	1/41	1970-74
	474	lethargy	11/22	1969-74
	464*	death attributable to surgery (thalamic hemmorrhage)	2/45	1970-73
Amygdalectomies				
	525	impaired memory and orientation	1/8	1970-71
Hypothalatomies				
	449	subcortical abcess	1/3	1971-73
	27	dyskinesis	2/11	1970-72
	483	dyskinesis	3/31	1970-74
	142	impaired endocrine functions	3/4	1970-75
	142	increased weight	2/4	1972-75
	27	hyperthermia	1/11	1970-72
	483	hyperthermia	1/31	1970-74
	27	disinhibition	2/11	1970-72
	449	lethargy	1/3	1971-73
	142	lethargy	2/4	1972-75
	483	death attributable to surgery	1/31	1970-74
Mesencephalotomies				
	495	loss of upward gaze	5/5	early 1970's

1 Including brain surgery for intractable pain.
*Operations performed in U.S.
+"Some,""several,""common,""many,""most," was the only quantitative information given by authors.

APPENDIX 9b. Postoperative Complications Following Psychosurgery[1] Performed Primarily After 1965 as Reported in the Literature

OPERATION	REF #	COMPLICATION	FREQUENCY	APPROXIMATE DATES OF SURGERY
Frontal Lobe Procedure	333*	anesthesia complications	2/475	most since 1964
	314	hemorrhage	1/38	1969-71
	505*	blood clots	3/109	1955-75
	505*	stroke	3/109	1955-75
	347	impaired visuomotor function	1/8	1969
	87	seizures	5/48	1960's
	129	seizures	4/90	1961-73
	333*	seizures	14/475	most since 1964
	413	seizures	8/95	late 1960's
	430	seizures	1/9	1967-71
	548	seizures	1/210	1961-68
	549	seizures	1/150	1961-68
	65	abnormal EEG	28/35	before 1972
	65	increased weight	some+/35	before 1972
	287	increased weight	21/40	1963-69
	548	increased weight	13/210	1961-68
	333*	eye complication	2/475	most since 1964
	548	headaches	1/210	1961-68
	548	anosmia	1/210	1961-68
	347	increased anxiety	1/8	1969
	413	lack of initiative & planning	9/95	late 1960's
	347	lethargy	1/8	1969
	65	lethargy	common/35	before 1972
	302	lethargy	some/13	1966-74
	505*	lethargy and apathy	some/109	1955-75
	302	flattened affect	2/13	1966-74
	287	irritability, tiredness, laziness, general personality change	1/40	1963-69
	505*	irritability and hostility	some/109	1955-75
	549	irritability, outspokenness, volubility(slight)	11/150	1961-68
	302	disinhibition	several/13	1966-74
	549	promiscuity, disinhibition, hedonism	2/150	1961-68
	287	outspokenness, and euphoria, personality change	13/40	1963-69
	549	aggression	1/150	1961-68
	463	aggression, poor impulse control	1/12	since 1967
	549	frigidity	1/150	1961-68
	302	confusion	2/13	1966-74
	549	impaired concentration,memory	1/150	1961-68
	287	impaired concentration,memory	1/40	1963-69
	314	impaired intellectual functioning	1/38	1969-71
	413	impaired intellectual functioning	1/95	late 1960's

CONTINUED

OPERATION	REF #	COMPLICATION	FREQUENCY	APPROXIMATE DATES OF SURGERY
Frontal Lobe Procedure (continued)	505*	impaired creative thinking	some/109	1955-75
	176	lowered morality and law-breaking	7/17	1960-65
	549	excessive smoking	3/15	1961-68
	463*	inability to work	1/12	since 1967
	470*	death attributable to surgery (fatal seizure)	1/13	1967-72
	505*	death attributable to surgery (seizure and clot)	2/109	1955-75
Cingulotomies	574	meningitis, hemorrhage	1/43	1969-71
	88	hematoma	2/63	1960-70
	365*	subdural hematoma	2/68	1968-72
	365*	superficial infection	2/68	1968-72
	35	infection	4/48	before 1969
	256*	idiopathic polyneuritis	1/68	1964-72
	35	seizure	2/48	before 1969
	44*	seizure	1/66	1962-1970
	88	seizure	1/63	1960-70
	574	seizure	1/43	1969-71
	35	increased weight	several/48	before 1969
	33	hemiparesis	1/200	1963-74
	598*	hemiparesis	1/25	1962-73
	574	hemiplegia	1/43	1969-71
	35	extreme sensitivity to alcohol	many/48	before 1969
	329*	minor motor loss	some/11	before 1974
	302	flattened affect	2/13	1966-74
	617*	flattened affect	13/23	1966-71
	32	unresponsive	some/150	1964-71
	35	lethargy	1/48	before 1969
	129	lethargy	2/49	1961-71
	312	impaired imagination	1/20	1968-70
	313	impaired imagination	most/46	1968-72
	129	impaired intellect	4/49	1961-71
	88	impaired intellect	10/63	1960-70
	88	severe dementia	5/63	1960-70
	598	prolonged stupor	2/25	1962-73
	32	death attributable to surgery (cerebral hemorrhage & edema)	1/180	1964-71
	598	death attributable to surgery (intracranial hemorrhage)	1/25	1962-73
Thalamotomies	139	akinetic syndrome	3/32	before 1972
	225	psychomotor akinesis	1/43	before 1972
	164	hemiparesis	?/165	1963-72
	598*	hemiparesis	1/54	1962-73
	523	abnormal bodily sensations	2/32	before 1971
	523	severe Dèjerine-Roussy syndrome (pain)	1/32	before 1971
	164	hyperthermia	?/165	1963-72
	18*	impaired memory	1/6	1961-67

CONTINUED

OPERATION	REF #	COMPLICATION	FREQUENCY	APPROXIMATE DATES OF SURGERY
Thalamotomies (continued)				
	225	impaired memory	2/43	before 1972
	139	impaired memory	2/32	before 1972
	139	acalculia	2/32	before 1972
	397	lethargy	some/44	before 1971
	139	depression	2/32	before 1972
	164	confusion	?/165	1963-72
	598*	prolonged stupor	1/54	1962-73
	225	"mild undesirable long lasting side effects"	9/43	before 1972
	22*	death attributable to surgery	2/30	1961-70
	464*	death attributable to surgery (thalamic hemorrhage)	2/45	1970-73
Amygdalectomies	288	seizure	4/18	1967-70
	244	hemiplegia	1/17	1967-72
	245	hemiplegia	1/18	1967-72
	527*	hemiplegia	1/58	1963-73
	288	hemiparesis from cerebral thrombosis	1/18	1967-70
	361*	oculomotor paresis	1/10	1963-70
	243	transient oculomotor paresis	1/10	before 1971
	243	hormone imbalance	2/10	before 1971
	400	unsteadiness	7/25	1959-69
	244	gynecomastia	1/17	1967-72
	361*	hyperphagia	1/10	1963-70
	400	polyphagia	7/25	1959-69
	244	anti-social behavior	1/17	1967-72
	245	less adaptive behavior	1/18	1967-72
	400	hypersexuality	7/25	1959-69
	290	increased sexuality	most/63	before 1972
	361*	impotency	1/10	1963-70
	167	psychosis	1/ 135	1952-72
	245	impaired memory	2/18	1967-72
	42	death attributable to surgery (hematemesis)	1/128	1964-70
	397	death attributable to surgery (fatal seizure)	1/8	before 1972
	37	deaths due to surgery	9/235	before 1973
Hypothalamotomies	397	hemorrhage	1/12	before 1972
	42	hematemesis	1/128	1964-70
	488	impaired endocrine function	most/53	1962-72
	488	increased weight	most/53	1962-72
	398	increased eating	2/10	before 1972
	141	circling behavior	1/6	before 1975
	398	disinhibition	2/10	before 1972
	488	lethargy	many/53	1962-71
	141	impotency	1/6	before 1975
	477	impotency	2/10	1968-70
	436	impaired memory	1/3	1969-72
	475	death attributable to surgery	1/11	1962-70
	488	death attributable to surgery	1/53	1962-71
	37	deaths due to surgery	2/16	before 1973

CONTINUED

CONTINUED - 4th page
APPENDIX 9b.

OPERATION	REF #	COMPLICATION	FREQUENCY	APPROXIMATE DATES OF SURGERY
Stria Terminalis Lesions	104	increased eating	1/13	1966-71
Midbrain Tractotomy	403*	impaired visuomotor function	8/8	1963-68
	403*	hyperesthesia of tongue	1/8	1963-68
	403*	flattened affect	many/8	1968-68
Mesencephalotomy	598*	impaired visuomotor function	9/52	1962-73
	598*	abnormal sensations	6/52	1962-73
	598*	hearing loss	1/52	1962-73
	598*	hemiparesis	3/52	1962-73
	598*	death attributable to surgery (intracranial hemorrhage)	1/52	1962-73

[1] Including brain surgery for intractable pain.

*Operations performed in U.S.

+"Some," "several," "many," "most," was the only quantitative information given by authors.

FINAL REPORT ON
PSYCHOSURGERY PILOT STUDY

Allan F. Mirsky, Ph.D.,
Maressa Hecht Orzack, Ph.D.

Boston University

Contract No. N01-HU-6-2114

Acknowledgements

We wish to offer our appreciation to the many who participated in the gathering of the data of this report, sometimes under extremely rushed, if not frantic conditions. The effort was made possible, in part, by the knowledge that we were participating in a project of high national importance, and the expectation and hope that we wouldcontribute to the study of a problem of great public concern. Thanks are due to the following: Dr. A. Earl Walker, Dr. Marvin Powell, Dr. Robert Feldman, Dr. Phillip Wolf, Dr. Daniel Tarsy, Dr. George Gardos and staff, Dr. John Gambill, Dr. Michael Nelson, Dr. Arje Latz, Dr. David Dorney, Mrs. Gloria Spodick, Ms. Stephanie Craig, Mr. Leon Pierce, Mrs. Thelma Klayman, Ms. Constance Ray, Ms. Cheryl Grady, Ms. Deborah Orzack, Dr. Douglas MacNair, Dr. Carla DiScala and staff, Dr. Conan Kornetsky, Dr. Peter Knapp, Dr. Sanford Cohen, Dr. John Knott, Dr. Joseph Tecce and staff, Dr. Jacob Swartz, Dr. Carol Nadelson, Mr. Henry Appleton, Mr. Paul Miller, Ms. Barbara Feldman, Ms. Carol Filaberti and Ms. Marjorie O'Connell. Special thanks are due to that stalwart and indefatigable worker, Mr. Stafford Mclean, and to Mrs. Marcia Kornetsky for her highly skilled efforts and devotion to the project.

We are also grateful to Dr. Joseph Zubin, Dr. Phillip May, Dr. Heinz Lehman, Dr. Daniel X. Freedman and Dr. Richard Wittenborn for advice and suggestions in the early stages of this project and to the psychiatrists who referred control patients to us. The collaboration of our cooperating and truly co-operative neurosurgeons made this study possible. The patient subjects were also colleagues in this work in a very real sense; we thank them for their forebearance, and wish them well. We also owe a special debt of gratitude to our project secretary, Mrs. Charlotte Johnson, for her tolerance and competence, for the innumerable telephone calls she made, as well as uncounted trips to the business office, for the instant taxi service to patients, and for just generally holding the whole enterprise together. Our thanks also to Pamela Driscoll of the Commission office for retyping the final copy.

TABLE OF CONTENTS

Introduction and Background. The suggestion that a retrospective evaluation of the efficacy and safety of psychosurgery be conducted under the aegis of the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research emerged from the meeting of an _ad hoc_ advisory group which was convened on June 9, 1975. This study was viewed as necessary in view of the wording of Public Law 93-348, Section 202(c).

Broadly speaking, within the context of investigating the safety and efficacy of psychosurgery it was hoped to perform a pilot study to (1) determine the utility and value of a retrospective study of operated cases and (2) gather some preliminary information concerning the benefits and/or hazards of psychosurgical treatment. Negotiations with the principal investigators began in July 1975, and eventuated in a contract which was signed in early November 1975. The form of the contract stemmed not only from the recommendations of the first _ad hoc_ panel, but from a meeting of the principal investigators with the Commission on October 11, 1975 and a meeting with a second _ad hoc_ panel on December 3, 1975. The basic work scope states the following specific goals:

1. Assemble, coordinate, and supervise a clinical Evaluation Team including representatives of the disciplines of neurosurgery, clinical neurology, psychiatry, psychology and social sciences.

2. Develop a detailed evaluation protocol which shall specify procedures to:

   a. Identify at least two, and no more than four surgeons who will be asked to participate in the study by making available to the Evaluation Team the medical records of their patients who have been referred for psychosurgery and by contacting selected patients to request their cooperation.

   b. With respect to each of the surgeons, obtain populations of at least twenty and not more than thirty patients sufficiently homogeneous with respect to presenting behavioral problems, locus and size of lesion, and other significant variables in order to permit valid and reliable results.

   C. With respect to such patients, obtain from records (to the extent possible) information on:

(1) age, sex, race, and socioeconomic status;

(2) nature and duration of symptoms, including preoperative emotional status;

(3) nature and extent of previous treatment;

(4) preoperative intellectual and cognitive functioning;

(5) preoperative clinical neurological status;

(6) preoperative educational, employment, social adjustment and health status; and

(7) the surgeon's and/or referring physician's postoperative evaluation (including their rationale for such evaluation).

3. Select and enlist patients in accordance with the protocol requirements. The protocol shall be subject to the review and approval of the Project Officer.

4. Interview the patients and their families to determine: factors surrounding the decision for surgical procedures; patient and family perception of consent procedures; evaluation of outcome; and present status, including educational, employment, social adjustment, and health status. In addition, information which may be lacking on the medical reports regarding preoperative status may be obtained during such interviews.

5. Test patients with an appropriate battery of tests to evaluate present neurological, intellectual, perceptual, cognitive, and emotional status.

6. With regards to "2" through "5" above, use an appropriate number of controls. These individuals shall be persons for whom psychosurgery was recommended, but not performed.

7. Analyze the data obtained in accordance with an analysis play approved by the Project Officer.

Because of the difficulties in obtaining the requisite number of patients (to be detailed below), a modification of the work scope (Section 2B) was requested on April 28, 1976 to read " ... less than 40 ... but more than 30 subjects." This report presents information on 27 operated patients and 8 controls, for a total of 35. The difficulties in obtaining patients stem from the brief time over which the data gathering phase could actually take place (all but two patients were seen between March and May of 1976). The period from November 1975 through February 1976 proved to be necessary to complete IRB approval procedures, to contact and make necessary arrangements with the three cooperative neurosurgeons, assist them in obtaining informed consent statements from their patients, obtain records from the surgeons, make contact with the patients and arrange for their travel to Boston for study. This was true despite the fact that planning for the study began as early as July 1975. A formidable complication concerned the fact that only one of our cooperating neurosurgeons is in practice in the northeastern United States; the other two practice in the west. This resulted in a number of logistical problems relating to travel, time zone differences, etc. Towards the end of the data-gathering phase (i.e., in May 1976) a team consisting of a psychiatrist, social worker and psychologist saw three patients in a western city.

The two surgeons in the west were contacted only after our consultant, Dr. Walker, had spoken with at least seven other neurosurgeons located closer to Boston. No attempt was made to study their cases because they reported having done too few operations during the 1968-1972 study period (six surgeons) and/or they were not interested in participating (one surgeon). One surgeon declined to sign the informed consent statement. During the time that we were attempting to enlist the cooperation of surgeons, we requested and obtained permission from the Commission staff and the second _ad hoc_ panel to extend the study period to 1965-1974 since we believed that we would be unable to assemble the requisite number of study cases if restricted to the period from 1968-1972.

Although the three neurosurgeons have been extremely cooperative, there were delays of several weeks in each of two instances due to holiday-vacation plans or to the fact that all concerned underestimated the difficulty and time involved in sending out the initial requests to examine records. Our third surgeon reported to us that he finally had to close his office for a week in order to get the letters out. One surgeon accepted our offer to pay for temporary office help to expedite the process.

A further comment concerning the securing of control subjects: Our initial plan called for such subjects to be provided by leads from the surgeons themselves, from cases for whom surgery had been recommended but declined. Except for one surgeon (2), this proved to be a virtually non-existent group. All three surgeons report instead that they are sought out by persons who are desperate for relief from various symptoms; two of the surgeons also report that they will refuse to operate if certain patient and/or family criteria are not met. Collectively, surgeons 1 and 3 could not assemble as many as 5 cases over the years who had declined the recommended operation.

Surgeon 2 had a list of about 20 cases for whom surgery had been recommended but either declined or not yet performed; however, the diagnoses of these persons appeared sufficiently different from those of the other operated cases in the study to make them not comparable. Consequently, they were not contacted. Word of mouth contacts with our local colleagues had not yielded more than a couple of control patients. After some consultation, we sent a letter to all members of the Massachusetts Psychiatric Society (see appendix). Within a few days, we had made contact with a group of appropriate control patients.

In addition, much to our chagrin, we came into contact (in April 1976) with a local clinic whose chief psychiatrist could provide us not only with control cases but with an estimated population of 150 operated patients from Boston or the local New England region. Our consultant, Dr. Walker, had contacted a senior neurosurgeon at that clinic, but he was told that only a small number of operated cases had been done in recent years. This statement was apparently in error. At this writing, we are in the vexing position of approaching the end of our contract while having an available pool of 200 or more operated cases, including at least 50 late returns from surgeon 3 who would undoubtedly be willing to participate in our study.

Methods

Selection of Neurosurgeons. The three surgeons selected agreed to sign an informed consent statement (see appendix) and to make available to us all their records, on cases operated during the period 1965-1974. Each surgeon performs a distinctive type of psychosurgery. Surgeon 1 does only orbital undercuttings that sever fibers in the inferior surface of the frontal lobe (Figure 1); surgeon 2 performs multi-target bilateral, stereotaxic, radio frequency (or other) lesions aimed at destroying areas in the cingulate gyrus, amygdala and substantia innominata of the diencephalon (Figure 2). Usually 4 to 6 targets are lesioned in a patient. Surgeon 3 performs only pre-frontal sonic lesions (i.e., produced by focussed ultrasonic energy) either unilaterally or bilaterally (Figure 3). Two cases operated by other surgeons appear in Table 3. These patients received an anterior pre-frontal leucotomy, an older but still used procedure which severs fibers in the anterior frontal lobe.

Selection of operated cases. The initial letter to the patient was from the surgeon (see appendix), requesting permission to make his/her files available

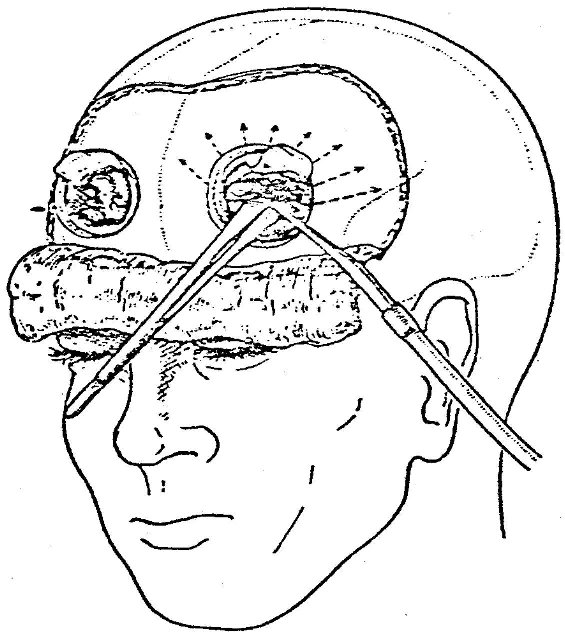

FIGURE 1

The orbital undercutting procedure (surgeon 1). By lifting the frontal lobes with a spatual it is possible to selectively cut the fibers beneath the more medial (orbital) portion of the prefrontal area. (From A. Asenjo, Neuro-surgical Techniques, 1963. Charles C. Thomas, Springfield, Ill.).

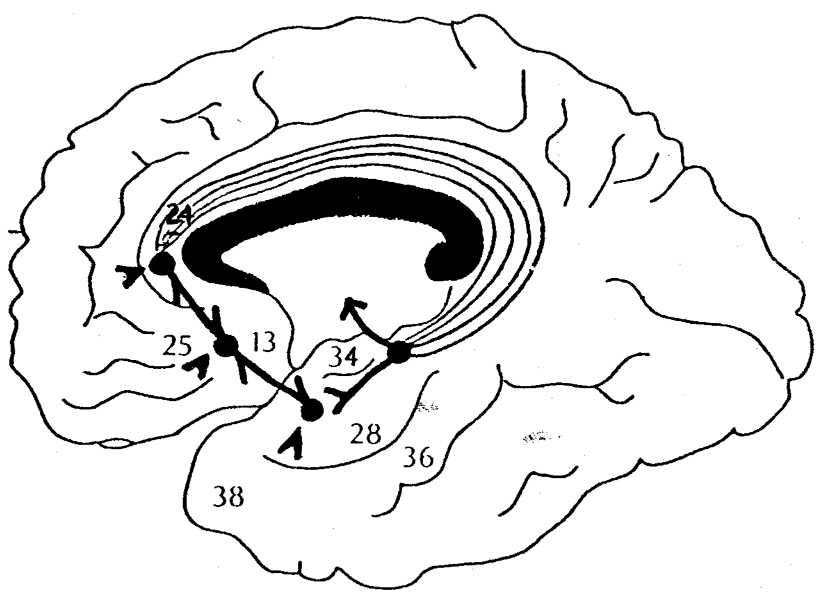

FIGURE 2

Multitarget procedure (surgeon 2). Stereotaxic lesions are made bilaterally in some or all of the areas indicated by arrowheads in this medial view of the right hemisphere of a human brain. The top-most arrowhead (near 24 on the diagram) indicates the cingulate target; the arrowhead nearest area 25 indicates the approximate locus of the substantia innominata target; the arrowhead nearest 28 shows the approximate locus of the amygdala target. (Diagram courtesy of surgeon 2).

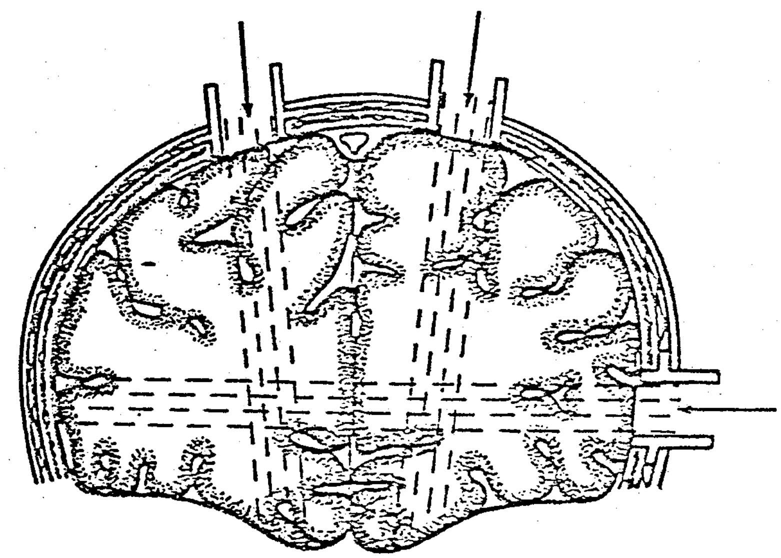

FIGURE 3

Illustration showing path of ultrasonic irradiation used in prefrontal sonic treatment (surgeon 3). The area of intersection of the two beams on each side shows the intended region of destruction in the lower quadrant of white matter in prefrontal lobes. (From Current Psychiatric Therapies, Vol. IV, Grune & Stratton, 1964).

to us. The response was to us (see appendix). Once a patient's file was available we asked 3 psychiatrists to make a diagnosis based on the pre-operative record. Our requirement for including a patient was that at least two out of the three diagnosis were in essential agreement. After this step, the patient was contacted and a visit to Boston was scheduled (a) if the patient appeared suitable (see appendix) and (b) if the patient was willing (see appendix). Most patients elected to bring a companion (usually a spouse or relative), thus allowing us to question this person concerning the pre- and postoperative status of the patient (see appendix), the nature of the contact with and information from the neurosurgeon, etc. Vigorous follow-up attempts (phone calls from the co-principal investigator) were made in the case of every patient to whom a letter was sent. Table 1 summarizes the patient contacting activities for each of the three surgeons.

TABLE 1

We attempted to ascertain the reasons for refusal in every case (see appendix). Of the 8 cases who wished no further participation, five checked the item, "for personal reasons," one indicated "too busy" and two indicated that they wished not to be reminded of the operation.

As can be seen, the percentage and number of refusals was small, and lends confidence to the belief that we were not missing a significant proportion of the operated cases.

The composition of the cases, including controls, is provided by Table 2. The preponderance of cases with diagnoses of depressive or affective illness

TABLE 2

TABLE 1 - Patient Contact and Followup Summary

Surg.	# operated 1965-1974	# letters sent	# replies	Full Partic.	Wished no further partic.	Records only no time/unable to test	Records only no time/unable to reach	Phone interview	We rejected
810*	32	23	19	8	2	0	2	4	3
815	156	19	15	7	1	2	1	2	2
804	193	150	43**	10	5	20	2	3	3
Other	unknown	-	-	2	-	-	-	-	-

* The numbers are the computer code designations used to refer to the surgeons in the study.

** The returns from the letters sent out by surgeon 804 are incomplete as of this writing (June 7, 1976).

TABLE 2 - Composition of Patient Group

#	Age	Sex	Date Op. (last)	Pre-Operative Diagnosis
109	32	F	10/72	Pseudoneurotic Schizo. (flat affect, fear)
122	51	M	11/72	Psychoneurotic Schizo. (depression, anxiety, paranoia)
123	37	F	3/71	Psychoneurotic-anxiety state w/obs-comp.
125	55	M	1/74	Chronic depressive anxiety state w/alcoholism
207	29	M	8/71	Pseudoneurotic Schizo, w/obsessive phobia
211	60	F	2/71	Schizo-affective w/depression
213	51	M	8/74	Manic-depressive
219	57	M	1/74	Psychoneurosis, depression, anxiety state
	SURGEON 815			
103	57	F	5/69	Anxiety Neur. w/depression & hypochondriasis
107	69	F	2/72	Schizo-affective
113	33	F	7/72	Psychoneurotic schizophrenia
118	45	F	8/74	Pseudoneurotic schizo, w/obs-comp & paranoia
124	41	F	7/67	Manic-depression w/phobic anxiety
209	63	F	10/72	Obs-comp. personality w/depression
222	33	M	3/73	Depressive neurosis w/passive-agressive
	SURGEON 804			
126	61	F	4/68	Manic-depressive w/acute anxiety
217	57	M	3/69	Anxiety reaction w/depression
220	57	F	1/72	Intractable pain with depression
114	55	F	4/67	Chronic anxiety/depression
203	46	M	4/71	Anxiety/extreme depression
127	66	M	12/71	Intractable headache/anxiety & depression
233	39	M	10/68	Migraine headache/anxiety reaction
129	67	M	1/67	Intractable headache/depression
226	42	F	5/67	Intractable pain/anxiety - addiction
104	29	F	6/67	Schizo-paranoid/depressive features
	OTHER SURGEONS			
112	34	F	5/70	Chronic schizophrenia, undifferentiated
224	54	F	7/70	Depression with obsessive component
	CONTROLS			
401	57	F		Manic-depressive
410	35	F		Chronic schizophrenia, undifferentiated
416	35	F		Depressive reaction w/marital problems
420	62	F		Manic-depressive

TABLE 2 - Composition of Patient Group
(continued)

423	54	M	Paranoid schizo w/obsessive phobia
523	50	M	Manic-depressive
404	30	F	Obsessive-compulsive
511	36	M	Obsessive-compulsive

and of obsessive-compulsive disorders was determined largely by the cases operated by surgeon 1. After having selected his cases to begin with, we sought to obtain subjects with similar diagnoses from the files of the other two surgeons, in order to minimize heterogeneity between surgery groups.

Selection of Control Cases. We sought patients in whom the primary diagnosis was obsessive-compulsive or recurrent affective illness, and did not exclude those in whom schizophrenia was also present (see appendix). The quality of the available records of the control cases is in general much poorer than in the case of the operated patients. Often, we had only a brief summary of the psychiatrists' notes or records. This is in contrast to the operated cases, where detailed pre- and postsurgical information of a diagnostic nature was available, including (in some instances) reports of psychological testing, notes from prior hospitalizations and descriptions of other therapies as employed or reported by the referring psychiatrist.

The Test and Interview Battery.

All patients were tested in Boston, except for three cases who were seen in a western city. The testing lasted for 2-3 days, and consisted, for the most part, of standard psychiatric, psychological, social work, neurological, EEG and neurophysiological procedures.

Psychiatric. All patients were administered the Spitzer-Endicott Psychiatric Status Schedule (PSS), a machine scored version of a standard psychiatric interview, which yields scores on various factors (i.e., depression) and for which norms derived from various psychopathological populations are available.

All of our psychiatrists were trained in the use of the PSS. In addition, the Spitzer-Endicott Psychiatric Appraisal Scale (PAS) (see appendix) was filled out by the psychiatrist and twice by the social worker. The psychiatrist's and one of the social worker's ratings addressed current functioning; the other filled out by the social worker estimated preoperative status as compared to optimal status. The patient was also asked to fill out the Hopkins Scale (HSCL-80), an assessment of current functioning, and the Profile of Mood Scale (POMS), addressed specifically to current mood. A drug questionnaire to assess drug intake and alcohol consumption was also administered. The psychiatrist also gave a global rating of each patient (see appendix).

Social work. The social worker administered several forms: a Social Adjustment Scale (SAS) (see appendix), a measure of pre-postoperative change (from both the patient and the companion or relative); a questionnaire designed to answer specific questions about preparation for the surgery raised in the work scope, derived also from individual interviews of the patient and the companion; two estimates of preoperative function, as compared to the persons optimal functioning, one three years prior and one immediately prior to surgery. The questioning of the control subjects was also suitably modified. Demographic data were also obtained from the records (see form in appendix).

In addition to these, a separate review was made by a psychopharmacological consultant of each patient's records and interviews to assess the nature and quality of preoperative, postoperative and current psychopharmacological therapy (see appendix). The several scales and forms are summarized in Table 3.

TABLE 3 - Scale and Form Summary - Examiners & Source

Measure	By whom administered or scored	Source Patient	Source Companion	Records	Status Evaluate
P.S.S.	Psychiatrist	X			current
P.A.S.	Psychiatrist, social worker (twice)	X	X		current, past
Drug Interview	Psychiatrist	X	X		current, past
Hopkins	Patient	X	X		current
P.O.M.S.	Patient	X			current
S.A.S.	Social worker (twice)	X	X		change
Social Worker Structured Interview:					
a) surgery	Social worker (twice)	X	X		past
b) 3 yrs. pre-op. funct.	Social worker	X			past
c) Immed. pre-op. funct.	Social worker	X			past
Drug review	Consultant (psychopharmacologist)	X		X	current, past

TABLE 3

Psychological Tests. The following procedures, designed to assess a variety of cognitive and motor functions, were administered by qualified psychologists (or in some cases trained technicians) to all subjects: the Wechsler Adult Intelligence Scale (designed to assess current intellectual function), Wechsler Memory Scale (a test which yields a memory quotient designed to be comparable to the IQ), Porteus Maze Test (a measure of visual-spatial and planning abilities), the Wisconsin Card Sorting Test (a test of the capacity to categorize and sort, and to shift set or plan), Benton Visual Retention Test (a test of the accuracy of visual-spatial memory), Continuous Performance Test of Attention (CPT) (a measure of sustained visual attention and vigilance in which the subject is required to press a response lever for certain "critical" stimuli), tapping speed and hand dynamometer (strength of grip).

Neurological Examination. All patients were subject to a routine but thorough clinical neurological examination by a board-certified neurologist. Positive findings were entered on a specially designed form (appendix) which permitted scoring of both individual symptoms and global functioning.

EEG Examination. This consisted of a clinical examination conducted in accordance with the current standards of the American EEG Society and included waking and sleep recordings (if possible), hyperventilation and photic stimulation. The records were read by a board-certified electroencephalographer and then ranked on a 0-4 scale, where

0 = normal

1 = normal + drug induced fast or slow activity

2 = moderately abnormal: excessive slow activity, asymmetry, etc.

3 = abnormal due to presence of spike focus

4 = abnormal due to presence of multiple spike foci.

Special Neurophysiological Techniques. In conjunct ion with the administration of the Continuous Performance Test (CPT), a measure of attention to rapidly-presented visual stimuli, evoked potentials to the task stimuli were recorded from occipital-parietal regions of the scalp. Other techniques included measurement of "expectancy waves" or contingent negative variations (CNV) from various anterior scalp locations and the eye movement (pendulum) procedure of Holzman. In conjunction with the CNV procedure, measurement was also made of reaction time, eye blinks, and heart rate during the examination.

Neurosurgical Evaluation. Copies of all operative records of study cases were sent to a neurosurgeon for his evaluation and comment. Special note was to be made of any complications or unusual operative circumstances that could be adduced from the surgeon's notes.

RESULTS

General Approach. Since the number of cases contributed by any single surgeon was small, we chose to ignore surgery type and instead to classify cases according to outcome. Patients could be classified into four categories: very much improved or "cured"; slight to moderate improvement; no improvement; worse.

Outcome was decided on the basis of the social work interview-questionnaires and an independent interview by the principal investigator. Outcome was evaluated on the basis of the patient's answers to questions such as, "Do you feel you benefitted from the operation?," "How did-you benefit?," "Knowing what effect it had, would you have the operation again?." Answers which led to a classification of "very much improved" or "cured" included: "It saved my life" or "I would be dead now if not for the operation" or "It was like being born again." Other answers, leading to a less favorable outcome classification included, "It helped for a while, but then my trouble started again," or "It was no help," or "I got worse." The majority of the patients, even those with a less favorable outcome, were protective of the neurosurgeon and reluctant to attribute blame to him. The patients' relationship with the surgeon will be discussed later in the report.

For the study cases there were 2 disagreements in the classification of the 27 subjects; in both it was a question as to whether the improvement was very much or moderate. The differences were resolved by discussion and review of the information. Since the number of cases per category would otherwise be too small, the outcome was dichotomized into very much improved or "cured" versus all other outcomes. We have labeled these groups Very Favorable Outcome (VFO) and Less Favorable Outcome (LFO), respectively. This yielded a separation of the 27 operated cases into 14 VFOs and 13 LFOs. The case composition is presented in Table 4. The asterisks in the table denote the ten cases who were found to have had an additional psychosurgical procedure prior to the one which brought them into the study.

TABLE 4 - Outcome Groups

Very Favorable Outcome (VFO) Case No.	Surgeon	Less Favorable Outcome (LFO) Case No.	Surgeon
123	810	109*	810
125	810	122	810
211	810	207	810
103	815	213	810
107*	815	219	810
113*	815	118*	815
124	815	126	804
209	815	217*	804
222*	815	112*	other
104	804	127*	804
224	other	233*	804
220	804	129	804
114	804	203*	804
226	804		

* Indicates patient had prior psychosurgery.

The 27 patients were classified into 14 VFO and 13 LFO cases on the basis of two independent interviews. The classification relfects basically the patient's evaluation of the degree of relief obtained from the symptoms, his or her current status and willingness to undergo the operation a second time.

TABLE 4a - Listing of Surgical Procedures for Each Operated Case

	Orbital Undercut (Bilat.)	Cingulot. (Bilat.)	Amygdalot. (Bilat.)	Subst. Innominot. (Bilat.)	Prefrontal Sonic (Bilat.)	Prefrontal Sonic (Bilat.)	Prefrontal leucot. (Bilat.)	Transorb. leucot. (Bilat.)
VFO (N=14)								
211	1 *							
123	1							
125	1							
209		1	1					
124		1						
103		1						
222		1,2	1					
113		1,2	2	1				
104					1			
226					1			
114					1			
220					1			
224							1	
LFO (N=13)								
219	1							
122	1							
213	1							
109	2	1						
207	1							
118		1,2	2	2				
217						2		1
129					1			
233					1	2		
203					1	2,3		
127					1	2		
126					1			
112							1,2	

* 1=lesion done at first operation
2=lesion done at second operation
3=lesion done at third operation

As an example, case 107 had a cingulotomy in the first operation; in the second operation lesions were made in the cingulum a second time as well as lesions in the amygdala and substantia innominata, all bilaterally.

TABLE 4

Table 5 presents the demographic and certain other descriptive characteristics of the two outcome groups and the control subjects. As can be seen from the table, the two surgical groups are reasonably similar on these measures and do not differ sharply in any respect from the controls. Worthy of note is the fact that there are significantly ($p<.05$) more women in the VFO than in the LFO group, that the patients are all white and predominantly (on the average) middle-aged.

We attempted an analysis of changes in occupational, educational and marital status pre- and postsurgery but it revealed relatively little in the way of change. Two VFO patients resumed their education after surgery and one was married. Three VFO cases improved their occupational level, one retired and the one who was married quit her job. One LFO case improved occupationally and one took a less demanding position after surgery. It should be noted that these educational, occupational and marital variables are commonly used as indices of psychosocial adequacy and adjustment. Their failure to indicate substantial change in this instance may reflect, in part, the fact that 17 of the 27 operated cases are female and most of them OCCUPY a housewife-homemaker role. Changes in this status were rare.

TABLE 5

Psychiatric and social work. Since the various scales and forms (Table 3) administered by the psychiatrist and social worker and self-administered by the patient cover the same ground, it is not surprising that they tend to yield much the same result: the Very Favorable Outcome (VFO) appears healthier

TABLE 5 - Demographic and Other Descriptive Characteristics*
of Two Outcome Grousp and Controls

	VFO (N=14)	LFO (N=13)	Control (N-8)
Age (at testing 4/76)	49 range years (29-69)	48.4 range years (29-67)	45.4 range years (30-62)
Sex	2M, 12F	8M, 5F	3M, 5F
Occupation (pre-surgery)			
Higher exec. or profess-admin. personnel	5	7	6
Clerical - never worked	9	6	2
Education			
Professional training-Some college	7	8	7
High school grad.	7	5	1
Time from 1st symptom to most recent surgery	17.5 (4-45)	22.0 (5-40)	--
Time from most recent surgery to present examination (4/76)	5.3 (2-9)	4.9 (2-9)	--
Time from first symptom to present exam (4/76)	22.4 (10/49)	26.9 (10-47)**	19.4 (12-31)**
Marital Status			
Never married	2	4	3
Presently married (1st)	5	4	4
Presently married (2nd)	1	0	1
Previously but not now (div., widow, etc.)	1	1	0

* All patients were white.
** Data unavailable for one person in LFO and Control group.

than the Less Favorable Outcome Group (LFO). The Hopkins and POMS Scale data tend to support this finding, as well. The VFO appeared significantly "healthier" than either the LFO or control group on the following POMS items: tension-anxiety ($p<.05$), friendliness ($p<.05$) and depression ($p<.05$). The Hopkins Scale revealed greater ($p<.05$) depression and tendency to panic in the LFO and controls than in the VFO subjects and a suggestion of greater schizophrenic tendencies in the LFO cases and controls.

On a number of measures from the PSS and PAS (Table 6) both operated groups appear healthier than the controls. This is true, apparently for impulse control, grandiosity and retardation on the PSS, and for seven of the nine PAS variables in Table 6. In some instances, on the other hand, the LFO group resembles the controls rather closely: behavior disturbance, daily routine and speech disorganization on the PSS; overall severity and depressed mood on the PAS. Significant results were evaluated, usually, by means of a one-way analysis of variance.

TABLE 6

It is of interest to examine the computer diagnosis yielded by the evaluation of the patients' answers to the PSS. Since the PSS was administered by the psychiatrist independently of contact with the social worker or principal investigator, the data so generated provided some support for the patient separation into VFO and LFO classifications. The PSS diagnostic data are presented in Table 7 and they indicate that there were significantly more "normal" (no mental illness) diagnoses in the VFO than in either of the remaining groups.

TABLE 6

Psychiatric and Social Work

Interview

Significant Results

A-PSS Measure	No Illness*	VFO	LFO	Controls	P
			Present Functioning		
Denial of illness	40.0	40.0	45.2	41.1	<.05
Behav. disturb.	41.0	42.8	50.8	59.3	<.05
Impulse control disturb.	45.0	45.3	47.5	52.6	<.05
Grandiosity	47.0	47.0	47.0	54.1	<.01
Retardation	43.0	43.8	48.4	53.5	<.05
Daily routine	37.0	41.7	50.1	53.12	<.05
Speech disorg.	45.0	45.5	51.4	66.4	<.05

*"No illness" score values are derived from the original normative data and indicate no pathology on a particular measure

Higher scores tend toward greater pathology.

B-PAS Measure**

	VFO	LFO	Controls	P
Suicide thoughts	1.0	1.2	2.0	<.01
Obs-compulsive	1.8	1.5	4.1	<.001
Speech disorganization	1.0	1.2	2.1	<.05
Leisure problems	1.4	2.1	2.9	<.05
Overall severity	2.5	4.8	5.0	<.001
Depressed mood	1.9	2.9	3.0	<.05
Suspicion	1.0	1.4	2.1	<.05
Hallucination	1.0	1.0	2.0	<.05
Anger	1.0	1.5	2.3	<.05

**Scores indicate 1-none; 2-slight; 3-mild; 4-moderate and 5=marked.

Underlining denotes disparate group.

TABLE 7

Computer Diagnosis

From

PSS (Present Funct.)

	No Mental Illness	Other Psychiatric Illness*
VFO	8	6
LFO	1	12
Controls	0	8

p for $X^2 < .005$

* A variety of other diagnoses were indicated, including chronic undifferentiated schizophrenia, manic-depressive illness, hysteria, etc.

TABLE 7

The thrust of these findings raises the question as to whether or not the VFO group was less psychiatrically ill to begin with, i.e., presurgery. The PAS scores derived from the patients' and companions' estimates of preoperative functioning suggest that this was probably not the case. Although there was significantly greater ($p<.05$) grandiosity in the LFO cases, there was significantly more ($p<.01$) depression in the VFO cases preoperatively. This latter finding indicates that the VFO group was more depressed than the LFO group prior to the operation, and hence shows a greater improvement after the operation. Several findings bear this out: the PAS estimate of present functioning (Table 6) shows significantly better functioning with respect to overall severity ($p<.001$) and depressive mood ($p<.05$) in the VFO than in the LFO group. In addition, the SAS (assessment of change) Scale, from both the patient and companion as informants indicates greater ($p<.001$) overall change in the VFO than in the LFO group.

Social Work Guidelines Questionnaire. This questionnaire, administered by the social worker to both the patient and the companion, was designed to reveal the nature of the information available to the patient and family and the decision-making process at the time of surgery. This form also sought information about the patient's current feeling about the operation and the question of as to whether or not he/she would undergo the procedure again. Obviously much of the information obtained went into the classification of cases into VFO and LFO groups used throughout this report; however, the issue of risk/benefit communications will be addressed here.

The "typical" picture for a patient will be described as a narrative, with exceptions noted where the VFO and LFO groups differed. Some data from Table 5 are also incorporated.

The patient is a married white female with some college training, who is in her late 40's. Her illness dates back sixteen or more years and she has usually had at least one hospitalization and one course of electroshock therapy. If her illness was classified as pain or headache she received many analgesic and probably narcotic drugs. She has also received tranquilizer and antidepressant drugs, and most often, psychotherapy. The operation suggested or recommended by a psychiatrist, usually, and was described to her in at least superficial terms. Moderate benefits were promised by the surgeon and expected by the patient. No promises were made concerning exactly when the benefits would be forthcoming. The surgical risk was explained as minimal to none (slightly more ($p<.05$) recall of risk in the VFO group) and the patient was told that she would probably not be made worse, nor would her intellect suffer.

There seemed to be no alternative to surgery at the time it was being considered, and usually no other types of psychosurgery was discussed. The patient and the other informant-generally felt free to question the surgeon virtually *ad libitum.* The patient herself (usually with input from spouse or family) made the decision to have the operation. Three of the LFO cases (only) reported (or recalled) some family disagreement as to whether to have the surgery. However, there was little pressure from family members or other sources. If improvement came, it was within a year or less. (Note here that both the patient and the other informant see significantly more (p<.001) overall beneficial change if she is a member of the VFO as opposed to the LFO group. This highly significant difference comes through in every change measure). There are few if any regrets expressed, although more (p<.05) of the informants of LFO cases (6 of them) express regrets than the informants of VFO cases (only one). The VFO case would almost unequivocally have the operation again, but there are more reservations and qualifications among both the patients and informants of the LFO group.

Since this is a description of the "typical case," it fails to indicate the variability in some of the measures. However, this narrative would apply in large measure to most of the patients. A difficulty with the description concerns the remembered interaction with the surgeon at the time of preoperative evaluation. Many patients report being so ill (including being so heavily medicated) at the time that they have faulty or little recall of what the surgeon told them. Often the patient describes having been desperate for help and as having been willing to accept any risk if there were some chance for relief. This datum tends to agree with the surgeons' reported experience noted in the Introduction and relates to our problems in obtaining persons for whom the operation was recommended but declined.

Another imponderable complication is this narrative concerns the fact that 10 of the 27 operated patients had a prior experience with psychosurgery; in seven cases this was with the same surgeon who performed the procedure of concern in this study. Presumably there must have been at least partial, if temporary, relief afforded by the earlier operation, and some of the material in the interviews attests to this. The effects of this earlier experience on patient and informant attitudes are difficult to assess, since it is not clear whether it tended to result in more positive or negative expectations.

Evaluation of other therapies. A thorough and detailed analysis of this question is impossible, either because of incomplete records or faulty memory on the part of patient and informant. Consequently, the precise dosages of drugs, length of treatment (either pharmacological or psychotherapy) the exact number of hospitalizations, numbers of ECS treatments, etc. were often unavailable. Nevertheless, most patients had trials with many other psychiatric treatments prior to psychosurgery over the 17-22 years (on the average) that they suffered from their illness prior to psychosurgery. This includes: minor tranquilizers, major tranquilizers, antidepressants of various types, sedatives, lithium, stimulants, analgesics and narcotics for pain, hospitalization with or without insulin coma or electroshock therapy, intermittent, regular or intensive psychotherapy and miscellaneous other treatments. It should also be noted that 3 of the VFO and 7 of the LFO cases had prior psychosurgery; one of the latter had two prior procedures. Significantly ($p<.05$) more VFO than LFO cases took MAO inhibitors (antidepressent) presurgery. So far as the current drug treatment status of the three groups is concerned, Table 8 summarizes the information.

TABLE 8

The table indicates that the least medicated group is the VFO patients, and that there was relatively little difference between the LFO and control subjects at the time of our examination.

TABLE 8

Current Drug Status of Three Groups

No. persons/group taking a given type of drug

Drug Type	VFO N=13	LFO N=12	Controls N=7
Anticonvulsants*	3	3	0
Major tranquilizers	2	3	3
Minor tranquilizers	3	4	2
MAO inhibitors (antideprs.)	0	1	0
Tricyclics (antideprs.)	2	2	1
Lithium	0	2	5
Mean no./persons	0.77	1.25	1.57

* Dilantin (an anticonvulsant) is usually given to patients post-psychosurgery as a prophylactic measure for at least one year. All of these patients are at least one year postoperative, however. Data from three patients were unavailable.

TABLE 9

Psychological Test Scores

	VFO N=14	LFO N=12	Controls N=7	p Value
Wechsler Adult Intelligence Scale				
Verbal IQ	117.5	109.9	108.9	--
Performance IQ	111.1	103.1	99.4	--
Full Scale IQ	115.8	107.4	105.4	--
Wechsler MQ	119.5	101.8	111.3	--
Wisconsin Card Sorting				
Persev. errors	29.9	24.1	7.0	<.05
CPT				
Errors of commission	6.6	33.4	15.7	<.05
Benton-Vis. Ret.				
Persev. errors	0.1	0.8	1.1	<.05

TABLE 10

WAIS Scores, Pre-Post Changes

	VFO*	LFO	Total
N	6	5	11
Preop FS IQ	111.7	104.0	108.2
Postop FS IQ	116.2	111.6	114.1
_p_ value of _t_ test	not signif.	p<.001	P<.05

* Three subjects obtained higher and three lower scores postoperatively.

Psychological tests. The majority of the scores yielded by the battery of tests indicated no significant differences among groups. The only significant differences that were found are presented in Table 9.

The individual significant findings must be viewed cautiously, since so many comparisons were made, However, the findings can be interpreted as follows: the perseverative error on the Wisconsin Card Sorting Task indicates a tendency to continue to sort the stimulus cards according to a previously correct sorting scheme (i.e., color, form or number), and to fail to shift when the examiner's response indicates that the prior scheme is now incorrect. Both operated groups appear to make large numbers of errors (slightly more in the VFO) suggesting some inability to adapt easily to the test requirements. The CPT error of commission reflects a tendency to respond inappropriately (and possibly impulsively) to non-critical stimuli in this vigilance-type task. The significant result here appears to be due to the poor performance of the LFO group. On the Benton task, the perseverative error is a measure of the person's tendency to repeat portions of a previously-presented stimulus card. The LFO and control groups appear to make more errors of this type.

TABLE 9

In addition, Table 9 presents some descriptive intellectual data. Two general characteristics appear: the VFO group is somewhat brighter than the other two groups, although not significantly, and has somewhat higher memory functioning. Also, all groups tend to have higher verbal than performance IQs and memory. For 11 subjects, preoperative IQ test scores were available. A comparison was made of the amount of changes in the VFO and LFO groups taken separately and combined. These data are presented in Table 10.

TABLE 10

The data of Table 10 indicate an overall improvement in Full Scale IQ pre-post ($p<.05$), but this is contributed primarily by the LFO group, all of whom showed an increase in Full Scale IQ. In the VFO group three patients improved and three obtained worse scores postoperatively.

Neurological and EEG examination. No significant differences were found in neurological status between the two outcome groups. Positive neurological findings were in fact rare and almost invariably attributed by the neurologist to other disease processes. Nor were differences seen in the average degree of EEG pathology among the three groups. Four subjects in the VFO group had EEG which was not considered normal, two of which showed a spike focus. The others were normal or showed changes attributable to medication. The LFO group contained three subjects with abnormal EEGs, one of which showed multiple spike foci. The others were normal or showed possible evidence of drug related changes only. No spike foci were seen in the control group, although the EEG in three of the subjects was classified as at least borderline abnormal. The remaining subjects showed possible drug related changes or were normal. At this writing, seven presurgical EEGs have been located. Four subjects have EEGs classified as normal at both pre- and postsurgical examinations; one with a postsurgical spike focus shows a focus presurgery; one subject with a moderately pathological EEG presurgery shows a less abnormal record postsurgery. In one subject only was there evidence that a normal EEG presurgery became moderately abnormal postoperatively, The number of cases is too small to indicate whether any particular operation is associated with risk of developing a pathological EEG. Nevertheless, it can be noted that in the three subjects in this report who have had an additional psychosurgical procedure prior to the one of interest in this report, one had a normal EEG (following transorbital leucotomy plus prefrontal sonic lesion), one shows evidence of possible drug-induced changes only (following cingulotomy plus orbital undercutting) and one shows a moderately pathological record (following cingulotomy plus a multiple target stereotaxic procedure). One additional note: four of the thirteen subjects in the LFO group were left-handed, whereas only one of the fourteen subjects in the VFO group was left-handed.

Special Neurophysiological Techniques

Visual Evoked Potentials (VEP). VEPs to the CPT task stimuli were examined in 12 VFO, 11 LFO and 6 control subjects. The VEP is considered an electrical index of the way in which the brain processes visual information, and has been studied in may psychopathological and neuropathological groups. Although our available data are not completely analyzed as yet, there is evidence of a significantly higher amplitude component in the VEP from the occipital region of the head (at about 200 msec post stimulus) for the VFO group. The LFO and control groups do not appear to differ in this region.

Contingent Negative Variation (CNV). The contingent negative variation (CNV) information was examined in 11 VFO, 8 LFO and 6 control subjects. The magnitude of this event-related electrical brain signal is considered to be an accurate index of alertness in the normal person and it has been studied in psychiatric illness as well as in some brain damaged persons. The following will serve to summarize what appear to be the significant findings from the CNV and certain other psychophysical variables at this time.

The amplitude (voltage) of the CNV waves was significantly largest in general, in control subjects, next largest in VFO cases and smallest in LFO cases. This was true for the more central and relatively posterior scalp locations sampled. For the frontal area, on the other hand, the VFO subjects had the smallest CNVs of the three groups. The disparity between the frontal and other CNVs may indicate some electrophysiological sign of impaired cognitive processing of information in the VFO group. Measurement of reaction time indicated no statistically reliable differences among the groups. The heart rate measure (thought to be related to anxiety or arousal level) was lowest (although not significantly) in the control group. The eye blink measure (also thought to reflect anxiety) was significantly higher in the VFO and LFO groups than in the control cases.

Discussion. This project was conceived as a pilot study addressed to two specific issues: to determine the feasibility of a retrospective approach to studying change ("efficacy and safety") in psychosurgery, and if possible, to contribute some information relating to the benefits and/or hazards of psychosurgery. We will discuss the second issue first.

Benefits and/or hazards of psychosurgery. From a consideration of the results of our study, it is apparent that 14 of the 27 subjects in our sample (the VFO group) have derived considerable benefit from the procedure. It should be noted that our division of cases into VFO and LFO groups is more rigorous and strict than the usual evaluation as published in the psychosurgical literature. Had we included those with slight to moderate benefit the proportion of "improved" cases would have been 21/27 or 78%, which is in agreement with at least some of the published studies. However, our dichotomy appears to have substantial validity, as evidenced by the patients' own (and their relatives') statements in several interviews, the standardized psychiatric and other interview material, the self-rating scales, their relatively low usage of psychotropic drugs and their general willingness to undergo the procedure a second time. That this may be a relatively permanent change in their behavior is attested by the fact that five years (on the average) have elapsed from the date of surgery to our examination.

On the other hand, the other thirteen cases of the sample (the LFO group) had outcomes ranging from worse to only moderate benefit. On a number of measures (Table 7, overall severity in Table 6) it is difficult to distinguish the LFO cases from the controls. These subjects (and the informant-family members) express more reservations about undergoing the procedure again. In this connection, we note that ten of the 27 cases had had an operation prior to the one which brought them into the study. In both groups of subjects the decision to undergo the procedures seems to have involved at least a fair degree of interaction and discussion with the surgeon and the psychiatrist or other physician who recommended it initially. The period of time over which the subjects suffered from some psychiatric illness ranged from 4 to 45 years (for the operated group as a whole) and since the mean is over 17 years (Table 5) it does not appear likely the decision even to contemplate the surgery would be considered premature. We will return to some of these considerations later in the discussion.

What can be gleaned from these data concerning the presurgical characteristics of persons who had a very favorable outcome? The following characteristics emerge which may possibly merit further evaluation: the VFO group shows greater evidence of depression or depressive symptomatology preoperatively than the LFO group and this is the symptom which appears to change most with surgery (interview data). The only other characteristic which emerges is an indication of less grandiosity in the VFO group, possibly an index of less schizophrenic-like pathology in this group. Also, significantly, more of the VFO than the LFO subjects were female (12 of 14 vs 5 of 13); the VFO group tends (although not significantly) to be somewhat brighter postoperatively than the LFO group and presumably this was true prior to surgery as well. Some preoperative IQ data support this. Only one of the VFO patients as compared with four LFO patients, were left-handed.

There are some postsurgical characteristics of the subjects who had major benefit that merit comment, but the picture which emerges, is by no means entirely consistent. The VFO cases show greater evidence of what might be viewed as cognitive loss: (1) there is a trend for VFO patients to make the most perseverative errors on the Wisconsin Card Sorting Task, despite the fact that they appear somewhat brighter and appear to have a somewhat better memory (Table 9). This measure of the ability to shift "set" in a flexible way has been shown to be sensitive to frontal lobe damage (Milner, B. Effects of different brain lesions on card sorting. _Arch. Neurol.,_ 9:90-100, 1963); (2) the VFO subjects do not show as a group the highly significant rise in IQ seen in the LFO group, presumably due to practice and/or amelioration of psychiatric illness; and (3) on the CNV measures from frontal locations, there is some indication of reduced capacity to show the usual cerebral electrical activity in relation to response-contingent stimulus events.

Not all of the findings conform-to this pattern of greatest "deficit" in the VFO group; the error scores on the measure of visual attention (CPT task) suggest that the least accurate (and possible most impulsive) performers are in the LFO group, followed by the controls, with the VFO group being most superior. Nevertheless, the findings which are summarized above suggest that the VFO group is performing in certain ways below the expectation created by their somewhat higher IQ compared with the LFO cases.

These speculations raise the possibility that recovery from the severe and crippling psychiatric illnesses from which these patients suffer may in some cases be made at a price - the loss of certain cognitive capacities. And in some way, this loss permits the patient to function in a more effective and less troubled way. It also follows that recovery is less likely to occur if some cognitive loss is not sustained. Further examination of this hypothesis (which cannot be considered to have robust support in these data) could be the subject of further studies. For the present, the following set of case histories and psychological test reports are presented since the postoperative characteristics of the two operated cases seem to offer some rough and partial clinical validation of the hypothesis. The first case, classified as VFO, apparently shows some striking cognitive lacunae. The second case, classified as LFO, apparently does not. The third case, a control, is included for purposes of comparison.

The Feasibility of a Retrospective Study of Psychosurgery. Our experience with this problem leads to the conclusion that retrospective studies are indeed feasible, but that they have certain clear limitations (and advantages) some of which we did not anticipate.

After some initially disappointing contacts with surgeons, we were able to make extremely satisfactory arrangements to obtain patients, and are literally in the position now of having several hundred additional cases that could be studied. The neurosurgeons were extremely cooperative and made their records open and available to us. Efforts to verify or cross-check the surgeon's list with the hospital record of operationswere usually (to this writing) unsuccessful. This is apparently due to the slowness and/or recalcitrance of the administrative personnel of the hospital to release the information and not obviously because of the surgeon's wish to conceal data. Indeed, the only hospital operating room list we have so far obtained came after strong input from the surgeon to the hospital administration. Another was extremely angry when told the hospital had not replied to the request.

Any study design or plan that required the surgeon to serve merely as a passive supplier of names and addresses would appear unlikely to succeed. We learned that many of the cases (including those whom we classified as VFO) called the surgeon (or in some cases their psychiatrist) to ask whether or not they should participate. One of the surgeons had in fact modified the original permission letter (appendix) because he thought it too cold and impersonal. Another added a personal note to each letter. The effort supplied by the surgeons in recruiting cases and in donating their time would, in ordinary scientific-medical publications, require that they be coauthors of this communication.

Control subjects, for reasons discussed in the report, are more difficult to obtain. However, given adequate time (the commodity we did not possess) suitable persons could be obtained and matched carefully with the experimental group (i.e., the operated cases). Such a design (several of them in fact) was planned by us but had to be essentially abandoned because we did not always have the luxury of rejecting cases that did not fit our experimental plan. The fact that our groups are as closely matched as they are indicates that we did exercise some selection (and perhaps also reflects some divine intervention). Nevertheless, the apparently necessary input by the surgeon leaves the possibility open that he might have (intentionally or unintentionally) biased the sample by and with his communication with patients, i.e., putting more pressure to participate on those who had what he considered more favorable outcomes. Although this is a possibility that cannot be dismissed, it is not our impression. Moreover, the refusal rate in general appears to be low.

A major benefit which a retrospective study cannot share with a prospective study is the chance to study the same individual pre- and postsurgery. This is a serious problem, particularly (for example) in view of the hypothesis that we are offering, tentatively, concerning cognitive loss being somehow necessary (in some cases) for psychiatric recovery. Testing this hypothesis would require careful assessment of cognitive capacity (to the extent that it can be measured in sick, distressed persons) prior to the surgical insult. No retrospective study can do this, and our attempts to estimate preoperative function are probably only partially successful. The stress surrounding the period when the operation was being discussed probably interferes with the effective recall of events, particularly by the patient. As noted, many patients report this.

<u>Comment:</u> The fact that some patients eventually have psychosurgical treatment is probably a function of the limits of current psychiatric knowledge, or at least of the application and utilization of available knowledge. The resort to the surgeon in medicine, generally, means that there are no satisfactory

treatment alternatives available which are less drastic. One of our surgeons put it succinctly when he noted that he saw only psychiatry's failures, and none of its successes, on the operating table. That some mentally ill patients apparently benefit from brain intervention is a complicated and interesting phenomenon; that direct intervention into the brain is considered necessary in some patients is no less interesting and a vastly more complicated phenomenon.

SUMMARY

Under the auspices of the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, a pilot study was undertaken to investigate the feasibility of a retrospective investigation of the efficacy and safety of psychosurgery and to contribute some information concerning the benefits and/or hazards of psychosurgery.

To accomplish this, a study was made of a group of 27 persons who received psychosurgical operations during the period 1965-1974. In addition, a group of eight unoperated control persons, with psychiatric illnesses similar to those of the operated cases, was also studied. All but two of the operated patients were provided through the cooperation of three neurosurgeons. All cases were evaluated by a team of investigators from Boston University Medical Center and Boston State Hospital. The team included psychiatrists, psychologists, social workers, neurologists, electroencephalographers, and other experts in the area of psychiatric and neurological research and practice.

The primary symptoms of the majority of the patients included depression or affective illness, obsessive-compulsive behavior, phobias, acute anxiety

and chornic pain. These symptoms were usually present in varying combinations and were accompanied in some cases by a diagnosis of schizophrenia. The patients were on the average in their late 40's, had had their symptoms on the average of 17-20 years and had received a large variety of other psychiatric therapies (usually with little or no lasting benefit) before undergoing surgery. The prior treatment included other psychosurgical treatment in 10 cases. Of the 27 operated cases, 17 were female and 10 were male; all were white.

We conclude the following:

1. The large majority of patients were adjudged to have had adequate preparation by and discussion with the surgeon before the operation, including a fairly adequate review of the risks and benefits.

2. Fourteen of the cases were adjudged to have had a very favorable outcome; this we determined on the basis of subjective relief of symptoms as reported by the patient and a spouse, family member or close friend, and was supported by the results of independent psychiatric and sociologic evaluations. This very favorable outcome was not accompanied by detectable neurologic deficit.

3. Thirteen of the cases had less favorable outcomes varying from slight or moderate benefit to worse (two cases). Their symptoms were ameliorated temporarily or only to a slight degree by the surgery. However, there was no significant evidence of neurological deficit attributable to the operation.

4. The results suggest that the symptom of depression was especially amenable to psychosurgery in these patients, and that the greatest change in those with very favorable outcomes was in that symptom.

5. There was no evidence of overall cognitive or intellectual deficit attributable to the psychosurgery, although this is difficult to assess considering the distressed state of the patients prior to surgery.

6. The study also suggests that retrospective research on this problem is feasible, and that further study may help to illuminate the question of which patients may receive benefit from psychosurgical intervention.

Additional Electrophysiological Studies

Electrical Brain Activity (Contingent Negative Variation) and Related Neuropsychological Functions

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The aim of psychosurgery is to relieve emotional distress by altering the structure and function of the human brain. One method that has been useful over the years in assessing changes in brain functioning is that of measuring electrical brain waves or electroencephalography (EEG). The EEG technique provides a noninvasive approach to localizing, within broad areas, changes in brain functioning that underlies behavior.

Of particular value in the assessment of brain-behavior functions has been the event-related slow potential, contingent negative variation or CNV,[3] so called because it appears as a negative-going shift in the EEG baseline that depends upon the contingency or association of two events (see Figure 1).

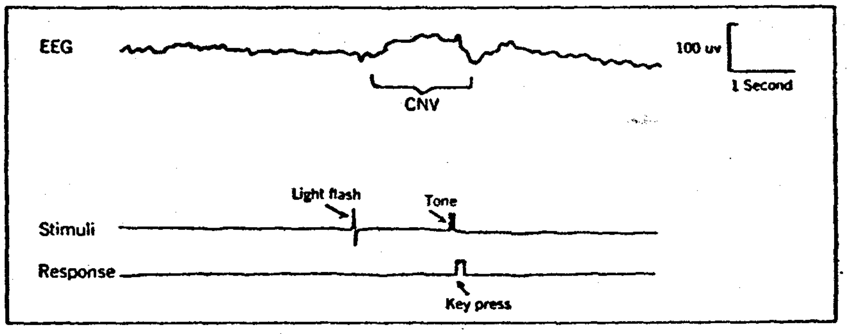

Fig I.– *Example of contingent negative variation (CNV) in the raw EEG trace. CNV is the upward shift in EEG baseline occurring between light and tone. For all figures, scalp placements are vertex (Cz) and the right mastoid; relative negativity at Cz is upward.*

The first event is a preparatory signal (first stimulus) that tells an individual to get ready. The second event is an imperative signal (second stimulus) that tells the person to do something, for example, press a button. As can be seen in Figure 1, when a light flash (first stimulus) is followed in 1.5 seconds by a continuous tone (second stimulus), which is terminated by the patient's key-press, CNV appears as a surge in the EEG baseline that shows a rise-fall sequence between the two stimuli (events).

In an attempt to understand the psychological meaning of CNV, we carried out a review of the literature and came up with an explanation of CNV development in terms of how well people attended to preparing a response to the second stimulus.[4] Based on the assumption that the inability to resist distracting thoughts from information overload is a principal attribute of psychopathology, we recently carried out a series of studies to assess the sensitivity of CNV in reflecting attention impairment produced by distraction. Our finding was that distraction produced a disruption in CNV development (lowered CNV amplitude or height).[5,6] Since the reduction in CNV amplitude was accompanied by slowing of speed of response to the second stimulus as well as heightened levels of heart rate and eyeblink rate, we interpreted the distraction-produced disruption in electrical brain activity, as reflecting a distraction-arousal coupling and as being associated with cognitive and emotional distress (distraction-arousal hypothesis).[7]

It is our general objective in the present project to evaluate cognitive processes and emotional distress in psychiatric patients who have received psychosurgery and those who have not. Within this broad goal, we specifically intended to describe psychosurgery patients differing in therapeutic outcome from brain surgery and control (non-operated) patients in terms of electrical brain activity (CNV) and related psychophysiological functioning (heart rate and eyeblink frequency) and attention behavior. Of particular interest was the comparative evaluation of CNV development in frontal regions of the brain (areas most apt to be affected by surgery) and in nonfrontal regions (areas least likely to be affected by the operations).

METHODS

Patients. We tested 26 of the 35 patients seen in the main study: 20 psychosurgery and 6 control patients. The age range was 29 to 69 (average age: 49.42). Twenty-two patients were right-handed and four left-handed. Mean WAIS Full Scale IQ was 113.46 (SD = 13.81). Based on interviews by a psychologist and social worker who reviewed the patient's present emotional adjustment and his own judgment of the effects of surgery, the 20 psychosurgery patients were grouped into 11 patients having a more favorable therapeutic outcome from surgery and 9 patients having a less favorable outcome. Table 1 presents basic information on the psychosurgery outcome groups and control patients for sex, age, IQ, and handedness. The patients evaluated in the CNV study are listed in Table 2. The 20 operated patients received three types of surgery, which, broadly defined, are: orbital undercutting (six patients); prefrontal sonic treatment (nine patients); and multi-target lesions in cingulate gyrus, amygdala, and substantia innominata (five patients). Evaluation of CNV by surgery-type will be reported on at a later date.

Procedures. As previously shown in Figure 1, the basic test procedure involves the presentation of a light flash which serves as a get-ready signal (first stimulus) followed in 1.5 seconds by a continuous tone (second signal or stimulus), which the patient is instructed to terminate by a key press. The light flash is a cue provided to produce anticipation of the tone (CNV occurs during anticipation of the tone) and facilities preparation for response to the tone. The speed of response is the patient's reaction time, which is a measure of general alertness. The sequence of light-tone-key press is considered a single test trial. Sixteen test trials makes up a test run, which lasts about four minutes.

In order to provide a description of electrical brain activity over a variety of frontal and nonfrontal brain areas, we selected for mapping CNV development eleven recording sites on the scalp according to the international (10-20) system of electrode placement. Monopolar recordings were made with reference to linked earlobes. Three montages (run either once or twice each, depending on the availability of time for the individual patient) were used: (a) F7, F3, Fz, F4, and F8; (b) T3, C3, Cz, C4, and T4; and (c) Fz, Cz, Pz, F3, and F4. Test runs _a,_ _b,_ and _c_ were given in counterbalanced order where possible. Figure 2 shows scalp locations of the eleven CNV recording sites. Five sites have been artitrarily classified as frontal (F7, F3, Fz, F4, and F8) and six sites nonfrontal (T3, C3, Cz, C4, T4, and Pz).

Heart rate (recorded at sternum and lower left chest) and eyeblinks (recorded from above and below the right eye) were recorded during CNV test runs. CNV amplitude is measured by the height of voltage excursion occurring between the light flash and tone relative to EEG baseline (see Figure 1).

Following the CNV test runs, the patient was administered the Continuous Performance Test (CPT) of attention,[8] which consists of a series of rapidly occurring visual letters to which the patient is required to make a key press when he sees the letter "X" (which occurs randomly 20% of the time). Whereas reaction time in the CNV tests is based on speed of response following a preparatory signal, the CPT requires sustained vigilance without the benefit of a warning cue. The time to respond to the letter "X" is a measure of discrimination latency and sustained attention.

Treatment of data. Independent _t_ tests were used to evaluate the reliability of differences among more favorable and less favorable outcome groups

Table 1

Patients Classified into Therapeutic Outcome and Control Groups

	n	Sex Groups (M/F)	Hand Dominance (R/L)	Mean Age	Mean WAIS IQ
More Favorable Outcome	11	2/9	10/1	49.91	117.64
Less Favorable Outcome	9	5/4	6/3	49.78	106.56
Controls	6	2/4	6/0	48.00	116.17
Totals	26	9/17	22/4	49.42	113.46

Table 2

Classification of Patients in Therapeutic Outcome and Control Groups

	More Favorable Outcome	Less Favorable Outcome	Controls
	104	109	401
	107	112	404
	114	118	416
	123	122	420
	124	126	423
	125	129	523
	209	203	
	211	217	
	220	219	
	222		
	224		
Total Number	11	9	6

and controls. Correlated _t_ tests were used to evaluate mean differences between frontal and nonfrontal CNV within each of these groups. Degrees of freedom are generally based on 10 more favorable outcome patients, 9 less favorable outcome patients, and 6 controls. These number are 9, 6, and 6, respectively, for CNV analyses, since one more favorable outcome patient and three less favorable outcome patients had an excessive number of eyeblinks that precluded accurate CNV measurement.

Results and Comments

The two surgery and control groups of patients were evaluated for electrical brain activity (CNV amplitude), attention behavior (reaction time and CPT latency), and psychophysiological arousal level (heart rate and eyeblink rate).

Electrical brain activity (CNV). As shown in Table 3, the more favorable

Table 3

Number of Recording Sites Showing
Higher Mean CNV Amplitude for More Favorable
and Less Favorable Outcome Groups

Patient Groups	Recording Sites		
	Frontal	Nonfrontal	Totals
More Favorable Outcome	2	5	7
Less Favorable Outcome	3	1	4
Totals	5	6	11

STANDARD INTERNATIONAL (10-20) ELECTRODE PLACEMENT

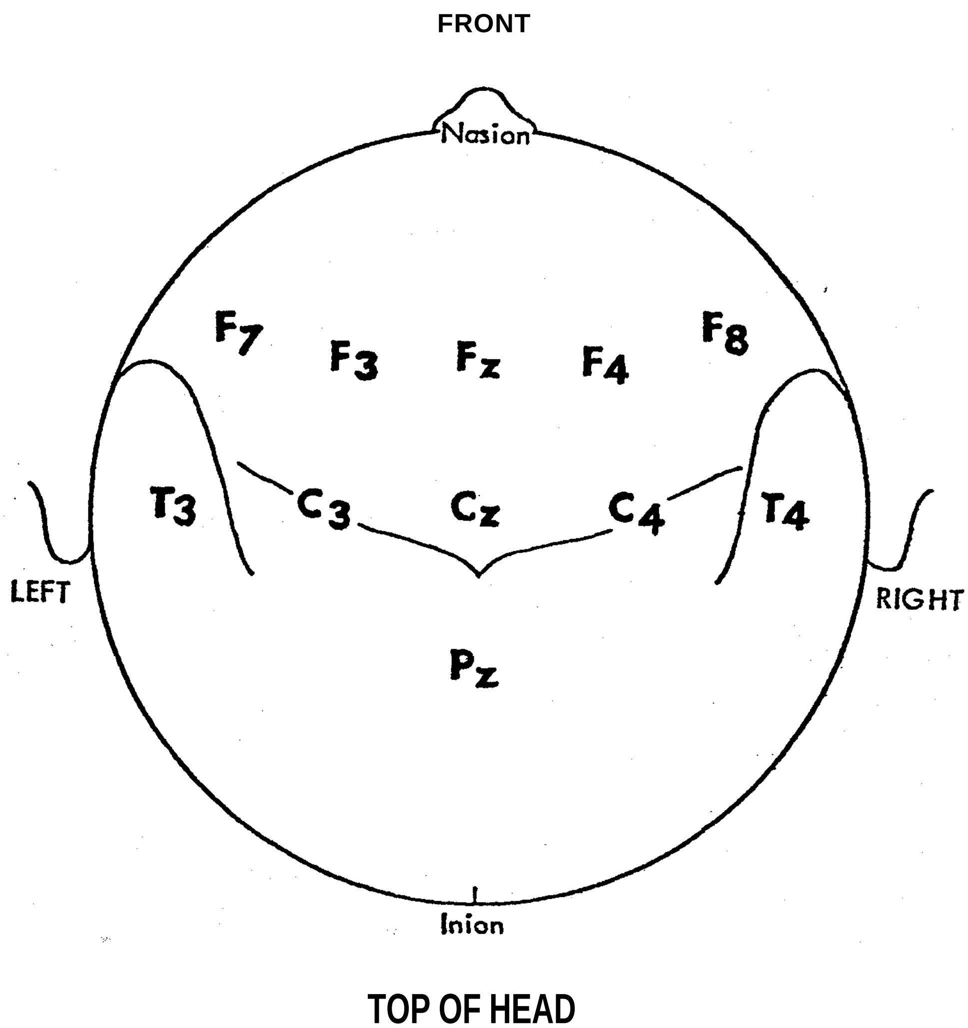

Figure 2. Eleven scalp locations used to evaluate electrical brain activity (contingent negative variation) in sixteen psychosurgery and six control (non-operated) patients. The method of determining electrode placements is the international 10-20 system.

outcome group has higher CNV amplitudes than the less favorable outcome group for 7 of the 11 recording sites (5 out of 6 nonfrontal locations and 2 out of 5 frontal locations). The control group has higher mean CNV amplitudes than either surgery group for all 11 recording sites. Representative locations for frontal and nonfrontal locations were selected to provide comparative evaluations of CNV development along the midline (Fz, Cz, and Pz -- see Figure 2). The upper part of Table 4 indicates that the more favorable outcome group tends to have higher (but not statistically significant) CNV amplitude for central (Cz) and parietal (Pz) areas of the brain and lower CNV amplitude for the frontal area (Fz). The control group had higher ($p<.05$) CNV amplitude than either surgery group for the Fz site and tended to have higher CNV amplitudes for Cz and Pz as well. Figure 3 shows a clear pattern of ordering of CNV amplitude from highest in the control group, next highest in the more favorable outcome group, and lowest in the less favorable group for central and parietal brain sites. Also clear in Figure 3 (and Table 4) is the tendency for selective reduction in CNV amplitude for the frontal (Fz) recording site for the more favorable outcome group.

Figure 4, indicates that whereas there is significantly larger ($p<.05$) CNV amplitude in frontal (Fz) than nonfrontal (Pz) locations for more favorable outcome and control groups, there is no Fz-Pz difference for the less favorable Outcome group (note for this group the similarity in height for the two bars representing Fz and Pz in the right-side of Figure 4).

Comment. The findings on CNV amplitude indicate that the more favorable outcome group tends to show more robust electrical brain activity than the

Table 4

Comparison of Means of CNV Amplitude, CPT Latency, Reaction Time, Heart Rate, and Eyeblink Rate for Patient Groups

			Patient Groups		
			More Favorable Outcome	Less Favorable Outcome	Controls
Electrical Brain Activity	CNV Amplitude (uv)	Frontal Area	2.31*	4.22*	8.87
		Central Area	11.14	7.63*	17.94
		Parietal Area	7.53	5.28*	13.60
Attention Performance	Reaction Time (msec)		388.90	399.20	372.70
	CPT Latency (msec)		590.90	668.00	590.25
Psycho-physio-logical Functions	Heart Rate (BPM)		77.12	78.98	73.31
	Eyeblink Rate (bpm)		27.33*	35.43*	15.57

* Significantly different from controls

— Designates more efficient cognitive functioning and lower levels of emotional distress for more favorable outcome group compared to the less favorable outcome group less favorable outcome group for central and posterior brain areas but that the more favorable outcome group has a selective reduction in CNV development in frontal regions of the brain. We interpret the frontal CNV deficit in the more favorable outcome group as reflecting a cognitive deficit resulting from surgery that may be a necessary condition for psychosurgery to be therapeutic. Too much thinking can cause emotional distress. Frontal lobe surgery may reduce emotional distress by muting cognitive activity. This hypothesis was discussed by Dr. Mirsky in the main report and has been supported by other psychosurgery investigations.[9]

The finding that the less favorable outcome group shows reduced differentiation in CNV development between frontal and nonfrontal areas (the normal pattern is significantly higher CNV amplitude in Pz than Fz) suggests that one aspect of the emotional distress of this patient group is a defective interrelationship among functions of different brain regions.

Control (nonoperated patients) showed higher levels of brain functioning (higher CNV amplitude) than either surgery group. The superiority of the control group was clearest in the frontal brain area. This finding probably reflects the alteration in brain tissue produced by neurosurgery as well as the efficacy of drug treatment in maintaining normal attentive functions in control patients. In this regard, CNVs of two control patients (423 and 523) who showed hyper-attentive behavior (paranoid and obsessive symptoms) were among the highest in magnitude ever recorded in our laboratory over the past six years (over 300 normal and psychiatric patients tested). We concluded from these findings that CNV amplitude is a sensitive and accurate indicator of tissue alteration produced by psychosurgery and that it reflects attention functions.

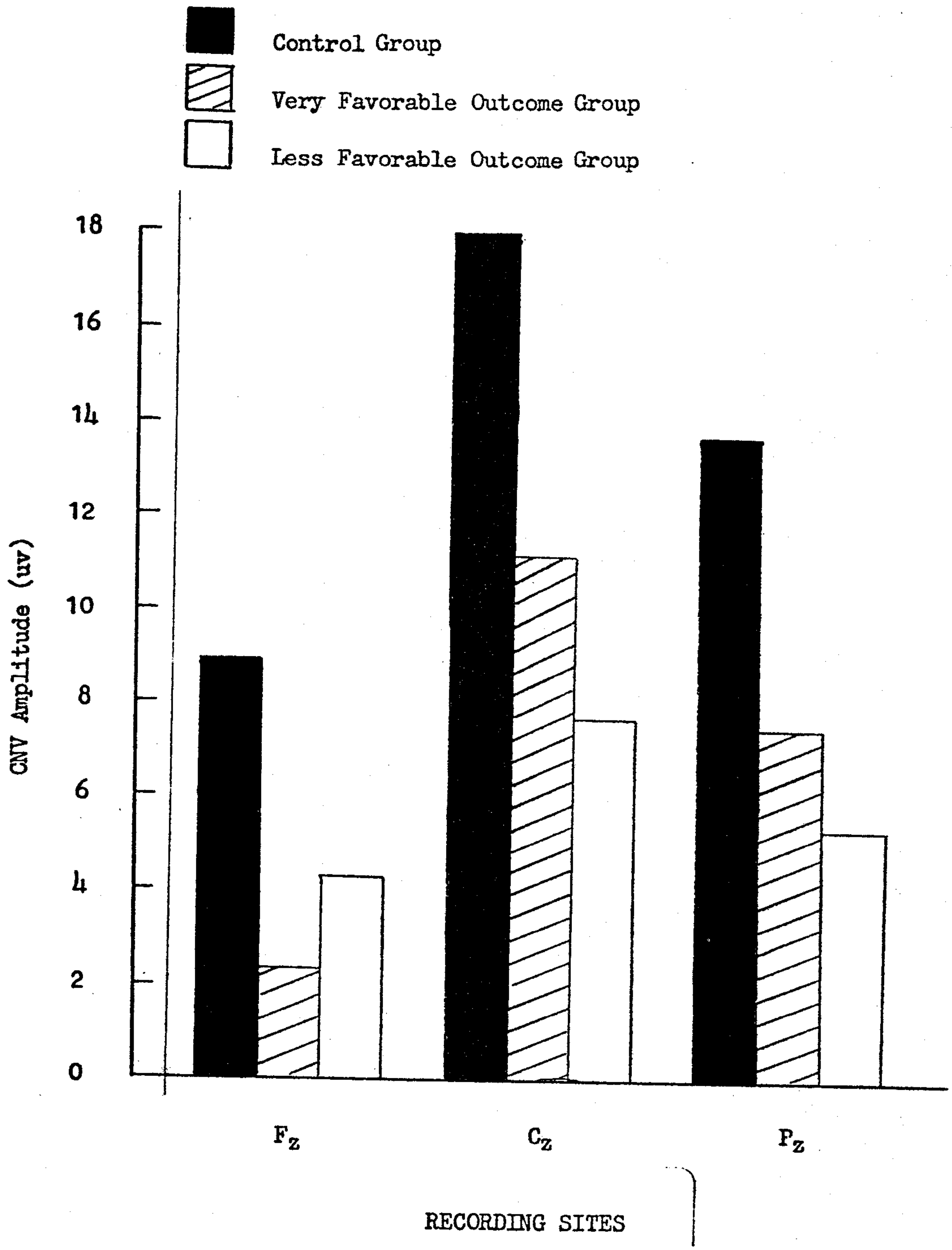

Figure 3. Mean CNV amplitude for frontal (Fz), central (Cz), and parietal (Pz) recording sites of the three patient groups.

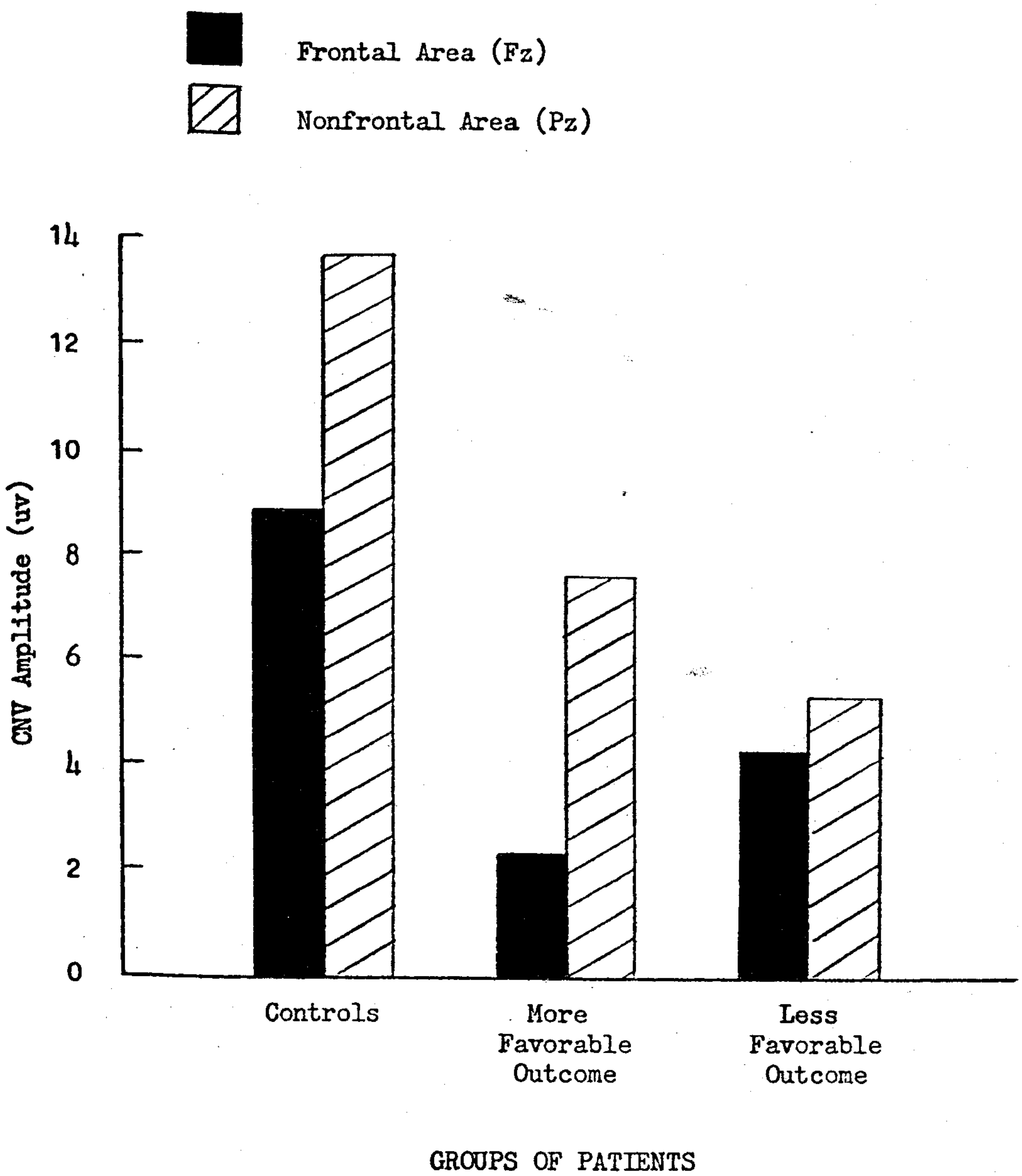

Figure 4. Mean CNV amplitude for frontal (Fz) and nonfrontal (Pz) recording sites of the three patient groups.

Attention performance. The middle section of Table 4 and Figure 5 shows that the less favorable outcome group tended to have slower latencies on the CPT and that the direction of the difference with both reaction time and CPT latency was that of faster response speed for the more favorable outcome group. Although none of these differences was statistically significant, the pattern of ordering for speed of response on reaction time and CPT latency was fastest for controls, next fastest for the more favorable outcome group, and slowest for the less favorable outcome group.

Comment. The pattern of findings for reaction time and CPT latency, although lacking statistical significance, indicates that the more favorable outcome group tended to show somewhat better attention performance than the less favorable group. Since the more favorable outcome group tended to show a frontal CNV deficit and faster motor response, it appears that optimal frontal brain functioning may not be necessary for satisfactory attention functions. The point of this finding for psychosurgery seems to be that the tissue damage in the frontal areas of the brain produced by some operations simply may not cause abnormal attention functions.

Psychophysiological arousal levels. The lower part of Table 4 and Figure 6 indicates that the more favorable outcome group tends to have a slightly lower heart rate and eyeblink rate than the less favorable outcome group and that the control patients tend to be lower in heart rate and eyeblink rate than either surgery group. The blink rate for controls is significantly lower than for the less favorable outcome group ($p<.05$) and for the more favorable outcome group ($p<.10$).

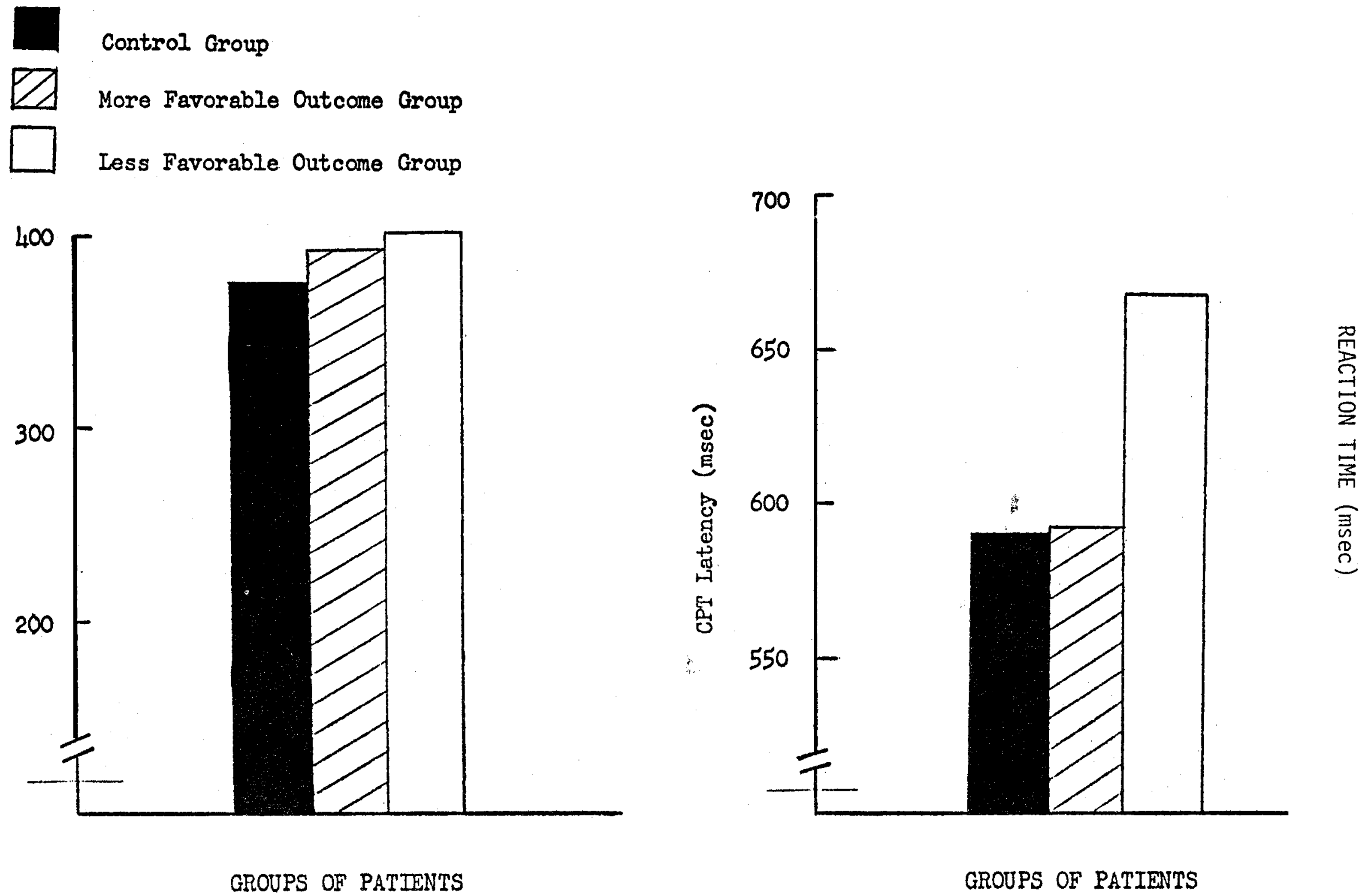

Figure 5. Mean reaction time and mean CPT latency for the three patient groups.

Comment. The trend in the psychophysiological findings is for the more favorable outcome group to be lower in arousal level than the less favorable outcome group, although the differences are not significant. The pattern of ordering indicates lowest arousal level for the control group, next lowest for the more favorable outcome group, and highest arousal level for the less favorable outcome group. Eyeblink rate appears to be a sensitive indicator of whatever processes are differentiating the control patients from surgery groups.

General comment. Table 4 indicates that for the three measures of electrical brain activity, the two measures of attention performance, and the two measures of psychophysiological functioning, the more favorable outcome group shows "healthier" neuropsychological functioning than the less favorable outcome group for six of the seven measures (note the heavy underscoring of data). Since this profile is a reliable indicator of psychological stress in normals, we interpret the present findings as indicating less emotional distress in the more favorable outcome group compared to the less favorable outcome group. The one instance where the more favorable outcome group is deficient, that of having a CNV deficit in the frontal brain area, seems to reflect a cognitive cost that the more favorable outcome group has paid for the ameliorative effects of psychosurgery on emotional distress. The price does not appear to be a prohibitively stiff one since the more favorable outcome group is comparable to controls in attention performance. Thus, although these findings generally lacked statistical significance, the consistent pattern of the findings appear to support the above interpretation.

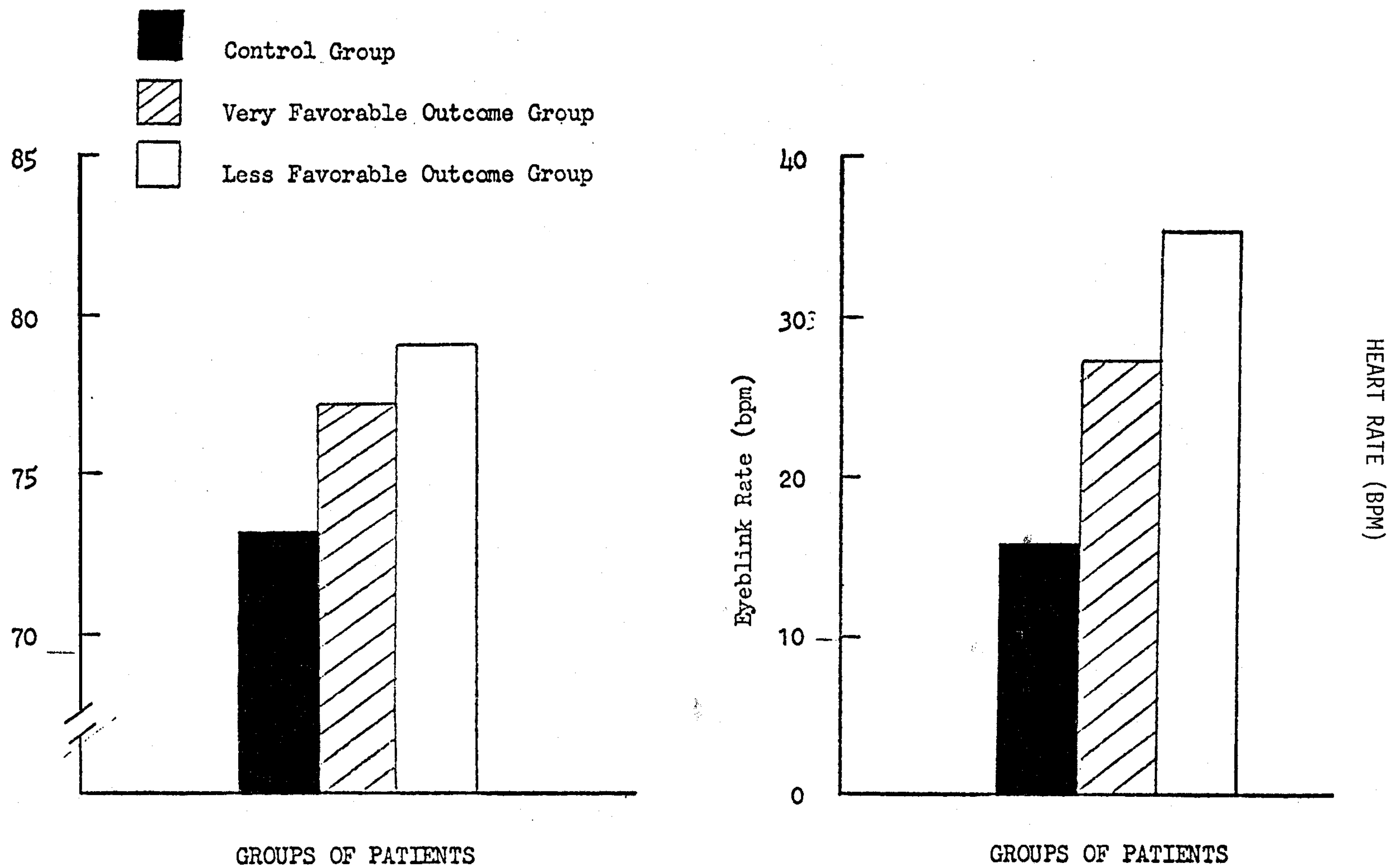

Figure 6. Mean heart rate and mean eyeblink rate for the three patient groups.

The uniformly healthier level of functioning in the control group of patients may be a function of the considerable medication being received by several individuals. In addition, the types of psychopathology shown by some patients in the group (e.g., paranoid symptoms and obsessive-compulsiveness) may serve to facilitate attention performance and brain activity (CNV) associated with attention functions.

Conclusions

1. The more favorable outcome patient group tends to show a pattern of less emotional distress than the less favorable outcome group on measures of electrical brain activity, attention performance, and psychophysiological arousal levels.

2. The one deficit of the more favorable outcome group is in frontal electrical brain activity, a finding that suggests that reduced cognitive functioning in frontal brain areas may be therapeutic in the achievement of lowered emotional distress by psychosurgery.

3. The normally higher level of electrical brain activity in nonfrontal compared to frontal brain areas was found for the more favorable outcome group and control patients but not for the less favorable outcome group and seems to reflect defective brain functioning in this latter group of patients.

4. Control patients show a uniformly "healthier" pattern of electrical brain activity, attention performance, and psychophysiological arousal levels than either psychosurgery group. We interpret this finding as due to the

drug regimen of some control patients as well as the facilitation of neuropsychological functioning by their hyperattentiveness.

5. The neuropsychological profile of seven measures employed to evaluate effects of psychosurgery in the present study appears to be a useful battery of tests for the assessment of psychopathology. Magnitude of CNV and eyeblink rate appear to be particularly sensitive indicators of psychological disturbance.

Footnotes and References

1. This study could not have been done without the competent research assistance of Debbie Meinbresse, Baiba Liepins, and Connie Dessonville. Other staff members who made a significant contribution in data analysis are Kathy Cowdell, Tim Clifford, Mary Harold, Ken Mitchell and Martha Monahan.

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ADDENDUM

CASE HISTORIES

VERY FAVORABLE OUTCOME GROUP

Case History #103. This 57 year old Caucasian female suffered from anxiety neuroses with depressive and hypochondriacal features over an 11 year period. She had a short-lived marriage to a homosexual and believes that this may have laid the ground work for her presurgical difficulties. In addition, she has had numerous other surgical procedures for functional complaints.

She had two children, one of whom was mentally retarded and was in a special school. Prior to surgery she required 2-3 cans of beer in order to cook supper and Tuinal for sleeping. She was given anti-depressants, mild and major tranquilizers, all to no avail. In 1969 she made the decision for surgery. Both her husband and physician backed her decision. Her surgery was performed in 1969. Since that time her progress has been excellent. Although she still takes some medication occasionally, she has recovered completely from her anxiety and depression as well as her physical problems. Her postoperative testing scores showed no special problems.

The patient has no regrets about the surgery and would certainly do it again under the same conditions.

Case History #107. This 70 year old grandmother had suffered from recurrent unipolar depressions for at least 40 years. During that time she was hospitalized approximately a dozen times. She was married in 1924 and her first hospitalization for a nervous complaint occurred in 1927. She dates her major illness to 1942 and in 1946 she began receiving ECT. Similar treatments were given until 1969, during four separate hospitalizations. She was actively suicidal prior to these periods of treatment. Her symptoms also included agitation, crying episodes and feelings involving (1) her head burning and (2) perpetual sexual climax. In 1970 the patient underwent psychosurgery. The decision was hers and had the concurrence of her doctor and family. She underwent surgery in 1970 and was discharged as improved. Her condition was good for 15 months. After that time her symptoms reappeared in 1971 including the burning in her head, the sexual climaxes and depression. In 1971 she was readmitted and given a further psychosurgical procedure. Her condition since then has been good. All her previous symptoms have either disappeared or are only to a mild degree.

While her intellectual level and memory were about average, she performed poorly on the Wisconsin Card Sorting Test and Benton Visual Retention Tests.

The decision for the second surgery was hers alone with the support of her family. She has no regrets and would definitely do it again. This patient took her first long plane trip from the west coast to participate in this study. Prior to this time her anxieties would not have permitted her to do this. Both she and her husband are now enjoying his retirement.

<u>Case History #113.</u> This 33 year old, white, single female had a history of marked depression, phobias and inappropriate thoughts for a period of 10 years. Several hospitalizations, electroshock treatments, psychotherapy and

medication including major tranquilizers helped, but remission was only temporary each time and the same symptoms plus increasing anxiety became manifest. She made two suicide attempts.

The patient had two operations, both in 1972. There was no pressure exerted on her for the operations, although mother and aunt were available and helpful. Patient states that her memory is not clear as to all the events just prior to surgery. She has no regrets about the surgery and states if not for the operation she would probably have been found at the bottom of the ocean.

postoperatively her intellectual level is well within the normal range, but she shows many errors on the Benton Visual Retention Test and the Wisconsin Card Sorting Tests. She has now resumed college training towards a degree.

<u>Case History #114.</u> This 55 year old white female patient had the following history. In 1964 she had an automobile accident which injured her lower back. Later that year she had a "nervous breakdown." Her tension and depression continued to increase. In 1965 her family problems became multiple and she was unable to work. At that time she received several short courses of ECT treatments, with transient improvement. In 1966 she continued to work, but complained continuously of body symptoms, weight loss, nausea, etc. and fear that people were talking behind her back. In 1967 her psychiatrist referred her for psychosurgery, which was performed during that year. She made the decision herself with no disagreement from her family. She reports "substantial" benefit from the procedure and although she is not symptom-free

("moodiness" is a problem), she had no regrets about her decision and would do it again. Her postoperative performance showed her intelligence to be well within normal limits but the number of errors on the Benton Visual Retention Test was two standard deviations above the mean for the group.

Case History #123. This is a 37 year old white female who is presently married for the second time and who has one child.

Her illness had been present for ten years, precipitated by sadistic beatings in her first unhappy marriage. She was first seen in 1962 for confusion, fear of being alone, and treated with psychotherapy and given adjunctive medications with only minimal improvement. Following this, she was given additional treatment including more than 20 ECTs.

In May 1965 she married for the second time. In August of that year her symptoms recurred when she became pregnant. The obsessive-compulsive symptoms continued during pregnancy and psychotherapy combined with anxiety medication and major tranquilizers did not relieve her emotional state. In 1966 she became depressed. She was maintained on anti-depressants and monthly supportive visits until it became necessary to hospitalize her for a course of 6 ECTs. The ECTs relieved the depression but did not alter her obsessive-compulsive symptoms. Her obsessions were related chiefly to cleaning which involved cleaning the house, setting the table and dressing, all of which were done over and over again. Added to these symptoms was a passive-dependent personality with some schizoid loose thinking. It became necessary for her mother to move into the house. The patient also developed a type of nervous dermatitis in her hands which required cortisone injections. This patient underwent a psychosurgical procedure in 1971. Improvement was noticed about 6 weeks after the operation. She made the decision along with her mother. She stated that she has no regrets and that it helped her.

Her postoperative condition has been good. She has been able to raise her family and run her home effectively. Her performance on the psychological tests were varied. Some subtests of the IQ test were all well below normal but her overall level was within normal limits. She failed to grasp any of the concepts of the Wisconsin Card Sorting Test.

Case History #124. A 40 year old single white female was diagnosed as suffering from manic-depressive psychosis with phobic anxiety. Her initial symptoms appeared at age 13. At that time she attempted suicide after 3 ECT treatments. Shortly after that, still a teenager, her symptoms were at such intensity that she was given an additional 24 ECTs. Thereafter, she remained well enough to graduate from high school. She was unable, however, to stay in college for fear of failure.

At age 19 she enlisted in the Navy Medical Corps for five years during which period she was hospitalized on a number of occasions. In 1960 she again tried suicide. She was given chemotherapy and psychotherapy for several years. Her symptoms included numerous phobias about heights, flying, as well as more and more depressive episodes.

In 1967 she had psychosurgery; the decision was hers alone. Her treating psychiatrist tried to dissuade her and demanded a letter from her releasing him of all responsibility. No one in her family knew of her decision. She has no regrets and would definitely do it again. Her mother felt that it saved her daughter's life. The patient's progress since surgery has been good. She returned to nursing school and was graduated. She is currently undergoing tests for hearing loss but this is definitely peripheral in origin.

Her performance on the psychological tests were well within normal limits.

Case History #125. This patient is a married white male, age 55. Since 1967 he has had chronic recurrent depression and episodes of clandestine drinking. He was hospitalized in 1972 and given 11 ECTs. His depression was completely remitted. The patient was given a battery of psychological tests which showed him to have superior intelligence. At time of discharge he was having Transcendental Meditation therapy and attended AA meetings. He continued to drink surreptitously. His symptoms returned, however, and early in 1974 he agreed to surgery. The surgeon was reluctant to do this because of his history of alcoholism, but felt that there was a 50-50 chance of improvement. Postoperatively he has returned to work full time as a high level executive and is a member of AA. However, he still admits to surreptitious drinking. He has had three grand mal seizures since the operation but these are considered to be a function of his alcoholism and not the surgery specifically. At the time of this interview he felt that his drinking was much more under control. He felt that the lessening of his depressions and decrease in his obsessive feelings as a result of surgery were enabling him to cope with the drinking more effectively.

His postoperative psychological testing still showed superior intelligence, with scores even higher than on his preoperative testing. His performance on the Wisconsin Card Sorting Test, however, was very poor. He and his wife made the decision to have the operation after only a weeks' deliberation. He has no regrets and would definitely do it again. He does wish, however, that both he and his family had been given more preparation concerning the time necessary for recovery.

Case History #211. This 60 year old white woman was diagnosed as schizo-affective with chronic depression and extreme agitation. She was characterized as being tangential in her thinking and having certain paranoid tendencies. Her problems seemed to center around a very unhappy marriage and problems with her mother. She was resistent to therapies of all kinds ranging from ECT to chemotherapy. According to her therapist she would never permit herself to take drugs with any degree of regularity. She also did not benefit from psychotherapy, characterizing the sessions as "torture."

Her husband had therapy to try to gain acceptance of his wife, but gained little from it. Her behavior became worse to the point where she acted out like a rebellious adolescent, dressing up to the teeth, running from bar to bar and staying out until 3 or 4 o'clock in the morning. After such sessions she would go into deep depressions that bordered on a catatonic-like state. Surprisingly she was able to keep up her job during this period.

She was referred for surgery and operated in 1971. At that time her EEG was considered abnormal, but she showed no organic symptoms. Since that time she has been happy, relaxed and free of all her depressed and obsessive-compulsive symtpoms. She knows no bizarre behavior and is definitely not considered schizo-affective now. Her relationship with her husband is still poor, but it doesn't bother her now. Her EEG has not changed.

Her performance on the WAIS remained the same as on her presurgical tests. She performed within normal limits on the other tests.

The decision for surgery was hers alone, but she had her husband's full support. She consulted a friend who had undergone the same operation successfully. She has no regrets and would definitely do it again.

Case History #220. This 57 year old white married female was originally seen by the neurosurgeon in 1963. At that time she had back surgery due to an accident which occured many years before, at age 18. This was one of six back operations she had undergone.

In 1971 she contacted the neurosurgeon again because of continued pain in her lower back and legs. She had been through several medical procedures which included hospitalizations and myelograms. Tranquilizers and pain medication did little to alleviate the difficulty of sitting or riding in a car for any length of time. She had to use a crutch and dragged her left leg. Additional spinal surgery had not been advised and she was reluctant to increase and become dependent upon pain medication. Early in 1972 she was seen for a psychiatric evaluation. She felt embarrassed to go out socially since it was frequently necessary for her to use a wheel chair. She felt guilty and ashamed of her condition and was very sensitive to the attitude of others toward her. She spent a great deal of time alone whereas prior to this episode she had been active socially and physically.

In 1972 she underwent a psychosurgical procedure from which she derived benefit both physically and emotionally. She made the decision herself. She stated that she sometimes has regrets because of headaches, but would do it again if the alternative was being confined to a wheel chair.

She performed well on all the psychosurgical tests except that she made many perseveration errors on the Wisconsin Card Sorting Test.

Case History #224. This 54 year old white woman with a Ph.D. in mathematics had a history of severe depression and tension dating back 17 years to a postpartum depression after the birth of her second child. She was given anti-depressant medication but with limited effect. With ECT she improved somewhat but became depressed again. She was unable to obtain a job in the small midwestern town where her husband taught mathematics. This may have contributed to her feelings of depression and rejection.

In 1970 she underwent psychosurgery. She made the decision herself with no disagreement from her family. She has no regrets and would do it again.

Since surgery she has lost her depressive feelings. She is taking further training while in Boston for a year in order to have special qualifications for a job. Her performance on the IQ and Memory tests were superior although there was a considerable discrepancy between the verbal and performance scores. She was able to perform the Wisconsin Card Sorting and Benton Visual Retention Tests with minimal errors.

Case History #226. This patient is a 42 year old white married woman who had a history of functional and organic disorders. One description was that she had "multiple illness, multiple surgery and multiple medication and even multiple addictions." Her history is lengthy and full of pain, difficulty and indications of personality disorder. She was finally referred in 1967 to the neurosurgeon for intractable pain, anxiety reaction and addiction.

She underwent a psychosurgical procedure in May 1967. She made the decision along with her husband even before she met the neurosurgeon. Although she still has pain, she reports that the operation "saved my life." She has absolutely no regrets and says that she would do it again. She is now working as the director of a youth center.

Psychological tests all fall within the normal range. She made fewer rotation and misplacement errors on the Benton Visual Retention Test than would have been expected.

Case History #104. Background Note. This 29 year old, Caucasian female was operated on the 29th of June, 1967 for the hopeful amelioration of severe depression, anxiety and intractable itching. The symptoms commenced, apparently, while subject was a junior high school student and intensified thereafter. She was treated with various psychoactive drugs and electroconvulsive shock in an in- and outpatient setting.

Various members of the subject's family including mother, sister and brother and more distant relatives have suffered from psychiatric ailments. Subject's preoperative diagnosis was "mixed schizophrenic reaction."

The subject's postoperative course has been one of steady improvement. She considers herself cured with family members, surgeon and previous psychiatrist concurring. She has married, is the mother of a small child and is well adjusted in both roles.

Test Performance. The battery consisted of the following tests: Wechsler Adult Intelligence Scale (WAIS), Wechsler Memory Scale (WMS), Wisconsin Card Sorting Test (WCST), Porteus Maze (PM), Benton Visual Retention Test (BVRT), Continuous Performance Test (CPT), Tapping and Hand Dynamometer.

With the few exceptions noted below, subject's performance on all tests was within normal limits and well balanced. There is no indication of either organic or psychological pathology. On the BVRT, she reproduced correctly all but one of the designs and that under delay conditions. Furthermore, each reproduction was of good quality. Similarly, performance on the visual reproduction subtest on the WMS was without error. On the WCST, she solved all six sorting series, exhibiting good ability to shift set and form abstractions. On the PM, she obtained a mental quotient of 126 - the number of qualitative errors was small. Thus, she shows good mental planning capacity and ability to execute.

Although her performance IQ of 97 (WAIS) is 20 IQ points lower than the verbal IQ of 117, performance on the specifically psychomotor subtests was well maintained. Subject showed good attentional capacity both immediate and sustained. Her WAIS, Digit Span scaled score is 14 and performance on the CPT was errorless. The test results, then, support her self report regarding the absense of anxiety and depression. Her psychomotor control is good both with regard to accuracy and speed. Her psychomotor vigor was also evident on the Tapping Test and in the strength of squeezing on the hand dynamometer.

Subject functions in the normal range of intelligence, Full Scale IQ of 109. There is little scatter among the verbal subtests indicating good cognitive balance. Among the performance subtests, two groupings emerged: the 3 psychomotor subtests with scaled scores of 11, 10 and 11; and the two remaining (Picture Completion and Picture Arrangement) with scaled scores of 7 and 8. It is my conjecture that the latter two reflect unresolved conflict with respect to certain impulses. The subject's social reserve and somewhat withdrawn (albeit friendly) attitude are in my opinion, not ego-synthonic but rather defensive.

The patient made the decision herself to undergo surgery and has no regrets about her decision. She would have it done again under the same conditions.

Case History #222. Biographical Sketch. Subject was born on January 23, 1943 into a white, protestant middle class family. He has two siblings who are well. The mother was not interviewed, but according to subject his delivery was uneventful and so was his mother's pregnancy. Subject's father died 1½ years ago of lymphosarcoma. His mother is living and well. The interpersonal relations in the family have been bad and he rejects the mother as a source of emotional support.

Pre-Operative Course of Illness and Treatments. 1. Symptoms and diagnosis. Subject was diagnosed as suffering from "severe depressive neurosis and passive-aggressive personality reaction." On a different occasion the diagnosis was "depressive neurosis." Recently, three psychiatrists basing their judgments on available historical material and an interview, have arrived at the following retrospective diagnoses: (1) "neurotic depression," (2) "neurotic depression with marked anxiety symptoms," and (3) "depression (neurotic, recurrent, unipolar)." Thus there is high concordance with respect to the diagnosis of depression, and less so with respect to anxiety. Perhaps in retrospect depressive features being more anchored in objective phenomena are easier to judge. According to the record, subject was suffering from a severe emotional illness for at least 6-8 years prior to the operation. His chief complaints centered around feelings of depression and anxiety. The anxiety was severe and there were frequent states of panic accompanied by palpitations and the experience of choking. The depressive features were experienced in chronic dysphoric mood states, low energy and an inability to work and socialize. He had frequent uncontrollable crying spells and was ruminating about suicide. However, despite the prolonged illness and emotional pain, subject did not attempt to relieve the symptoms by excessive use of alcohol nor did he self administer drugs of abuse.

2. Medical - neurological. There is no indication in the record of any physical condition that may have contributed to the psychiatric illness.

The neurologic history is negative except for a reported episode at age 17 when subject experienced nausea, severe headache, and some poorly remembered blurring of vision. He was told that if another episode were to occur a spinal tap might be necessary. The symptoms have never recurred.

3. Social adjustment. For at least 3 years prior to the operation the subject's social contacts were gravely impaired. During this time he was divorced and may have made a suicide attempt. According to one of his friends who accompanied him for the examination his social contacts were not as gravely impaired as perceived by the subject. This discrepancy may be due to either expectations, felt closeness or both.

4. Education and employment. The subject graduated from college apparently before he experienced the reported symptoms gravely. Since graduation he was employed only occasionally and briefly. For the last 3 preoperative years, he was unemployed because of his psychopathology.

5. Psychological evaluation. One month prior to the operation (on 10/15/72), the subject underwent a psychological evaluation by means of the Rorschach, TAT, Sentence Completion Test and the MMPI. The report notes the subject's good intelligence and lack of psychotic-like symptoms. On the negative side, it emphasizes the pervasive and deep seated emotional difficulties. The projective material is interpreted as indicative of very strong over-determined and ungratified (and ungratifiable) dependency needs. These the psychologist felt are the dynamic determinants of the subject's depression. Anxiety was found to be moderate. As a sign of some strength, the psychologist notes that the subject expressed guarded optimism about an improvement in human relations.

The MMPI record was computer analyzed and among other summaries it states that "the findings clearly indicate a significant emotional disorder. The pattern is typically classified as neurosis. The subject is strongly signaling psychologic problems. Coping ability appears inadequate and defenses are down." The report describes the bind the subject is in between his difficulties in expressing positive emotional responses and the hostile reaction to rejection. It finds the subject experiencing difficulties with sex role identification and notes the presence of suicidal tendencies.

6. Therapy. During the period of protracted illness, the subject sought psychiatric help on a number of occasions. He attempted various modes of psychotherapy including psychoanalytic gestalt, sensitivity groups, and "primal regression therapy." According to subject all these attempts were futile and his symptoms worsened in time. Pharmacotherapy, tranquilizers and anti-depressants were equally of no avail in symptom relief.

Post-Operative Adjustment. 1. Self-report (4/13/76). According to the subject he experienced a significant improvement immediately after the operation with a dramatic diminution ("60%") in symptoms. Yet the remaining symptoms were still "intolerable." After the second operation he experienced a further and more gradualimprovement and considers himself now able to live normally. He states categorically that he would submit again to such an operation under the same conditions and that he has no regrets whatsoever for having been operated on. He has gone back to school as a health professional on a full time basis and experiences increased effectiveness in work and a marked increase in social competence.

When confronted with a 5 choice range from "not at all" to "extremely" on a mood scale, the subject rates words indicative of dysphoria such as "worn out," "sad," "helpless" and "hopeless" as "not at all" characteristic of his feelings during the past week (and presumably more). The same rating. he ascribes to feeling words indicative of anger-aggression. However, he is less certain with respect to the anxiety component of his earlier complaints. "Panicky" he rates as "not at all," but "anxious" is rated as "moderately." Its likely, of course, that he was merely reporting anxiety related to his coming for the examination, but from other material its my impression that he is bothered by moderate anxiety more chronically. His self ratings on items indicative of psychic energy and physical well being, personal satisfaction, interaction with others and euphoric-like states are from "moderately" to "quite a bit." A suspicion of hypomania is ruled out by the absence of any markings in the column "extremely." The response record is that of a satisfied, fulfilled and balanced person.

2. Report by companion (4/13/76). The person who accompanied the subject and provided information on some of the same questionnaires was a male friend. Generally, the friend reported less preoperative pathology and less postoperative improvement. Interestingly, when asked about relations with family, the subject reported "quite a bit better" whereas the friend saw it as "very much better." This may be a small difference, but it's a dramatic one since with respect to other items the judgments were reversed.

The friend has also a somewhat different view on the subject's affective postoperative state. According to him, for about a year after the operation the subject was affectively flat and docile. "The docility waned but the flat affect persisted." It is difficult to judge the companion's perceived accuracy. I don't know the nature of their acquaintance and its history. Its important to note that their reports differ in magnitude not direction.

3. Psychiatric evaluation (4/14/76). On the Global Assessment Scale, the examining psychiatrist gave the subject a value of 89. A value of 81-90 is interpreted as reflecting: "transient symptoms may occur, but good functioning in all areas, interested and involved in a wide range of activities, socially effective, generally satisfied with life, everyday worries that only occasionally get out of hand."

4. Neurological evaluation (4/14/76). The EEG was found to be normal whether awake, drowsing or asleep. The summary of the neurological examination reads: "By the patients description he has a grand mal seizure disorder (generalized motor seizures). These appear to be under adequate control with Dilantin. There is no other evidence of neurologic dysfunction based on this examination." Following is a description of the seizure disorder, quoted from the neurological report:

> Since surgery the patient has had six "grand mal" seizures characterized by sudden loss of consciousness without aura during which there is generalized stiffening followed by clonic shaking and tongue biting. He does not lose bladder control and awakens fatigued but without mental confusion. The first two of these occurred within one month of the time of surgery and were nocturnal. He had been placed on Dilantin prophylactically following the surgery. The remaining four episodes occurred between nine months following surgery and six months ago and in each case followed an attempted reducing of his dose of Dilantin

Immediately following surgery the dose had been 200 mg daily; it was subsequently raised to 300 mg.; and attempts to reduce the dose were always followed by seizures. For the past six months he has been on 300 mg daily. No other anti-convulsants have been used.

In addition to Dilantin, the subject has been taking for the last six months Triavil prophylactically for depression and Triaminic, cough syrup, for allergy, also for the last six months. Its not clear why both of these latter medications were started at the same time. The subject did not say that the allergy may cause depressive feelings,

5. Psychological evaluation (4/15/76). The following tests were administered: Wechsler Adult Intelligence Scale (WAIS), Wechsler Memory Scale (WMS), Benton Visual Retention Test (BVRT), Wisconsin Card Sorting Test (WCST), Porteus Maze (PM), Continuous Performance Test (CPT), Tapping and Hand Dynamometer.

The most immediately observable result is the adequacy (indeed superior) performance on all tests but one, the WCST.

In the intellectual sphere, the subject functions in the very superior range achieving a full scale IQ of 133. The summary table is reproduced below:

SUMMARY		
TEST	RAW SCORE	SCALED SCORE
Information	27	17
Comprehension	25	17
Arithmetic	14	13
Similarities	23	16
Digit Span	13	12
Vocabulary	76	18
VERBAL SCORE		

TEST	RAW SCORE	SCALED SCORE
Digit Symbol	65	12
Picture Completion	20	16
Block Design	47	16
Picture Arrangement	24	10
Object Assembly	44	18
PERFORMANCE SCORE		72
	TOTAL SCORE	165

Verbal Score	93	IQ	132
Performance Score	72	IQ	129
Full Scale Score	165	IQ	133

The difference between the verbal and performance IQs is small and within normal range. As the table shows all performance subtests except one are considerably above average (average being a scaled score of 10). This suggests the absence of depressive symptomatology at this time and is in agreement with the subject's subjective evaluation in this regard. Interestingly, the results on the WAIS supply further corroboration of the subject's self report and this with respect to the presence of signs of anxiety. Reference to the verbal subtests shows that the lowest performance was on "digit span" and "arithmetic." Performance on the former is indicative of attentive effort and the latter of the ability to concentrate. Lowered scores on both of these subtests appear in the records of people suffering from anxiety. It has to be emphasized, however, that it's merely a relative lowered score and that both functions of attention and concentration are adequate. That the subject does not suffer from any impairment in the ability to maintain a state of sustained attention is indicated by the absence of any errors of omission (or commission) on the CPT.

Further support of the presence of anxious feelings was provided by the subject's spontaneous verbalizations during the performance on most of the tests. Despite the subject's superior intellectual endowment he seems to be plagued by insecurity. This could be a result of very high expectations or colored by his dependency needs.

The other noteworthy score on the WAIS is the relatively low score on "picture arrangement." The reason, I believe, is because of his lack of facility with social interactions which this subject comes closest to measure. It is also probably a result of his conflictual sex role identification. His score was lowered by failure on both of the last two items of this subtest. One depicts a heterosexual scene and the other an authority relationship. To judge by available clinical material, the subject has unresolved conflicts around both of these themes.

Performance on the WMS indicates good short term memory functioning, although his MQ of 120 is somewhat below expectations for a person with a WAIS IQ of 133. He was a bit overly anxious as examplified by a score of 0 on one of the subtests measuring "mental control." Even a person of average intelligence has no difficulty in counting by 3s (i.e., 1, 4, 7, etc.). The subject tried to do it so fast (seeing the stop watch in my hand) that he ran away with a series of errors. He immediately perceived the errors and asked to repeat which he did errorlessly. Again, the test results indicate good short term memory.

To the extent that the other tests are indicative of intellectual functioning, his performance on these corroborates the results from the WAIS and WMS. On both the BVRT and PM, subject achieved maximum scores, his performance being errorless.

To the extent that these tests reflect central functioning, the subject's performance strongly indicates adequate central nervous system functioning in agreement with the EEG data and the neurological examination. It is a moot question whether these tests are adequately sensitive to pick up any abnormality underlying the reported seizures, or whether such presumed abnormality is masked by the Dilantin.

However, there is one problematic finding and that is the performance on the WCST. The test administration allows for six correct solutions in the following successive order of sorting the cards; according to criteria of color, form, number, and again color, form, number. The subject solved the first matching after only one mistake but was unsuccessful in meeting any additional matching criteria. The most common interpretation of such a performance is organic brain damage and its behavioral expression in the inability to shift set. Although such an interpretation cannot be totally and absolutely rejected I feel that it is not warranted (1) because all the other available material indicates the absence of a behavioral expression of such damage, and (2) more careful examination of his performance on this test as well indicates, at least, doubt. During his attempt at the second solution, the subject made 109 sortings (the total test is 120 cards). Of this about half were correct and of the errors half contained a color component, which were classified as perseverative responses. Thus perseverative responses were only 1/4 of the total. In a brain damaged individual one would expect a much higher ratio. A further observation of note is the deliberateness of his responses. The subject took a long time with each choice and although obviously tired did not become impulsive but remained slow and deliberate until the 120 cards were all sorted (at one point the tester started feeling that perhaps the subject was being negativistic). The nature of his performance, the content of his utterances and his response at the end of testing as to strategy indicate that the subject was looking for solutions more complex than the test demanded. Still the fact of a poor performance on this test cannot be totally discounted, even though its meaning is an enigma.

6. Pre-post comparison. To judge by the subject's report, the operation was an unqualified success. He expressed this sentiment through a variety of self-report inventories and interviews. It is most dramatically exemplified in his statement "it saved my life."

The accompanying friend's report is more guarded. Perhaps they refer to different baselines and consequently judge differing amounts of change. This issue is more fully discussed in the text above, but the important point is how the patient feels and not how others think he feels. The objective behavior as evident from his going back to full time studies and improved social and family relations is highly encouraging.

The preoperative record shows the presence of pervasive emotional illness centered around a depressive neurosis with severe anxiety symptoms. Psychological tests administered one month prior to surgery indicate that his defenses were crumbling and that there was danger of the imminence of severe somatization of his psychological conflicts.

At present, psychiatric evaluation and psychological tests show the subject to be free of depressive symptomatology and suggest that his intellectual and psychomotor functioning are nearly optimal.

Yet there are indications of persistent feelings of some anxiety and dynamic conflicts related to sex role identification, unresolved dependency needs and difficulties with social facility. These are all no doubt related and have historical antecedents. It is noteworthy that for the last six months, the subject has been taking Triavil. Although the reason, according to the subject for taking this drug is prophylactic, it does indicate a concern that depressive symptoms may appear.

The patient decided on his own prior to seeing the neurosurgeon that he wanted the surgery. He made the final decision after the interview and has no regrets or reservations about his decision. He would have surgery again under the same conditions.

Case History #209. This patient, diagnosed as suffering from a combination of obsessive-compulsive and affective illnesses, was operated when she was nearly 60 years old. This was the culmination, perhaps, of a long history of psychiatric treatment for an illness that began in the 1930s. The treatment she received from some 11-12 psychiatrists and psychologists over this long span included psychotherapy, several courses of electro-convulsive therapy, three separate hospitalizations, a large number of psychotropic medications, "maxivitamin" (sic) therapy and other dietary supplements for hypoglycemia. She received only temporary benefit from the shock therapy; many of the medications made her physically ill. Despite her illness, there is a report of a preoperative Full Scale IQ of 123 suggesting (see below) some postoperative loss of intellectual capacity. Her long-suffering and devoted husband, a highly-trained professional, has provided great care and devotion to her for many years. He investigated the operation thoroughly before it was done and probably was at least as responsible as the patient for the decision to undergo the surgery. She describes being very ill at the time and adds, "I would have accepted anything." After surgery, which produced great symptomatic relief, "Life began for us again." She is now able to participate with her husband in many of his professional activities, including traveling, which they both enjoy.

The psychological testing, the report of which follows, was performed during a visit to Boston in which she was accompanied by her husband. Not all of the test results are reported below. It should also be noted that her EEG examination was within normal limits. Her neurological examination revealed only, "absence of ankle jerks ... and reduction in vibration sense in both ankles." There was no evident explanation of these signs, nor were they considered to be related to the psychosurgery,

<u>Psychological Test Report.</u> Tests administered. Wechsler Adult Intelligence Scale, Wechsler Memory Scale, Benton Visual Retention Test (Form D,

Administration D), Porteus Maze Test, Wisconsin Card Sorting Test.

Testing behavior. This neatly dressed woman of 63 was extremely cooperative throughout the testing, although she remained somewhat reserved throughout. During breaks between tests she did not socialize, but went directly to the book she was reading and read until testing resumed.

The self-observations interspersed between test items were generally self-deprecatory ("I should know that," "That's something I'll have to go home and learn") and she gave frequent, stereotyped addenda to answers: "That's all I can say about that one I guess," "I guess that's enough." All of these remarks were delivered in a calm, matter-of-fact manner. A number of comments appeared to indicate a recognition of less-than-acceptable (to the subject) functioning: "That didn't come out quite right," "It may have some deeper meaning I'm not finding," and to the proverb, "Shallow brooks are noisy," a response of "Maybe your gray matter isn't as good as it should be." These comments, as well, were delivered in a very matter-of-fact tone, with little or no indication of associated affect or subjective distress.

The patient employed a trial-and-error approach to the more difficult of the tests requiring visual-motor coordination and integration, continuing unruffled (at times greatly beyond the scorable time limit) until she succeeded. This approach was in marked contrast to her abrupt discontinuation of answers to verbal and information tests as soon as she felt unsure of her ability to give a correct response, rather than working out or developing one.

Intellectual and cognitive functioning. Patient received a Full Scale IQ Score of 116, with a Verbal of 121 and a Performance IQ of 108. This large a difference is unusual. Variability within the various subtests of the Verbal section was also very great, while Performance subtests did not vary significantly from each other.

Analysis of the subtest scores within the Verbal section of the WAIS reveals a noteworthy difference between the subject's performance on the Information, Comprehension, Similarities, and Vocabulary subtests, and her performance on the Arithmetic and Digit Span subtests. Her very superior performance on the first group indicates an excellent "word knowledge," above average fund of general information and excellent judgement, showing an ability to organize possessed information and use abstract reasoning.

In contrast to these, her scores on the Arithmetic and Digit Span tests were very significantly lowered. These are tests which depend primarily upon one's ability to concentrate and to scrutinize critically and select from complex situations. They also depend upon a certain facility with and recall for numbers. It is interesting to note here that a large proportion of the easier items which the subject missed on the Information subtest were those which involved the recall of numbers. The contrast between the overall Verbal and Performance Scales was very marked -- a difference which is frequently indicative of depression. The Performance subtests are also more sensitive to the effects of aging than are the Verbal subtests.

A more detailed analysis of the functions required by the various subtests of the Performance section would indicate that this subject has particular difficulty with tasks which involve concentration and the capacity to utilize the perception of pattern and organization -- in the recognition of inconsistencies (Picture Completion) as well as in the recognition of consistencies and sequence which allow for visual and spatial concept formation (Picture Arrangement; Block Design).

In summary, we see a woman who tests overall in the superior range of intellectual functioning, with a pattern of performance suggestive of depression, and reflecting her advancing years. What also becomes apparent is this subject's relative deficit in the capacity for concentration and for non-verbal integration and organization, as well as a difficulty in recalling and manipulating numbers.

Her memory, as assessed by the Wechsler Memory Scale, was excellent for her age, with an age-corrected Memory Quotient of 134. She showed little to no impairment in her capacity to shift set, to remain flexible as to sorting categories, as measured by the Wisconsin Card Sorting Test and her understanding of the task reflected intact abstract functioning. Her performance on the Porteus Maze Test was unremarkable, other than for a tendency to proceed slowly and plan in advance on this task involving visual-motor coordination and spatial organization.

The subject was also administered the Benton Visual Retention Test, which tests delayed visual memory. Although reliable normative data are not yet available for the particular form and administration used in this assessment, there is strong evidence to suggest that the performance of this subject was well below that predicted by her intelligence and age. Particularly notable were the high number of rotation errors in the figures reproduced -- a type of error which appears relatively frequently in the productions of brain-diseased patients. It is reasonable to conclude, on the basis of the information presently available regarding expectations of performance on this test, that an appreciable impairment of cognitive function exists in this subject.

Clinical impression. On the basis of this subject's test performance and behavior I would conclude that she is a woman of superior intelligence, with particular skills in areas involving verbal ability and abstract thinking and striking deficits in her capacity to organize and to retain visual information and in her ability to integrate visual and motor activity. Her difficulty in organizing visual material and numerical information makes it hard for her to grasp sequences and to think ahead as she goes along. She appears to deal with this incapacity by using, instead, trial and error approaches, in a somewhat hit or miss fashion. Her test results alone would not be incompatible with depression, perhaps of an involutional type, and this is further indicated by the frequent comments about her inadequate performance made during the testing sessions, and what appears to be a rather poor self-image. However, what is most striking is the lack of depressive affect or distress or anxiety which would normally be expected to accompany the recognition of such cognitive deficits as she manifests.

Both the patient and her husband made the decision for surgery. She had no-regrets and would do it again under the same conditions.

CASE HISTORIES

LESS FAVORABLE OUTCOME

Case History #109. This 30 year old, Caucasian female has a history of panic attacks and phobias dating back to age 3. Starting at age 13 her high level of performance in school started dropping off. At that time she reported fearful feelings all the time. After several false starts in jobs and college, she eventually completed 3½ years of the 4 year course. Her claim was that she could not go on any further because she might not be able to leave the classroom. Her marriage is generally successful since her husband's job permits him to be home with her much of the time.

Her therapeutic treatments have included hypnosis, LSD, Ethanol and ECT. The latter she claims made her worse. She tried suicide 3 times. She first underwent psychosurgery in 1970. The success of this was questionable. A series of psychological tests shortly after that revealed that she was functioning relatively well. Her symptoms returned and she tried other therapies, i.e., hospitalization and group therapy sessions. Prior to her last psychosurgery she was diagnosed as schizophrenic. Besides her crippling phobias and anxieties she was extremely dependent on her parents. Although there was some question at that time as to the nature and depth of her psychic pain, she sought out the neurosurgeon in 1972 and begged him to perform the operation. At the time he predicted 25% chance of success.

Her post surgical progress has been poor. Her self evaluation is that of slight improvement. She feels that the surgery was of little benefit, but does not regret having tried it and would do it again. Her postoperative performance on the psychological tests shows no particular deficits.

Case History #112. This 34 year old, white single female first showed symptoms of depressive and obsessive-compulsive behavior at the end of her senior year in college. At that time she attempted suicide because of her compulsive sexual thoughts. Nevertheless she taught as a substitute teacher for 3 years until her symptoms became incapacitating. She was hospitalized and underwent surgery for the first time. She improved sufficiently to teach on a regular basis for a few months, until her symptoms again made it impossible to continue. She returned for a repeat of the same-psychosurgical procedure. From 1964 to 1970 she underwent 50 shock treatments in addition to the two surgical procedures.

Since her second psychosurgical procedure she has been hospitalized in a state hospital. Her current diagnosis is chronic undifferentiated schizophrenia. She still has obsessive sexual thoughts and frequently lights fires.

She made the decision about surgery both times against her family's wishes. She now feels that the decisions were wrong and she would not do it again.

Her performance on psychological tests is well below what should be expected from a person with her education. She performed at a low normal level on the IQ test and extremely poorly on the Benton Visual Retention, Wisconsin Card Sorting and Porteus Maze Tests.

Case History #118. This is a 44 year old, single, white female, who is a college graduate and is presently working as a school teacher. She has been under psychiatric care since 1957 and diagnosed as schizoaffective disease with depressive and obsessive-compulsive features, and borderline psychosis.

Since 1957 she has had five hospitalizations as well as weekly psychotherapy sessions. In addition she has received courses of electrotherapy and insulin shock. She has also received a large variety of tranquilizers and anti-depressive medication throughout the years. In 1972 she underwent a psychosurgical procedure.

Her obsessive-compulsive state forced her to concentrate on minor details and worry about any small thing in which she felt that she had not reached perfection. She had a rather dreary home life which included an alcoholic mother and brother and this made her fearful and overly preoccupied with minor aspects of her work. She is described as a good teacher although feels insecure when she is not able to control the liveliness of the children. She was self-critical, blocked in her communications and was afraid of people. She worried over everything and her passive-dependency created a continuous need for attention and "rescue."

In 1974 she underwent a second psychosurgical procedure. After about one year the patient states she felt significant improvement, headaches were gone and she didn't worry as much as she used to.

Interview with mother indicates that the patient now drinks very heavily and uses obscene language. Patient states that she made the decision for the second operation in consultation with her psychiatrist. Although her parents did not agree, they did not pressure her in any way. She does not have any regrets, although she wishes that it helped her more to feel better about herself. She states she would do it again if her psychiatrist suggested it.

Her postsurgical psychological testing is varied. While her performance on the intelligence and memory scales are within the normal range, the number of errors on the Benton Visual Retention Test appear to be beyond the normal range.

Case History #126. The patient is a 61 year old Caucasian women who has had manic depressive illness since 1964. She was a college graduate then unemployed. At that time she was diagnosed as having an "involutional depression with severe agitation." Anti-depressant medication was prescribed but proved ineffective. She continued to have cyclical swings from low to high. She was given anti-depressants for lows and lithium for highs, but the medication was ineffective. In 1968 she underwent psychosurgery. She made the decision for herself but was influenced by her sister-in-law who had undergone the same surgery. There was no disagreement and she has no regrets about having had the surgery. She states that she would do the same thing again.

Since the surgery she has continued to have cyclical swings but the degree of impairment due to her emotional difficulties has lessened. Since 1971 she has had lithium therapy which now seems to be more effective. This is reported by both the patient and her husband.

Her post surgical test performance on the intelligence test was surprisingly low for a college graduate. She was able, however, to do the Wisconsin Card Sorting and did reasonably well on the Benton Visual Retention Test.

Case History #129. This 67 year old white male was referred initially to a psychiatrist for depression and drug addiction. He had a history of sleeping problems which were treated initially with tranquilizers, but eventually barbiturates became necessary.

He was afflicted with a number of functional disorders and had a series of operations as a consequence; he had four operations for ulcer, the first performed when he was 18 years old. He was depressed and dependent on his mother. In 1967 he was referred to the neurosurgeon for intractable pains in the head, aching and twitching in the legs, tremor and tension. He found difficulty in carrying out his job of bookkeeping and was depressed about this. Early in 1967 he underwent psychosurgery.

The patient made the decision for surgery after two months of treatment. He has no regrets and would definitely do it again.

Since surgery he had continued to be somewhat depressed and has tried to "wean" himself from his mother. He has since retired and is much involved in retirement activities. According to his wife he still has a secret cache of drugs. He himself claims that he feels better and is generally in better health. His performance on the psychological tests are within the normal range for his age with the exception of a poor score on the Benton Visual Retention Test.

Case History #207. This 28 year old single man was referred in 1966 for diagnostic evaluation. At that time he admitted having difficulty in relating to people. His parents complained of his apparent laziness and non-participation in school activities.

His psychological testing at that time showed him to have such obsessive-compulsive behavior that he was unable to function normally. He was diagnosed as psychoneurotic with obsessive-compulsive and depressive features. The psychologist cautioned that he might become more confused and withdrawn and eventually schizophrenic. In 1971 he was referred for psychosurgery with a new diagnosis of schizophrenic personality with an overlay of obsessive-compulsive behavior. Most of his obsessional feelings were sexual in nature. The neurosurgeon felt that the chances of improvement were about 50%. Just prior to surgery he was tested and found to be dull normal in intelligence but his visual and visual-motor control had deteriorated since his first testing. Surgery was performed in 1971. His father made the decision for the surgery but the mother was against it. The patient says he has no regrets, but would not do it again.

Since surgery the patient has exhibited no basic change, although some of his obsessive behavior has lessened. At the time of the interview he was talkative, occupied with sex and rather oblivious to consequences resulting from his actions. His performance on the psychological tests was still of the dull normal level. He failed to grasp any of the concepts of the Wisconsin Card Sorting Test.

On the way to his home located in another state after the completion of testing, he decided to continue on the bus and was missing for two or three days. His family did not seem too concerned.

Case History #213. This 50 year old white physician referred himself for psychosurgery in 1974 because of a 13 year history of incapacitating cyclical manic depressive behavior and alcohol addiction. His father was a manic-depressive and his brother suffered from depressive episodes. The patient was particularly concerned about mania since he knew his father had died during a manic episode. The patient had been given treatments which included psychotherapy, Lithium therapy, phenothiazine and anti-depressant drugs, as well as combinations thereof. In addition he had undergone shock treatments and responded reasonably well to those, His life had been wrecked by divorce, loss of his surgical practice and loss of his personal fortune.

He was tested prior to surgery-and scored at a superior range of intelligence. However, there was a significant discrepancy between his high verbal and low performance IQs. This discrepancy, according to the examining psychologist, was indicative of apprehension, insecurity and anxiety after extensive and thoughtful consultation with neurosurgeons and psychiatrists. He has no regrets and would do it again under the same conditions.

His post surgical history has been somewhat varied. Initially he felt much better (his depression lifted). He returned to work and moved to a new state, but found he was unable to function as he was expected to. He started drinking again. At the time of our study, he had moved back to his home town and was making plans to resume practice there.

His performance on the psychological tests were highly superior for the verbal and average for the performance subtests. He was able to do the Wisconsin Card Sorting and the Benton Visual Retention Jests with minimum errors.

Case History #217. This 56 year old white married male has had periodic depressions since age 19. At age 34 he underwent a psychosurgical procedure and did quite well for some 10 years. Electroshock therapy gave some improvement as did psychotherapy, although the relief from the latter was for a very short period of time. He took major tranquilizers for five years.

It became necessary for him to leave his job as a school teacher and go to semi-skilled work. At the time of his contact with the neurosurgeon for his second operation he was depressed, tense and pessimistic although he presented a controlled and affable personal appearance. He was obsessively concerned about almost everything and was easily overwhelmed by the regular details of his job and life. He had stopped work because of his symptoms 10 days prior to his contact with the surgeon.

The patient was operated for the second time in 1969. He made the decision himself, He has no regrets and would do it again. He returned to work one week after surgery. He does a great deal of walking. His social life has improved and his thoughts of suicide are gone.

His performance on the psychological tests are well within normal limits except for a few areas.

Case History #219. This patient is a 56 year old white male who had a history of recurrent depressions with anxiety. According to the patient, it started when he was in his teens. He reports several hospitalizations and having been given 30-40 ECTs, as well as insulin shock treatment. The improvement was always transient. In 1974 he underwent surgery even though the surgeon was very reluctant to perform it because of the number of prior shock treatments. The surgeon's decision to operate was reportedly based on the fact that 10-20% improvement might result and that there was no other hope.

Immediately after surgery he appeared to improve markedly. His psychiatrist called the change amazing. At that point the patient convinced the psychiatrist that he was a lawyer and was trying to take the bar exam. The subject had in fact never completed college. Four months after the surgery he developed seizures, which have continued until the present. Since that time his doses of Dilantin have been increased. He is still markedly depressed and has returned to smoking, although it was recommended that he not because of emphysema. This condition was exacerbated, and just prior to our study he had been hospitalized with bronchial pneumonia. When interviewed by telephone he said that he would come to Boston, that his treatment was a failure but that he did not blame the neurosurgeon; he had done his best. He made the decision for surgery himself, but really regrets it. He would not have it again under the same conditions.

His performance on the psychological tests was at law normal levels and below. He became tired and was unable to perform the Benton Visual Retention Jest.

Case History #233. This is a 39 year old white, divorced male who is currently unemployed. He had suffered from headaches since 1957. He was given antihistamine medication which failed to help for more than a month at a time. In 1964 he was referred for a psychosurgical procedure because the headaches had changed becoming more irregular and more aggravated by tension. The headaches lasted from one to three days.

The patient did well for several months after surgery but the headaches gradually became worse. In 1968 the patient's wife contacted the neurosurgeon again because of the patient's incapacity to work.

Since the surgery the patient's symptoms have returned and have become worse. The patient made his own decision to undergo surgery. He has no regrets and would undergo the procedure again. Recently, he has been contemplating further brain surgery.

His performance on the psychological tests was within normal limits with few noteworthy aspects.

Case History #122. A. Biographical Sketch. Subject was born on the 11th of July, 1924 into a Caucasian Protestant family of modest means. He had a strict, disciplinary upbringing with moralistic overtones. He is the second of two sons, his brother being 17 years older. Subject finished high school and enlisted in the armed services.

His employment status was and is that of an unskilled service worker. After his discharge he lived with his parents. His father died and he has continued to live with his mother despite reported friction. He never married but did apparently have several heterosexual relationships. In fact, the one big reported trauma in his life was the termination of such a relationship where the intention on his part was marriage, but his procrastination led to her breaking the relationship off.

<u>B. Adjustment Prior to Surgery.</u> 1. Course of illness. From reports by patient, his family, notes from treating and examining psychiatrists, psychologists, neurologists and others it appears that subject has been suffering from emotional difficulties continuously since 1946. There is no data for evaluating the subject's adjustment during adolescence and childhood but his adulthood is one continuous story of woe.

Subject was discharged from the army in 1946 and shortly afterwards suffered a "breakdown" of sufficient severity to require hospitalization. The episode turned into a chronic condition and hospitalization was prolonged until 1951. During the course of his hospitalization there was no remission of the referring symptoms of depression, anxiety and suicidal thoughts. In fact after a course of electro- and insulin shock treatments his symptomatology is reported to have encompassed paranoid hostility as well. In 1951, the subject was discharged to his parents home apparently not much improved. His discharge was justified by the claim that the patient was not responding to any of the treatments so perhaps he would do better at home. Interestingly, despite the supposed lack of improvement, he was never rehospitalized.

Subject has been seen by various treating personnel on an outpatient basis. In 1970 the subject's behavior began to show regression and an intensification of symptoms. It progressed over the next two years to the point where the subject and his family sought out a neurosurgeon for consultation about an operation.

According to the account of the subject and his brother, the neurosurgeon did not make any promises of cure, but considering the long standing suffering, the subject felt he had nothing to lose and much, hopefully, to gain from an operation. Members of the family and other physicians supported his decision.

In light of the postoperative course, it is enlightening to quote at this point from the neurosurgeons note concerning prognosis: "Will do surgery reluctantly as last resort, but prognosis somewhat poor because of tendency towards self pity. Operation will benefit his anxiety and his mild. depression and possibly his paranoid trends." This prognostication was to a great measure justified.

2. Non psychiatric conditions. There are no indications that subject suffered from any complicating organic conditions. His presurgery EEG was normal.

3. Indications of emotional strong points. Despite debilitating depression and anxiety, the subject has a reasonably good work and social history. He maintained a job and although work environment was somewhat sheltered and protective, the subject by all indications performed his duties well. In addition throughout the post-hospitalization period he maintained social contacts, including some heterosexual relationships, even though none lead to marriage.

The subject used alcohol excessively at times, but did not use drugs of abuse. It is of some interest that despite the reported symptoms of deep and chronic depression, the subject did not suffer from sleep disturbances or any of the physical symptoms that often accompany prolonged states of depression. There were no suicidal attempts either.

C. Treatments. As already indicated, the subject received treatment both in an in- and out-patient setting. His record indicates 27 electro-convulsive shock treatments, 60 insulin shock treatments and a plethora of psychoactive drugs singly and in combination including major tranquilizers and tricyclic anti-depressants. He was also in psychotherapy and occupational therapy.

D. Psychological Evaluation. Just prior to surgery, the subject was evaluated by means of a battery of psychological tests including the Wechsler Adult Intelligence Scale, Bender Visual Motor Gestalt Jest, Memory for Designs Jest, Rorscharch, Thematic Apperception Jest, and Sentence Completion Jest.

His Full Scale IQ was 107 (high average) with both the Verbal and Performance IQs at 106. Analysis of the performance on the various subtests of the WAIS indicated difficulties with the maintenance of attention and a true understanding of patterns of social interaction. None of the test results suggested organicity. The projective tests indicated adequate reality testing and the absence of any bizarre, unusual or irrational ideational trends. There was no indication of crumbling defenses or personality disorganization.

E. Diagnosis. I am including diagnostic considerations in the concluding rather than commencing section of the subjects presurgical history because it is a confusing sequence of statements when divorced from some familiarity with the behavioral and symptomatological changes over the years.

Following are the diagnostic statements as they appear chronologically in the subject's record:

1. Pseudo-neurotic schizophrenia manifested by depression, anxiety and paranoid trends

2. Schizophrenia, paranoid

3. Schizophrenia, catatonic

4. Mixed psychoneurotic schizophrenia manifested, by chronic anxiety, constitutionally inadequate personality, paranoid trends.

The change from diagnosis 1 to 2 above was made after the insulin shock series which produced, it seems, a state of confusion. There were apparently some signs of anxiety and paranoid suspiciousness throughout, but it is extremely interesting that except for diagnosis 1 which was established upon the hospital admission when florid symptoms first appeared, there is no mention of depression despite the subject's continuous complaint of its presence. Examining psychiatrists were, it seems, less impressed with the importance of the depressive features in the subject's illness. I have difficulties in finding the reasons for the diagnosis of catatonic,

The reader will also recall that the psychological evaluation makes note of the absence of schizophrenic symptoms.

During the present evaluation (4/9/76) three psychiatrists diagnosed the subject retroactively, i.e., his presurgical state, and suggested three different conditions:

1. Pseudoneurotic schizophrenia; schizoaffective disorder might also be considered

2. Personality disorder-inadequate personality

3. Borderline psychosis with depressive and paranoid features.

On the basis of the reviewed diagnostic history, it can be fairly stated that the subject's behavior and manifest symptomatology prior to surgery were difficult to interpret.

F. Adjustment Postsurgery. 1. Psychological evaluation 3 months after surgery. On February 27, 1973 the subject was re-evaluated by the same psychologist who tested him just prior to surgery. The psychological report notes that there are no subjective changes in reported feelings of depression and anxiety. Intellectual performance was almost identical, with the Full Scale IQ changing from 107 to 105 and subtest pattern as before. The projective tests, according to the report show a similar, though more positive picture: "less constricted with regard to emotional expression, and although he denies it, does not seem to be in as much despair about the future. As was the case at the time of his last examination, the basic finding is that of anxiety with depression secondary. There is no evidence of psychotic features."

2. Course of illness between surgery and present evaluation. On the 30th of November, 1972 -- about two weeks after the surgery -- the surgeon notes that during the first week postsurgery the patient was lethargic but then began to "perk up." He goes on to state that there are no objective signs of any schizophrenic reaction during convalescence. He estimates the prognosis "hopefully" at 25-35% improvement.

Since the subject continued visiting the same out-patient clinic, he was treated at before, the record contains periodic comments about his condition. The general impression is that of a tug of war with the treaters pulling towards an admission of improvement and the subject entrenched in a position of "no change."

Thus we find a comment on 1/8/73 that the subject is less depressed but doesn't admit to much improvement. Again on 2/20/73 that subject "reluctantly admits to possible improvement." The reports state that subject "appears less depressed but more obsessive." During the months of March and April of 1973, the entries in the record note that the subject felt somewhat less tense and anxious but is sad, discouraged and at times irritable. The most optimistic self report is noted from May, 1973. During this interview (6 months after surgery), the subject stated that he felt little nervousness, was not irritable, nor was he discouraged or sad.

It is not clear why the subject felt relatively healthy during this interview. It was never reported. In fact, the entry of August, 1975 (about 2½ years after surgery) is a restatement of all the complaints found prior to surgery. However, it is worthy of note that the subject's mother repeatedly stated that her son has improved, characterizing the improvement primarily as less frequent depressions. It is likely, but not clear that their relationship is also better and that the subject is less irritable.

<u>G. Present Evaluation (April 1976).</u> 1. Neurological Status. A comprehensive neurological examination found the subject symptom free. The EEG examination was normal under conditions of wakefulness, drowsiness,

sleep, hyperventilation and photic stimulation.

2. Subject's self report. As the reader by now suspects, the subject's self report is of mental and emotional anguish similar to that experienced over the years preceding the operation. When asked to rate feeling words characteristic of his state during the week preceding the examination, he marked none in the "extremely" category but many indicative of dysphoria in the category of "quite a bit" (as "unhappy," "blue," "hopeless," "miserable," etc.). Words describing anxiety states he rates as either "little" or "moderately" characteristic of himself. Practically all physical symptoms which often accompany emotional illness, he rates as "not at all" characteristic of himself, including such classically depression related symptoms as sleep disturbances. With respect to available level of energy, subject is inconsistent. For example, he rates both "fatigued" and "active' in the "quite a bit" category, and does the same with "weary" and "alert."

His self report is primarily one of low mood, without the psychomotor retardation and physical symptoms characteristic of depression. However, when asked to rate sentences rather than words, his reported symptomatology encompasses more severe disturbances in the psychomotor, energy level sphere as well, such as a rating of "quite a bit" for the statement "low in energy or slowed down," or "feeling everything an effort." It is my impression that the more fully a pathological symptom is described, the more readily the subject sees it as applying to himself. However, this is not true of physical symptoms.

The lack of reported physical symptoms could conceivably be attributed to his taking Parnate, Valium and Dilantin. I rather doubt it, as the two former should also affect his emotional state.

3. Psychiatric evaluation. Subject was given a rating of 75 on the Global Assessment Scale, which reads "minimal symptoms may be present but no more than slight impairment in functioning, varying degree of everyday worries and problems that sometimes get out of hand."

4. Psychological evaluation. The battery included the following tests: Wechsler Adult Intelligence Scale (WAIS), Wechsler Memory Scale (WMS), Wisconsin Card Sorting Test (WCST), Benton Visual Retention Test (BVRT), Porteus Maze (PM), Continuous Performance Test (CPT), Tapping Test, and Hand Dynamometer.

Following is the WAIS performance summary:

SUMMARY		
TEST	RAW SCORE	SCALED SCORE
Information	24	14
Comprehension	21	13
Comprehension	12	11
Similarities	22	15
Digit Span	11	10
Vocabulary	47	11
	VERBAL SCORE	74
Digit Symbol	54	10
Picture Completion	11	8
Block Design	34	10
Picture Arrangement	24	10
Object Assembly	40	14
	PERFORMANCE SCORE	52

TOTAL SCORE			
VERBAL SCORE,	74	IQ	116
PERFORMANCE SCORE	52	IQ	114
FULL SCALE SCORE	126	IQ	116

It indicates that the subject is of good intellectual endowment functioning in the bright normal range. It is noteworthy that his Full Scale IQ Score of 116 is appreciably higher than the ones obtained just prior to surgery (107) and three months thereafter (105). Since there is no indication in the prior reports of lack of cooperation or a noticeable motivational deficiency it appears unlikely that the improved performance is a function of test motivation. Since a 10 point IQ score difference is greater than chance variation, the hypothesis suggests itself that on the prior occasions of testing, the subject performed below potential. In particular, the earlier reports show that the subject was somewhat deficient in his ability to maintain attention and in his understanding of patterns of social interaction. An examination of the scaled subtest score distribution pattern shows that relative to the other functions, attentional capacity is still low but social interaction functions are well maintained. Subject shows a good informational fund, is well oriented and appropriate in relation to expected social interactions and shows good abstracting ability. The good performance on the Verbal Subtests and the scatter pattern do not suggest nor support a diagnosis of depression. The results from the WAIS, then, are at variance with the subject's self report regarding his depressive symptomatology. His relatively alert and vigorous performance on the Tapping and Hand Dynamometer tests are in agreement with the results from the WAIS.

That his overall intellectual functions are intact is supported by the WMS (Mental Quotient also of 116) by the good performance on the PM (Test Quotient of 126) and the reasonably good performance on the WCST, completing 3 out of 6 sequences with few errors.

However, there are deficiencies worth noting and an impairment of note. Reference to the WAIS summary shows that performance on the subtest of "picture completion" was lowest and the only one below average. My notes regarding his behavioral manner while working on this subtest reads: "worked quickly with compulsive urgency and showed poor judgment." He was guessing. In and of itself it is difficult to understand this aberrant performance. My guess is that the subject had difficulties recollecting the actual appearance of the objects and was therefore deficient in deciding what important part is missing (the test requirement). To diminish frustration he made quick decisions. Reference to his impaired performance on the BVRT supports this interpretation. Out of 10 designs on the test he reproduced correctly only 5. On 4 of the 5 he missed he made 2 errors on each. Of the 9 errors, 6 were distortions and 2 perseverations. My notes for this test read: "impatient with delay (administration called for a 10 second delay between card presentation and reproduction); showed signs of irritation, mentioned his feelings of depression." The errors, by the way, were more in the right visual field. Even without a delay, subject showed impairment in his capacity to reproduce visual material. Of the 7 WMS subtests, subject performed badly on memory for digits and visual reproduction. Not only is his visual memory impaired but also his visuo-motor execution is faulty. Although, as mentioned, his test quotient on the PM of 126 is good, he made 77 qualitative errors, 48 of which were because of a "wavy line."

Another area of impairment is that of attentional functioning. As will be noted in the WAIS summary the subtest regarded as a measure of this function, i.e., digit span is the one with the lowest score of the verbal subtests. On the WMS, the subject recalled correctly 6 digits forward and only 4 digits backward. His performance on the CPT, which measures specifically the ability to sustain attention, was impaired rather seriously with 52 commission and 28 omission errors.

In summary the test results suggest adequate intellectual-cognitive functioning (probably optimal for his capacity), good psychomotor performance, inadequate attentional functioning, especially when it requires sustaining it over time, and seriously impaired visuo-reproductive and especially visuo-retentive capacities. One would suspect an organic cause for the latter two. The test results do not indicate the presence of any serious signs of depression or anxiety (maybe such signs would have been evident on projective tests; but the psychiatric examination also failed to elicit such symptoms).

H. Comparison Between Subject's Condition Prior to Surgery and Now.

To judge by the subject's self-report he is as badly off now as he was prior to surgery. As in the past his main complaints center around feelings of depression and anxiety in various admixtures over time. On the face of it, the case would rest here. However, there is a discrepancy between the subject's self report and other evidence. The mother, as mentioned, sees his condition as improved. The psychiatric evaluation at present as compared to previous diagnoses suggests much less pathology. The psychological tests present a mixed picture. On a directly comparable measure (the WAIS), the subject shows appreciably better functioning. But from a comparison of the total batteries, it appears that he is suffering from a fairly severe visuo-memory deficit not previously reported. It is difficult to say whether this is the result of a central insult or due to dynamic conflicts. Either interpretation can be supported or negated by the evidence at hand. Also, the present test results show the subject to be impaired on tasks requiring sustained attention, a deficit noticed prior to surgery as well. The psychological tests do not provide more objective evidence about the presence of depression and/or anxiety.

During the course of the subject's illness there were evident discrepancies between self reported symptoms and inferences made by others. In an existential sense the subject's illness is mirrored by his reported feelings. From the point of view of a medical model, the subject appears to be suffering from intractable psychic pain. Perhaps a break up in the environmental cues triggering such pain would be of some help.

This patient made the decision himself with no pressure exerted from the family. He said he did not regret having the surgery but was disappointed in the results. He stated that he would have it again under the same conditions.

Case History #127. The onset of recurrent and severe headaches is reported by this 66 year old woman to have occurred in 1928 when she was 18 years of age. At that time the headaches usually were associated with her menses, and most often could be controlled with salicylates until the patient developed an allergy to them. The severity of this symptom has increased over the years and has been most distressing during the last ten year period. Her most recent diagnosis suggests the complexity of the problem: (1) intractable headaches, migrainoid but probably not true migrain; (2) anxiety reaction and depression. Over the course of this illness she has received a variety of analgesic, sedative and narcotic drugs for the relief of her pains, as well as various ergotamine-containing preparations. Psycho- and hypnotherapy afforded little relief to her. By the late 1960s she presented the picture of a person increasingly dependent upon multiple medications: cafergot suppositories; narcotics and barbiturates. In 1969 her treating physician recommended psychosurgery, since he felt there was nothing further that could be offered the patient. There was consultation with another surgeon who offered her no treatment and no prognosis, but warned her about the extent of the medication she was receiving. When finally the patient and her husband made contact with the surgeon who ultimately performed the psychosurgical treatment, there was a good deal of communication with him via letters and phone calls over a two month period. The actual face-to-face question and answer contact occurred in the hospital after diagnostic tests were performed and (according to her husband) only on the day of surgery. However, although the patient may not have understood completely the nature of the procedure, she and her husband had agreed that there was no alternative. She was told that "it would not harm my brain," that it would make her calmer and more relaxed, and that this would relieve the tension which led to the headaches. Her husband recalls being told that 35 - 40% of patients receive benefit from the procedure. The bilateral operation was performed in 1969, and was followed by almost immediate, if partial relief. This persisted for several months, when the intensity of the headaches began to increase. By 1971 the pain and discomfort were back to the preoperation level. Contact with the surgeon was maintained during this time, initiated both by him and by the patient. After considerable discussion and with much reluctance it was agreed that the patient should have a "booster" operation. This was done (a unilateral procedure) late in 1971, but afforded little benefit. The headache is now described as continuous (an effect attributed by the patient to the surgery) and is relieved only by her current medication: cafergot suppositories (with phenobarbital); percodan (a narcotic); darvon; dalmane (for sleep); and regitine, an antihypertensive for her high blood pressure. The EEG examination was considered to be within normal limits for the patient's age and the neurological examination was remarkable only for intermittent minimal jaw closure movement. This was attributed to a nervous habit originally associated with poorly fitting dentures and/or to the dry mouth side effect of the cafergot medication.

The psychological testing which is reported below was done at a western city near the patient's home.

Psychological Test Report. Tests Administered. Wechsler Adult Intelligence Scale, Wechsler Memory Scale, Benton Visual Retention Test (Form D, Administration D), Porteus Maze Test, Wisconsin Card Sorting Test.

Testing Behavior. This small, carefully dressed woman of 66, with a very wizened face and worried expression, performed most cooperatively on all the psychological tests anxious to "do anything that will help you figure out how to help me get well." She approached the testing apprehensively, commenting in advance on her concern over her performance and fidgeting throughout the testing sessions. She frequently pressed her fingers to her forehead, and a slight but nearly constant movement of the mouth and jaw was observable during testing.

She often remarked on her inability to answer or perform certain items, with comments such as "It’s a long time since I studied that," "I never stopped to think about it ... I don't know," and "you should have my sixteen year old grandson here." Following those answers of which she was uncertain, she frequently asked for reassurance that she was correct or that her explanation made sense to the examiner. At times she interrupted the testing to comment on her difficulty in answering and to talk about her complaints: "My power of concentration is not what it used to be"; "I can't remember -- it's gone. That's my problem right here -- ever since ... I never had that difficulty before. I can't repeat what people tell me, what I hear, for fear I won't get it right." It was occasionally necessary to redirect her to the task at hand, so pressing was her desire to communicate her troubles.

She exhibited an unwillingness to rely on her own perceptions, as indicated by the above statement, or on her own judgment, as with her answer to What is the thing to do if you find an envelope in the street that is sealed, and addressed, and has a new stamp?: "I'd take it to the post-master ... and let him decide what to do with it."

She was easily discouraged, and upon failure to complete one of the more complicated designs on the WAIS Block Design Subtest, she complained, "That's making me dizzy -- I'm getting a headache -- I can't think," and refused even to attempt the last design.

In spite of the great encouragement she needed at times just to continue a task, this support from the examiner did not have any appreciable effect on the quality of her subsequent performance, nor was her anxiety substantially decreased.

<u>Intellectual and Cognitive Functioning.</u> Patient received a Full Scale IQ of 105. Both Verbal and Performance IQs were also 105. These very consistent scores fall solidly in the average range for the subject's age. When "potential" scores were given for correct responses beyond the time limit (often used as a means of determining what is only "temporary insufficiency") the subject's Full Scale IQ was increased by four points, suggesting that the intellectual assets potentially at her disposal were only slightly impaired at the time of testing. Variability of subtest scores within both the Verbal and Performance sections was also low.

Within the Verbal section, the subject's score on the Digit Span subtest was notably lower than the other remarkably consistent scores. This is a task which requires a good deal of focused attention, unhampered by emotional conflict or distraction. it is particularly sensitive to anxiety, and relatively lowered scores are nearly always an indication of the presence of distracting anxiety. The other verbal subtest scores reveal an average fund of general knowledge and verbal ability which the subject is able to organize and select from and use efficiently in making judgments and in reasoning abstractly. Since the Vocabulary subtest score is most stable over time and most refractory to deterioration of function, the homogeneity of the Verbal subtest scores is a strong indication that this subject's reasoning ability, judgment, and abstract function have suffered no observable impairment.

The Performance section shows somewhat more variability than the Verbal section, although this was not substantial. The subject's scores on the Object Assembly and Picture Arrangement subtests were lower than the other Performance subtests, and comparable to her Digit Span score. Both of these tasks involve the ability to plan ahead, to anticipate an image of a whole object or sequence. They also both involve the capacity to integrate, organize, and give meaning to new non-verbal material. Depression usually interferes with this capacity to project into the future, and is the most common factor in a relative lowering of scores on these two subtests.

The subject's relatively high (when corrected for age) score on the Digit Symbol Substitution subtest show good visual-motor coordination and a well-preserved capacity for learning new associations.

In summary, this subject tests squarely in the average range of intellectual functioning. The internal consistency of her record is a good indication that this woman has shown no appreciable deterioration of intellectual function in any of the areas assessed. Her pattern of performance suggests the presence of anxiety and depression, which is confirmed by her testing attitudes and behavior.

No firm conclusions can be drawn from this subject's performance on the Benton Visual Retention Test (a test of delayed visual memory) because of the lack of normative data for the particular form and administration used, which draw upon both visuo-perceptive and memory functions. However, based on the available data, it is reasonable to conclude that her number of correct reproductions is somewhat below expectation for her intellectual level. This may be a reflection of her age, rather than cerebral dysfunction, as there is generally a decline in performance with advancing years. This is further supported by the observation that the kinds of errors made most frequently by this subject are not unusual in the records of normal controls. No significant difference existed between numbers of right and left errors. On the basis of her performance on this task there is little to indicate any cognitive impairment in this subject, beyond that predicted by her age.

Her memory, as assessed by the Wechsler Memory Scale, was average for her age (Memory Quotient - 99.5) and not inconsistent with her IQ. It is interesting to note that the subject performed more poorly here on the Digit Span task than she had on the identical task the previous day in the WAIS; on this day it followed directly an anxiety-producing memory passage task. Her memory for complex visual designs under conditions of delay was somewhat impaired. This is difficult to interpret by itself, but when compared with her performance on the Benton Visual Retention Test, it provides some evidence that it is the complexity of the visual material which makes it difficult for her to reproduce figures accurately, rather than the delay.

Her performance on the Wisconsin Card Sorting Test, which assesses the capacity to shift set -- to remain flexible as to sorting categories -- was inconsistent. She was able to shift through the three categories once, but was completely unable to do the same thing a second time, although given nearly the same number of trials. This could be accounted for by a withdrawal of attention part way through the test, or by a "giving up" due to frustration or anxiety.

Her performance on the Porteus Maze Test reflected her difficulty in planning ahead, particularly with regard to the organization of visual material. As the mazes became more difficult, she was able to progress only one stage at a time, rather than planning her course in advance, and the length of time she spent on each increased greatly as the complexity of the designs increased. She completed all the mazes, although for a number of them it was necessary for her to backtrace from the exit in order to find her way out.

Clinical Impression. On the basis of this subject's test performance and behavior I would conclude that she is a woman of average intelligence with no outstanding skills or striking deficits in her intellectual functions. Although she is quite concerned about her memory, her adequate performance on tasks involving various memory functions leads one to believe that her concern arises from a generalized anxiety around her overall performance and competence and a tendency to doubt the accuracy of her own perceptions and judgment. She does have some difficulty with the prospective organization of visual material and some deficit in her capacity to recall complex visual material. This is most likely a result of the widespread anxiety and depressive affect she is currently experiencing and which is manifested in much of her test performance and behavior.

The patient and her spouse made the decision to undergo surgery after talking to an operated patient. She regrets having surgery and claims that her headaches are more uncontrollable now than they were before. She would not have surgery under the same conditions again.

<u>Case History #203.</u> <u>Background Note.</u> This 46 year old, Caucasian, male subject underwent 3 operations (1964, 1967 and 1971) for the relief of anxiety and depression. The subject became ill in 1952 while a soldier. The course thereafter showed no remission despite a large number of varied treatments including electro and insulin shock, major tranquilizers and anti-depressants. From the beginning of the symptoms, the subject did not work and lived with his parents. He is not married. There is no history of mental illness in the family.

The post operative course has been similar on each of the three occasions. Initially, he responded well and showed a progressive improvement. After about 6 months his condition stabilized and remained so for about a year. Thereafter there was a fairly rapid reappearance of symptoms and complaints.

Test Performance. The battery included Wechsler Adult Intelligence Scale (WAIS), Wechsler Memory Scale (WMS), Wisconsin Card Sorting Test (WCST), Benton Visual Retention Test (BVRT), Porteus Maze (PM), Continuous Performance Test (CPT), Tapping and Hand Dynamometer Tests.

The record suggests the presence of organic inadequacies and schizoid character traits. Visual retention is seriously impaired. On the BVRT, he reproduced only 1/10 stimuli correctly: Of the nine missed, six reproductions had multiple errors. However, when tested without delay his reproduction of visual material is better. Thus, the performance on the visual reproduction subtest of WMS is considerably better than his performance on the BVRT.

On the PM, subject attained an adequate test quotient (118), but the quality of his performance was poor with many errors of "line crossing" and especially "wavy line." The sloppy performance is not a result of inadequate motivation. His cooperation on all tests was good and on the PM he did follow the instructions not to lift the pencil, an instruction many have to be reminded of often.

Of the six sequences on the WCST, subject solved correctly only two. Of the 120 cards, he sorted incorrectly 80 and of them half were errors of perseveration. An inability to shift set and the high ratio of perseveration errors again suggest an organic deficit.

We find further support for the above hypothesis in the large number of both errors of commission and omission on the CPT. He missed 64/200 critical stimuli and responded 97 times incorrectly. Such poor performance is characteristic of people suffering from serious difficulties in their ability to sustain attention. Lack of cooperation and poor test motivation has to be ruled out by the fact of so many commission errors. The impaired performance was not a result of not responding.

On a test requiring auditory attention, subjects performance was considerably better, Thus, on the subtest of Digit Span -- which appears in the WAIS and WMS -- subject correctly repeated 6 digits forward and 4 backwards. While not particularly good, it is a performance with a scaled score of 9 (10 being average). It appears then that the subject's sensory deficit is specific to the visual field and that both registration and retention are deficient. That his memory is deficient is also evident for the Mental Quotient of 89 on the WMS.

On the WAIS, subject achieved a Full Scale IQ of 101 placing him in the exact middle of the average range. His performance was spotty. The record shows considerable inter-subtest variance, especially between the performance subtests. On the verbal part, there is considerable intra-subtest variability: failures on easier items and passing more difficult ones. The above suggests distortions in the cognitive process -- possibly dynamic -- and interference with the ability to acquire new knowledge.
On the WAIS this incapacity is dramatically evident from the very low score on the subtest of Digit Symbol. On the other two psychomotor subtests, subject achieved scaled scores of 10 and 11, while on the Digit Symbol only 4. Interestingly, in light of the earlier discussion, this subtest requires

the reproduction of visual stimuli, but basically good performance depends on applying available knowledge to similar situations (without having to shift set). In another context, the associate learning subtest of the WMS, his performance was also poor. Even after three replications, subject did not require even one of the four more difficult associations (i.e., cabbage-pen; cabbage-?) despite his having been supplied with the correct answer after each mistake. It is a matter of speculation whether the noted learning deficiencies have contributed to the subject's inability to sustain new behavior after each operative procedure.

The test results do not indicate the presence of either anxiety or depression.

The patient made the decision in consultation with his doctors. He has no regrets and would definitely do it again, only sooner this time. Both the patient and family feels that his was a very successful case.

CONTENTS OF APPENDIX DOCUMENTS

APPENDIX 1

Boston University Medical Center

School of Medicine
80 East Concord Street
Boston, Massachusetts 02118

Division of Psychiatry
Psychosurgery Evaluation Program

March 23, 1976

To The Members of the Massachusetts Psychiatric Association:

After consulting with your president, Dr. Carol Nadelson, we are asking your help in securing patients for a study we are conducting for the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. This Commission was created by Congress to investigate a number of issues of current national concern in the areas of biomedical research, and to make recommendations to the Congress concerning possible new legislation. This project is designed, in part, to assess the effectiveness of psychosurgical therapy in various psychiatric illness. Our main focus is on patients who have undergone some kind of psychosurgical procedure during the period 1965-1974. However, we are also interested in persons for whom a procedure was recommended but declined, or who fit our current criteria of suitability as subjects. It is these persons, who have <u>not</u> had psychosurgery, that we wish to contact. Your help is needed here.

We wish to see persons with diagnoses of unipolar or bipolar affective illness of long standing, and those with diagnoses of severe and intractable obsessive-compulsive illness. We are not excluding persons who may also carry the diagnosis of schizophrenia.

If you know of patients who fit these descriptions we would be extremely grateful if you could so inform us. We can then describe the procedures we must follow to secure the patient's consent and to insure confidentiality. After suitable informed consent has been obtained, some patients would be invited to come to Boston University Medical Center and affiliated laboratories for 2 - 3 days of psychiatric, psychological and neurological tests. If necessary, participants may bring a companion, and both may be housed at a Boston hotel during this time. All their expenses (including travel) would be covered; in addition, the participants would receive $100 a day for their help. Some of the reports of the testing (including EEG, neurological examination, etc.) could be made available to the referring physician, if the patient and physician so desire.

Since this portion of our study must terminate by April 30, 1976, we must recruit subjects as soon as possible. We appreciate your cooperation in assisting us with this project. You will be aiding us in a study of high mental health relevance, the outcome of which may help to shape future national health policies. If you know of suitable patients, please call Dr. Maressa H. Orzack (collect) at (617) 288-1558.

Sincerely,

Allan F. Mirsky

Allan F. Mirsky, Ph.D.
Professor of Psychiatry (Neuropsychology)
and Neurology

Maressa Hecht Orzack

Maressa H. Orzack, Ph.D.
Associate Professor of Psychiatry
(Psychology)

APPENDIX 2

I agree to participate in the evaluative study on psychosurgery performed between 1966 and 1974 as mandated by Congress in 1974. I understand that everything possible will be done to keep my identity secret by assigning a code number to me and keeping it in a locked file. However, I also understand that the nature of my operative technique is such that I may be able to be identified. Knowing these risks I nevertheless agree to participate in this study.

Signed____________________________________ Date________________

Witness___________________________________ Date________________

APPENDIX 3

December 8, 1975

Dear

Several years ago you were referred to me for consultation about the difficulties you were experiencing at that time. As you may recall I recommended that you undergo ______________________________ a particular psychosurgical procedure. On ____________________________ this operation was performed on you.

At this time there is considerable interest in this operation and a Commission set up by the federal government has asked a research team composed of a psychiatrist, psychologist, neurologist and a social worker to evaluate this operation. In order to carry out such an evaluation the team must have access to records of patients on whom the operation was performed.

I am therefore requesting your permission to make available your medical records to this team. If your permission is granted all the information will be kept confidential. Your name will not be used in any way but some of the information may be used for statistical purposes. If this is done you will be assigned a code number which will identify you only to the team of researchers. Your name and code number will be kept in a locked file.

If the team feels it is necessary they may contact you for an interview and some possible testing. They will explain the entire procedure to you and at that time you will be free to decide whether or not you wish to participate in any further study. If you agree to be tested, you will be paid $100 a day plus expenses.

If you have any questions, please phone me or my secretary, __________ _____________, collect at _________________.

If not would you please fill out the enclosed form and mail it in the enclosed envelope.

If you do not wish to participate, please check here _________________ and return this letter in the enclosed envelope.

If you do not choose to participate in the actual study, we will send you a form on which you can indicate your reasons for not wishing to participate. This information will be kept confidential in a locked file.

Enclosed is a self-addressed, stamped envelope for your reply.

Sincerely yours,

APPENDIX 4

LETTER FOR PATIENT TO
RETURN TO NEUROSURGEON

I give Dr.__________________________ permission to show my medical records to the research team which is investigating the effects of psychosurgery. I understand that the data will not be used except for statistical purposes. and that my name will be kept confidential.

I understand further that I may be contacted by the research team composed of a psychiatrist, psychologist, neurologist and a social worker for an interview and further evaluation. Should this occur I will have the entire procedure explained and I will be allowed at that time to decide whether or not I wish to participate any further. I have had all my questions answered.

I have read this statement of informed consent. I understand this statement of informed consent. I understand that I may withdraw my consent at any time. I voluntarily give Dr. __________________________ permission to show my records to the research team.

Signed____Date______________________________

Witness____Date______________________________

APPENDIX 5

Boston University Medical Center

School of Medicine
80 East Concord Street
Boston, Massachusetts 02118

Division of Psychiatry
Psychosurgery Evaluation Program

Dear

Thank you very much for your permission to let us look at your records. We have done so and would like to include you in the rest of the study if you are willing.

If you recall in the initial letter which Dr. sent you, there was mention of the possibility that we would contact you for an interview and possible testing. This further phase of the study would consist of the following: we would bring you, (all expenses paid), to Boston. In addition we would pay you $100 a day for participating in the study. In Boston you will be housed in a hotel in the center of town and would be expected to spend the better part of two days undergoing tests and interviews.

If you feel it necessary, you may bring a companion with you to Boston, whose expenses (plus $100 a day) would also be paid. In that case, it would be most desirable if the companion were someone who knows you well and who knew you before the operation. Part of our study involves, with your permission, questioning some such person about your general health and well-being. If you bring a companion and this person is knowledgeable about you he or she may be interviewed while you are in Boston.

The members of the team who will see you are psychiatrists, psychologists, neurologists and social workers. You will undergo a psychiatric evaluation which lasts about one hour and a series of psychological tests which would be spread out over the two days. Some of these are paper and pencil tests and some require that you press buttons, sort cards and watch numbers presented to you. During some of these tests you may be required to have electrodes attached to your head and face to measure eye movements and brain waves.

A social worker will ask you questions about your feelings toward the operation now and in particular the way you felt about it before you had it. The social worker will also interview some member of your family about your adjustment in the community and how your family felt about your operation. You will also undergo complete neurological and EEG examinations at University Hospital.

You will be required during the course of the two days to fill out. questionnaires concerning how you feel. If in the course of the two days you wish to discontinue, you may do so and will be paid for the time you put in at the rate of $100 a day.

If you agree to participate in the study, all the information will be kept confidential. Your name will not be used in any way, but the information will be used statistically. In order to be paid, however, your name and social security number will have to be given to the Boston University financial office. No other identifying information will be necessary.

Enclosed are the consent forms which we would like you to fill out if you desire to participate in the study. We will follow this letter shortly with a phone call to obtain your answer and make any further arrangements.

In the event that travel to Boston is very difficult or impossible for you, we would like to know that as well. It may be possible to make some alternative plan to see you.

Sincerely yours,

Maressa Hecht Orzack, Ph.D.
Associate Professor
Psychiatry (Psychology)

Allan F. Mirsky, Ph.D.
Professor of Psychiatry (Neuropsychology)
and Neurology

MHO:CAJ
Enclosures

I agree to participate in this study of psychosurgery. I understand that it is necessary to test patients on whom this procedure was performed in order to evaluate the effects of psychosurgery.

I understand I will have to come to Boston State Hospital for approximately two full days where 1 will be interviewed and evaluated by a team of researchers composed of a psychiatrist, psychologist, neurologist and a social worker. I will have electrodes attached to my head, perform certain paper and pencil tests, and push keys for some other tests. These tests will measure my visual and verbal abilities. The results of these tests will be kept confidential and will be used only for statistical purposes. I understand my name will not be used in any way, I will be assigned a code number and my name and code number will be kept in a locked file.

I understand that there are no risks in this study except the possibility of minor skin irritation from the paste used to attach the electrodes to my head.

I understand that I will be given a complete neurological examination and I understand that if I wish, the results from my neurological exam will be made available to my physician. I understand that I will be paid $100 per day for participating in this study as well as any other expenses, including travel, which I may incur.

All my questions have been answered. I have read this statement of informed consent. I understand this statement of informed consent and the attendant risks described therein. I understand that I may withdraw my consent at any time without jeopardy to my current or future treatment and I will be paid for my participation up to that time. I agree voluntarily to participate in this study.

Signed ______________________________ Date ____________________

Witness ______________________________ Date ____________________

APPENDIX 7

I do not wish to participate in this study:

1. Because I just do not wish to participate for my own personal reasons.

2. Because I am too busy.

3. I do not wish to be reminded of this operation again.

4. I wish to have nothing to do with-the neurosurgeon.

5. Do not bother me again.

Sign____ Date____________________

APPENDIX 8

The research team conducting this study about the effects of psychosurgery has explained to me that they would like to gather information about my adjustment at home and in the community. They have asked me to give them permission to interview some members of my family. A social worker will visit my home to interview some of my family and ask them questions about my home and family adjustment. All of the information will be kept confidential. Neither my name nor my relative's names will be used since a code number will be assigned to my case. I understand my name will not be used in any way, I will be assigned a code number and my name and code number will be kept in a locked file. I voluntarily consent to allow the research team to contract my family about their willingness to be interviewed.

Signed ______________________________ Date ______________________

Witness ______________________________ Date ______________________

I agree to be interviewed by a social worker from the research team from Boston University investigating the effects of psychosurgery. I understand they wish to ask me questions about my relative ______________ ____________________ who was operated on by Dr.____________________________ on ________________________.

I understand that my relative knows that I will be asked questions about my home and community adjustment. I understand that the information obtained in this interview will be kept confidential and the data will be used for statistical purposes only. Neither my name nor my relatives' name will be used since a code number will be assigned to his/her case. The names and code numbers will be kept in a locked file.

I have read this statement of informed consent. I understand this statement of informed consent. I understand that I may withdraw my consent at any time without jeopardy to current and future treatment of my relative.

I voluntarily consent to be interviewed by the social worker who is a member of the research team.

Signed ____ Date________________________

Witness____ Date________________________

I agree to participate in this study of psychosurgery as a control.

I understand I will have to come to Boston State Hospital for approximately two full days where I will be interviewed and evaluated by a team of researchers composed of a psychiatrist, psychologist, neurologist and a social worker. I will have electrodes attached to my head, perform certain paper and pencil tests, and push keys for some other tests. These tests will measure my visual and verbal abilities. The results of these tests will be kept for statistical purposes. I understand my name will not be used in any way, I will be assigned a code number and my name and code number will be kept in a locked file.

I understand that there are no risks involved in this study except the possibility of minor skin irritation from the paste used to attach the electrodes to my head.

I understand that I will be given a complete neurological examination and if I wish the results of this exam will be made available to my physician. I understand that I will be paid $100 per day for participating in this study as well as any other expenses, including travel, which I may incur.

All my questions have been answered. I have read this statement of informed consent. I understand this statement of informed consent and the attendant risks described therein. I understand that I may withdraw my consent at any time without jeopardy to any current and future treatment I might undergo and that I will be paid for my participation up to that time. I agree voluntarily to participate in this study.

Signed ______________________________ Date ____________________

Address ____

Telephone # ____________________

Witness ______________________________ Date ____________________

I agree to participate in this study of psychosurgery. I understand that it is necessary to test patients for whom this procedure was recommended but not carried out in order to evaluate the effects of psychosurgery.

I understand I will have to come to Boston State Hospital for approximately two full days where I will be interviewed and evaluated by a team of researchers composed of a psychiatrist, psychologist, neurologist and a social worker. I will have electrodes attached to my head, perform certain paper and pencil tests, and push keys for some other tests. These tests will measure my visual and verbal abilities. The results of these tests will be kept for statistical purposes. I understand my name will not be used in any way, I will be assigned a code number-and my name and code number will be kept in a locked file.

I understand that there are no risks involved in this study except the possibility of minor skin irritation from the paste used to attach the electrodes to my head.

I understand that I will be given a complete neurological examination and if I wish the results of this exam will be made available to my physician. I understand that I will be paid $100 per day for participating in this study as well as any other expenses, including travel, which I may incur.

All my questions have been answered. I have read this statement of informed consent. I understand this statement of informed consent and the attendant risks described therein. I understand that I may withdraw my consent at any time without jeopardy to any current and future treatment I might undergo and that I will be paid for my participation up to that time. I agree voluntarily to participate in this study.

Signed ______________________________ Date ____________________

Witness ______________________________ Date ____________________

APPENDIX 12

I agree to be interviewed by a social worker from the research team from Boston University investigating the effects of psychosurgery. I understand they wish to ask me questions about my relative_____________ ______________________ for whom Dr._____________________ recommended a ________________________________.

I understand that my relative knows that I will be asked questions about my home and community adjustment. I understand that the information obtained in this interview will be kept confidential and the data will be used for statistical purposes only. Neither my name nor my relatives' name will be used since a code number will be assigned to his/her case. The names and code numbers will be kept in a locked file.

I have read this statement of informed consent. I understand this statement of informed consent. I understand that I may withdraw my consent at any time without jeopardy to current and future treatment of my relative.

I voluntarily consent to be interviewed by the social worker who is a member of the research team.

Signed____________________________________ Date_________________________

Witness___________________________________ Date_________________________

PROBLEM APPRAISAL SCALES (PAS)*

Patient's last name	First name	M.I.	Facility	Unit

INSTRUCTIONS: Rate the patient's condition during the last two weeks. When no information is available on a dimension or when a dimension is not applicable (e.g. Social Relations With Children), the scale should be left blank. 1=none, 2=slight, 3=mild, 4=moderate, 5=marked

[...]e or consecutive number

::0:: ::1:: ::2:: ::3:: ::4:: ::5:: ::6:: ::7:: ::8:: ::9::

Facility code

::0:: ::1:: ::2:: ::3:: ::4:: ::5:: ::6:: ::7:: ::8:: ::9::

Last day of two weeks being evaluated

Jan Feb Mar Apr May **Month** Jun Jul Aug Sep Oct

::1:: ::69:: ::70:: ::71:: ::72:: **Year** ::73:: ::74:: ::75:: Nov Dec

::2:: ::3:: ::4:: ::5:: ::6:: ::7:: ::8:: ::9:: ::10:: ::11::

::12:: ::13:: ::14:: ::15:: ::16:: **Day** ::17:: ::18:: ::19:: ::20:: ::21::

::22:: ::23:: ::24:: ::25:: ::26:: ::27:: ::28:: ::29:: ::30:: ::31::

TRANSACTION: initial evaluation / reevaluation / partial reeval / correction / deletion

PHYSICAL FUNCTION

01 Sleep problems
Too much or too little.
::1:: ::2:: ::3:: ::4:: ::5::

02 Eating problems
Too much or too little.
::1:: ::2:: ::3:: ::4:: ::5::

03 Enuresis, soiling
::1:: ::2:: ::3:: ::4:: ::5::

04 Seizures, convulsions
::1:: ::2:: ::3:: ::4:: ::5::

05 Speech articulation problem
::1:: ::2:: ::3:: ::4:: ::5::

06 Other physical problems
::1:: ::2:: ::3:: ::4:: ::5::

07 INTELLECTUAL DEVELOP.
Estimate if IQ score unavailable.

super bright	average	dull	retard
1+ 110-119	86-109	68-85	below 68

SOCIAL RELATIONS

08 With children
Impairment of expected parental role with his child(ren). Consider performance of expected tasks, comfort and satisfaction.
::1:: ::2:: ::3:: ::4:: ::5::

09 With mate, spouse
Impairment in satisfaction, comfort and performance of expected social and sexual activities with his mate or spouse (include common-law).
::1:: ::2:: ::3:: ::4:: ::5::

10 With other family
Impairment in satisfaction, comfort and performance of expected social activities with other family members (sibs, parents, cousins, in-laws).
::1:: ::2:: ::3:: ::4:: ::5::

11 With other people
Impairment in satisfaction, comfort and performance of expected social activities with other people (not in family).
::1:: ::2:: ::3:: ::4:: ::5::

SOCIAL PERFORMANCE

12 School
Impairment in performance as a student. Consider grades, work habits, missed classes. If not going to school because of psychopathology, rate 5.
::1:: ::2:: ::3:: ::4:: ::5::

13 Job
Impairment in performance of job. Include missing work, need for supervision. If not working because of psychopathology, rate 5. If retired leave blank.
::1:: ::2:: ::3:: ::4:: ::5::

14 Housekeeping
Impairment in the performance of duties associated with caring for home and family. Consider shopping, cleaning, cooking.
::1:: ::2:: ::3:: ::4:: ::5::

OTHER SIGNS AND SYMPTOMS

15 Suicidal thoughts
Suicidal thoughts or preoccupation.
::1:: ::2:: ::3:: ::4:: ::5::

16 Suicidal acts, gestures
Suicidal acts, attempts or gestures. Consider threat to life.
::1:: ::2:: ::3:: ::4:: ::5::

17 Anxiety, fears, phobias
Feelings of apprehension, worry, anxiety, nervousness, tension, fear and phobia(s).
::1:: ::2:: ::3:: ::4:: ::5::

18 Obsessions, compulsions
Unwanted recurrent thoughts, acts, or routines, the content or purpose of which he regards as senseless.
::1:: ::2:: ::3:: ::4:: ::5::

19 Depressed mood, inferiority
Feelings of sadness, depression, worthlessness, inadequacy, remorse, guilt, failure or loss.
::1:: ::2:: ::3:: ::4:: ::5::

20 Somatic concerns, hypochond.
Excessive concerns with bodily functions; preoccupation with one or more real or imagined physical complaints or disabilities.
::1:: ::2:: ::3:: ::4:: ::5::

21 Social withdrawal, isolation
Avoidance of contact or involvement with people; preference for being alone; feelings of isolation, rejection or discomfort with people.
::1:: ::2:: ::3:: ::4:: ::5::

22 Dependency, clinging
Feelings of being unable to cope without assistance, praise, or reassurance from others; clings to other people in order to get them to take care of him.
::1:: ::2:: ::3:: ::4:: ::5::

23 Grandiosity
Inflated appraisal of his worth, contacts, power or knowledge.
::1:: ::2:: ::3:: ::4:: ::5::

24 Suspicion, persecution
From mild suspiciousness to belief that he is being persecuted. Examples: distrustfulness; feels mistreated or taken advantage of; feels people stare at him.
::1:: ::2:: ::3:: ::4:: ::5::

25 Delusions
Conviction(s) in some important personal belief which is almost certainly not true.
::1:: ::2:: ::3:: ::4:: ::5::

26 Hallucinations
Hears voices or sounds; sees, feels, smells, or tastes something with no external source.
::1:: ::2:: ::3:: ::4:: ::5::

27 Anger, belligerence, negativism
Overt anger, belligerence, or negativism. Examples: evasive, argumentative, sarcastic, acts or threats of violence.
::1:: ::2:: ::3:: ::4:: ::5::

28 Assaultive acts
Actual physical violence or assault against some person.
::1:: ::2:: ::3:: ::4:: ::5::

29 Alcohol abuse
Excessive use of alcohol, causing physical symptoms, alteration in mood or behavior, or interfering with routine or duties.
::1:: ::2:: ::3:: ::4:: ::5::

30 Narcotics, other drugs
Excessive self medication, unprescribed use of narcotics, barbiturates, stimulants, or consciousness expanding substances.
::1:: ::2:: ::3:: ::4:: ::5::

31 Antisocial attitudes, acts
Lying; stealing; swindling; "conning;" encouraging breaking of rules; minor or serious illegal acts.
::1:: ::2:: ::3:: ::4:: ::5::

32 Sexual problems
Impairment in performance or satisfaction in sexual activities, homosexual or other perverse impulses or behavior.
::1:: ::2:: ::3:: ::4:: ::5::

33 Agitation, hyperactivity
Overt tension, agitation or hyperactivity. Examples: fidgeting, inability to sit still; pacing, fast speech. Do not include mere subjective restlessness or tension.
::1:: ::2:: ::3:: ::4:: ::5::

34 Disorientation, memory
Signs that he does not know where he is, the date or time of day, or who he is; impairment in memory of recent or past events.
::1:: ::2:: ::3:: ::4:: ::5::

35 Speech disorg., incoherence
Impairment in the form of speech which makes it difficult to follow or understand. Examples: speech aimless, too detailed, phrases or thoughts have little logical connection, makes no sense, rapid changes of topic so ideas are not completed.
::1:: ::2:: ::3:: ::4:: ::5::

36 Slowed up, lack of emotion
Slowing down or lack of speech or movements; lack of emotional expression or response in face, speech or gestures.
::1:: ::2:: ::3:: ::4:: ::5::

37 Daily routine, leisure time
Inability or refusal to do usual daily activities or to carry through tasks which he or others expect him to do; impairment in pleasure or ability in leisure time activities.
::1:: ::2:: ::3:: ::4:: ::5::

38 Inapprop. affect., appear., behav.
Inappropriate, odd, or strange affect, appearance or behavior.
::1:: ::2:: ::3:: ::4:: ::5::

Primary problem (Number of scale. 01 to 38. Leave blank if unknown.)
::0:: ::1:: ::2:: ::3::
::0:: ::1:: ::2:: ::3:: ::4:: ::5:: ::6:: ::7:: ::8:: ::9::

Rater code
::0:: ::1:: ::2:: ::3:: ::4:: ::5:: ::6:: ::7:: ::8:: ::9::
::0:: ::1:: ::2:: ::3:: ::4:: ::5:: ::6:: ::7:: ::8:: ::9::
::0:: ::1:: ::2:: ::3:: ::4:: ::5:: ::6:: ::7:: ::8:: ::9::

Overall severity of condition or impairment
not ill / slight / mild / moderate / marked / severe / among most extreme

Duration of condition or impairment less than
Present or most recent episode showing continuous evidence of disturbance; if chronic, when a noticeable change in intensity or nature occurs.
1wk / 2wk / 1mo / 3mo / 6mo / 1yr / 2yr / 2yr+

Signature | **Date**

* Developed by Robert L. Spitzer, M.D. and Jean Endicott, Ph.D. Biometrics Research [illegible] Department of Mental Hygiene [illegible]

HSCL-80 (1)

NAME ______________________ CODE ________ DATE ________ J.D. ______ VISIT ______

INSTRUCTIONS: Here is a list of symptoms or problems that people sometimes have. Decide how much each problem bothered or distressed you during the past week, including today. Circle one number to indicate whether it bothered you . . . . NOT AT ALL?, A LITTLE?, QUITE A BIT?, EXTREMELY?

During the past week including today, how much did each symptom bother or distress you? (Do not leave out any items.)

SYMPTOMS	NOT AT ALL	A LITTLE	QUITE A BIT	EXTREMELY
1. Headaches	0	1	2	3
2. Nervousness or shakiness inside	0	1	2	3
3. Faintness or dizziness	0	1	2	3
4. Loss of sex interest or pleasure	0	1	2	3
5. Feeling critical of others	0	1	2	3
6. Trouble remembering	0	1	2	3
7. Sloppiness or carelessness	0	1	2	3
8. Feeling easily annoyed or irritated	0	1	2	3
9. Heart or chest pains	0	1	2	3
10. Feeling afraid in open spaces or on streets	0	1	2	3
11. Low in energy or slowed down	0	1	2	3
12. Thoughts of ending your life	0	1	2	3
13. Trembling	0	1	2	3
14. Poor appetite	0	1	2	3
15. Crying easily	0	1	2	3
16. Feeling caught or trapped	0	1	2	3
17. Suddenly becoming scared for no reason	0	1	2	3
18. Temper outbursts you could not control	0	1	2	3
19. Being afraid to go out of house alone	0	1	2	3
20. Blaming yourself	0	1	2	3
21. Lower back pains	0	1	2	3
22. Feeling blocked in getting things done	0	1	2	3
23. Feeling lonely	0	1	2	3
24. Feeling blue	0	1	2	3

Psychopharmacology Laboratory
Boston University Medical Center
Boston, MA. 8

SYMPTOMS	NOT AT ALL	A LITTLE	QUITE A BIT	EXTREMELY
25. Worrying too much	0	1	2	3
26. Feeling no interest in things	0	1	2	3
27. Feeling fearful	0	1	2	3
28. Your feelings being easily hurt	0	1	2	3
29. Feeling others misunderstand you or are unsympathetic	0	1	2	3
30. Feeling people are unfriendly or dislike you	0	1	2	3
31. Having to do things very slowly to be sure you do them right	0	1	2	3
32. Heart pounding or racing	0	1	2	3
33. Nausea or upset stomach	0	1	2	3
34. Feeling inferior to others	0	1	2	3
35. Muscle soreness	0	1	2	3
36. Feeling watched or talked about	0	1	2	3
37. Trouble falling asleep	0	1	2	3
38. Having to check and double check what you do	0	1	2	3
39. Difficulty making decisions	0	1	2	3
40. Fear of going on buses, subways, or trains	0	1	2	3
41. Trouble getting your breath	0	1	2	3
42. Hot or cold spells	0	1	2	3
43. Having to avoid certain things, places or activities that frighten you	0	1	2	3
44. Your mind going blank	0	1	2	3
45. Numbness or tingling in your body	0	1	2	3
46. Lump in your throat	0	1	2	3
47. Feeling hopeless about future	0	1		3

Turn page and continue

CODE ________ VISIT ________

During the past week including today, how much did each symptom bother or distress you? (Do not leave out any items.)

SYMPTOMS	NOT AT ALL	A LITTLE	QUITE A BIT	EXTREMELY
48. Trouble concentrating	0	1	2	3
49. Weak feelings in your body	0	1	2	3
50. Feeling tense or keyed up	0	1	2	3
51. Arms or legs feeling heavy	0	1	2	3
52. Feeling all pleasure and joy has gone from life	0	1	2	3
53. Overeating	0	1	2	3
54. Urges to beat, injure or harm someone	0	1	2	3
55. Having to repeat the same actions (touching, counting, handwashing)	0	1	2	3
56. Restless or disturbed sleep	0	1	2	3
57. Thinking something is wrong with your mind	0	1	2	3
58. Urges to break or smash things	0	1	2	3
59. Feeling uneasy in crowds, shops or movies	0	1	2	3
60. Feeling everything an effort	0	1	2	3
61. Spells of terror or panic	0	1	2	3
62. Getting into frequent arguments	0	1	2	3
63. Feeling nervous when left alone	0	1	2	3
64. Feeling you may never enjoy yourself again	0	1	2	3
65. Dry mouth	0	1	2	3
66. Loneliness even when with people	0	1	2	3
67. Feeling so restless you can't sit still	0	1	2	3
68. Feeling worthless	0	1	2	3
69. Familiar things seem strange or unreal	0	1	2	3
70. Shouting or throwing things	0	1	2	3

SYMPTOMS	NOT AT ALL	A LITTLE	QUITE A BIT	EXTREMELY
71. Fearing you will faint in public	0	1	2	3
72. Feeling pushed to get things done	0	1	2	3
73. Not feeling close to another person	0	1	2	3
74. Guilt feelings	0	1	2	3
75. Not getting any fun out of life	0	1	2	3
76. Sleepiness during the day	0	1	2	3
77. Sweating	0	1	2	3
78. Awake early in morning and can't go back to sleep	0	1	2	3
79. Loss of interest in hobbies or social activities you once enjoyed	0	1	2	3
80. Making an argument of almost anything	0	1	2	3

Make sure you have answered every item on both sides

APPENDIX 15

E C F V A D T

NAME ______________________ DATE __________

Below is a list of words that describe feelings people have. Please read each one carefully. Then fill in ONE space under the answer to the right which best describes HOW YOU HAVE BEEN FEELING DURING THE PAST WEEK INCLUDING TODAY.

The numbers refer to these phrases:
0 = Not at all
1 = A little
2 = Moderately
3 = Quite a bit
4 = Extremely

IDENTIFICATION

Item	NOT AT ALL	A LITTLE	MODERATELY	QUITE A BIT	EXTREMELY
1. Friendly	0	1	2	3	4
2. Tense	0	1	2	3	4
3. Happy	0	1	2	3	4
4. Angry	0	1	2	3	4
5. Worn out	0	1	2	3	4
6. Unhappy	0	1	2	3	4
7. Confused	0	1	2	3	4
8. Lively	0	1	2	3	4
9. Unable to concentrate	0	1	2	3	4
10. Sorry for things done	0	1	2	3	4
11. Shaky	0	1	2	3	4
12. Listless	0	1	2	3	4
13. Overjoyed	0	1	2	3	4
14. Peeved	0	1	2	3	4
15. Agreeable	0	1	2	3	4
16. Sad	0	1	2	3	4
17. Active	0	1	2	3	4
18. On edge	0	1	2	3	4
19. Grouchy	0	1	2	3	4
20. Fatigued	0	1	2	3	4
21. Muddled	0	1	2	3	4
22. Blue	0	1	2	3	4
23. Energetic	0	1	2	3	4
24. Spiteful	0	1	2	3	4
25. Hopeless	0	1	2	3	4
26. Satisfied	0	1	2	3	4
27. Panicky	0	1	2	3	4
28. Helpful	0	1	2	3	4
29. Unworthy	0	1	2	3	4
30. Annoyed	0	1	2	3	4
31. Cheerful	0	1	2	3	4
32. Exhausted	0	1	2	3	4
33. Resentful	0	1	2	3	4
34. Forgiving	0	1	2	3	4
35. Discouraged	0	1	2	3	4
36. Relaxed	0	1	2	3	4
37. Bewildered	0	1	2	3	4
38. Sluggish	0	1	2	3	4
39. Uneasy	0	1	2	3	4
40. Kindly	0	1	2	3	4
41. Lonely	0	1	2	3	4
42. Miserable	0	1	2	3	4
43. Efficient	0	1	2	3	4
44. Bitter	0	1	2	3	4
45. Pleased	0	1	2	3	4
46. Alert	0	1	2	3	4
47. Ready to fight	0	1	2	3	4
48. Restless	0	1	2	3	4
49. Good-natured	0	1	2	3	4
50. Gloomy	0	1	2	3	4
51. Desperate	0	1	2	3	4
52. Rebellious	0	1	2	3	4
53. Nervous	0	1	2	3	4
54. Helpless	0	1	2	3	4
55. Weary	0	1	2	3	4
56. Elated	0	1	2	3	4
57. Forgetful	0	1	2	3	4
58. Deceived	0	1	2	3	4
59. Full of pep	0	1	2	3	4
60. Warm-hearted	0	1	2	3	4
61. Carefree	0	1	2	3	4
62. Furious	0	1	2	3	4
63. Uncertain about things	0	1	2	3	4
64. Worthless	0	1	2	3	4
65. Anxious	0	1	2	3	4
66. Vigorous	0	1	2	3	4
67. Terrified	0	1	2	3	4
68. Good-tempered	0	1	2	3	4
69. Guilty	0	1	2	3	4
70. Bushed	0	1	2	3	4
71. Bad-tempered	0	1	2	3	4
72. Refreshed	0	1	2	3	4

BE SURE YOU HAVE ANSWERED EVERY ITEM!

SUBJECT REPORT OF DRUG USE

1. Are you taking any medication (drugs) at the present time?

YES________________ NO____________________

If "yes"

A. What drug(s)
1. ____________________
2. ____________________
3. ____________________

B. Dose(s)
1. ____________________
2. ____________________
3. ____________________

C. Frequency
1. ____________________
2. ____________________
3. ____________________

D. For how long?
1. ____________________
2. ____________________
3. ____________________

E. Reason(s)**
1. ____________________
2. ____________________
3. ____________________

** e.g., "I was depressed, I was anxious, I had headaches."

2. After you recovered from surgery were you taking any medication?

YES ________ NO ________

If "yes"

A. What drug(s)? 1. ________

2. ________

3. ________

B. Dose(s) 1. ________

2. ________

3. ________

C. Frequency 1. ________

2. ________

3. ________

D. For how long? 1. ________

2. ________

3. ________

E. Reason(s) 1. ________

2. ________

3. ________

3. Alcoholic beverage

Presurgery:

Frequency of drinking: Daily ______ , Weekends______ , Once a month or less ______.

Amount per day when drinking (give number of drinks) ______.

Pattern of Drinking:

Usually drinks alone ______, with friends ______ , with strangers______.

Usually drinks at home ______ , at bar or club ______ , in street or park ______.

Postsurgery:

Frequency of drinking: Daily ______, Weekends ______, once a month or less ______.

Amount per day when drinking (give number of drinks) ______.

Pattern of Drinking:

Usually drinks alone ______ , with friends ______ , with strangers ______.

Usually drinks at home ______ , at bar or club ______ , in street or park ______.

APPENDIX 17

GLOBAL ASSESSMENT SCALE (GAS)

Robert L. Spitzer, M.D., Miriam Gibbon, M.S.W., Jean Endicott, Ph.D.

Rate the subject's lowest level of functioning in the last week by selecting the lowest range which describes his functioning on a hypothetical continuum of mental health-illness. For example, a subject whose "behavior is considerably influenced by delusions" (range 21-30), should be given a rating in that range even though he has "major impairment in several areas" (range 31-40): Use intermediary levels when appropriate (e.g., 35, 58, 62). Rate actual functioning independent of whether or not subject is receiving and may be helped by medication or some other form of treatment.

Name of Patient__________ ID No________ Consec No______ Group Code______

Admission Date________ Date of Rating________ Rater__________

GAS Rating: ______________

100–91 No symptoms, superior functioning in a wide range of activities, life's problems never seem to get out of hand, is sought out by others because of his warmth and integrity.

90–81 Transient symptoms may occur, but good functioning in all areas, interested and involved in a wide range of activities, socially effective, generally satisfied with life, "everyday" worries that only occasionally get out of hand.

80–71 Minimal symptoms may be present but no more than slight impairment in functioning, varying degrees of "everyday" worries and problems that sometimes get out of hand.

70–61 Some mild symptoms (e.g., depressive mood and mild insomnia) OR some difficulty in several areas of functioning, but generally functioning pretty well, has some meaningful interpersonal relationships and most untrained people would not consider him "sick."

60–51 Moderate symptoms OR generally functioning with some difficulty (e.g., few friends and flat affect, depressed mood and pathological self-doubt, euphoric mood and pressure of speech, moderately severe antisocial behavior).

50–41 Any serious symptomatology or impairment in functioning that most clinicians would think obviously requires treatment or attention (e.g., suicidal preoccupation or gesture, severe obsessional rituals, frequent anxiety attacks, serious antisocial behavior, compulsive drinking).

40 Major impairment in several areas, such as work, family relations, judgment, thinking or mood (e.g., depressed woman avoids friends, neglects family, unable to do housework), OR some impairment in reality testing or communication (e.g., speech is at times obscure, illogical or irrelevant), OR single serious suicide attempt,
31

30 Unable to function in almost all areas (e.g., stays in bed all day) OR behavior is considerably influenced by either delusions or hallucinations OR serious impairment in communication (e.g., sometimes incoherent or unresponsive) or judgment (e.g., acts grossly inappropriately).
21

20 Needs some supervision to prevent hurting self or others, or to maintain minimal personal hygiene (e.g., repeatedsuicide attempts, frequently violent, manic excitement, smears feces), OR grose impairment in communication (e.g., largely incoherent or mute).
11

10 Needs constant supervision for several days to prevent hurting self or others, or makes no attempt to maintain minimal personal hygiene (e.g., requires an intensive care unit with special observation by staff).
1

APPENDIX 18

PREOPERATIVE DATA INVENTORY

1. SUBJECT'S BIRTH DATE

2. SUBJECT'S SEX

    1 - male
    2 - female

3. SUBJECT'S RACE

    0 - caucasoid
    1 - negroid
    2 - mongoloid
    3 - other

4. MARITAL STATUS

    0 - never married
    1 - presently married for first time
    2 - presently married with previous marriage/s
    3 - previously but not presently married (separated or divorced)
    4 - previously but not presently married (widowed)

5. SOCIOECONOMIC STATUS

    A. OCCUPATION

        1- Subject's highest occupational attainment is . . .
        2 - Head of Household's highest occupational attainment is . . .

<u>If subject is head of household, code 0</u>

        1- Higher executive, proprietor of large concern, major prof.
        2 - Business manager of large concern, proprietor of medium-sized business, lesser professional
        3 - Administrative personnel, owner of small independent business, minor professional
        4 - Clerical or sales worker, technician, owner of little business
        5 - Skilled manual employee
        6 - Machine operator, semi-skilled employee
        7 - Unskilled employee.
        8 - Never worked in paid employment
        9 - Not ascertained

5. SOCIOECONOMIC STATUS

B. EDUCATION

1 - Using scale, code highest level attained by subject
2 - Code highest level attained by Head of Household

If subject is head of household, code 0

1 - Graduate or professional training (individuals who have completed or who have attended one year of a recognized professional course)
2 - College or university graduate (individuals who have completed a four year college or university course leading to a recognized college or university degree)
3 - Partial college training (individuals who have completed at least one year but not a full college course; individuals who have attended at least one year, or who have completed a recognized junior college, technical school, nursing school, etc.)
4 - High school graduate (private preparatory, public, parochial or trade school)
5 - Partial high school (individuals who completed grades 10 or 11 but did not complete high school)
6 - Junior high school (individuals who completed grades 7, 8 and 9)
7 - Less than seven years of school
8 - Information not available

6. TREATMENT STATUS

A. SUBJECT WAS: (mark one)

1 - not in any type of psychiatric treatment
2 - in psychiatric treatment as an outpatient
3 - in partial hospitalization, e.g., day or night hospital, halfway house, etc.
4 - hospitalized (24 hour)

B. PRIOR TO THIS EPISODE, SUBJECT HAS: (mark all applicable)

1 - never had any type of psychiatric treatment
2 - received psychiatric outpatient treatment
3 - received treatment in partial hospitalization setting
4 - received treatment in 24-hour hospital

7. SUBJECT'S PSYCHIATRIC HISTORY

Does subject have a history of:

0 - No
1 - Yes, but not within last year
2 - Yes, only within last year
3 - Yes, both in past and last year

1 - Excessive use of alcohol
2 - Excessive use of tobacco
3 - Excessive use of opiates
4 - Excessive use of marijuana
5 - Excessive use of sleeping pills or sedatives
6 - -Excessive use of Amphetamines/stimulants
7 - Excessive use of hallucinogens
8 - Excessive use of other drugs
9 - Imprisonment
10 - Sexual deviation
11 - Suicidal attempts
12 - Contributory physical illness or injury

8. LIVING SITUATION

1 - Parental or lineal	Patient does not carry major responsibility for the home; it is either the home of his family of origin or of his children. Code foster home here
2 - Conjugal	Patient or his spouse carries major responsibility for the home; the household may include his parents and/or children
3 - Collateral	Home is not the responsibility of the patient, his parents or children, but of a sibling, aunt or some other non-linear relative
4 - Alone	Patient maintains-wholly or in part his own quarters. Home may be shared with others not related to the patient, or he may live in a rooming house, dormitory, etc.

9. ROLE PERFORMANCE FOR THREE YEARS PRIOR TO OPERATION

A. Subject's occupational status:

0 - Not applicable
1 - Full time gainful employment
2 - Part time gainful employment
3 - Unemployed
4 - Dependent spouse or student
5 - Recipient of public or private assistance
9 - Not ascertained

B. Subject was gainfully employed:

1 - Briefly or not at all
2 - Less than 4 of the time
3 - Half of the time
4 - Most of the time
5 - Virtually all of the time
9 - Not ascertained

C. His/her employment was limited primarily by:

0 - Not limited
1 - Going to school
2 - Household responsibilities
3 - Job market
4 - Retirement
5 - Physical illness
6 - Psychopathology
7 - Institutionalization
9 - Not ascertained

D. The subject's work performance (whether in job, in household or as student) as compared to optimal performance was best characterized as:

0 - Not applicable
1 - Marked decline in effectiveness
2 - Some decline in effectiveness
3 - Adequate with no change in effectiveness, static
4 - Some increase in effectiveness
5 - Variable, fluctuating in degree of effectiveness

E. The subject's social functioning as compared to optimal performance was best characterized as:

1 - Marked decline in competence
2 - Some decline in competence
3 - Adequate with no change in competence, static
4 - Some increase in competence
5 - Marked increase in competence
6 - Variable, fluctuating in degree of competence

10. ROLE PERFORMANCE AT TIME OF OPERATION:

A. Subject's occupational status

0 - Not applicable
1 - Full time gainful employment
2 - Part time gainful employment
3 - Unemployed
4 - Dependent spouse or student
5 - Recipient of public or private assistance
9 - Not ascertained

B. Subject was gainfully employed:

1 - Briefly or not at all
2 - Less than 4 of the time
3 - Half of the time
4 - Most of the time
5 - Virtually all of the time
9 - Not ascertained

C. His/her employment was limited primarily by

0 - Not limited
1 - Going to school
2 - Household responsibilities
3 - Job market
4 - Retirement
5 - Physical illness
6 - Psychopathology
7 - Institutionalization
9 - Not ascertained

D. The subject's work performance (whether in job, in household or as student) as compared to optimal performance was best characterized as:

0 - Not applicable
1 - Marked decline in effectiveness
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1 - Marked decline in competence
2 - Some decline in competence
3 - Adequate with no change in competence, static
4 - Some increase in competence
5 - Marked increase in competence
6 - Variable, fluctuating in degree of competence

APPENDIX 19

FACE SHEET INFORMATION

Date and location(s) of operation(s)

1. ______________________________
____

2. ______________________________
____

3. ______________________________
____

1. Diagnosis

2. Nature and duration of symptoms and previous treatment(s). (List in chronological order).

FACE SHEET INFORMATION (continued)

3. Other pertinent illnesses or conditions.

4. Follow up evaluation including post-operative complications. (List in chronological order and give dates).

SOCIAL ADJUSTMENT SCALE

CODE #　　　　PATIENT　　　　FAMILY

AREAS	VERY MUCH WORSE	QUITE A BID WORSE	A LITTLE WORSE	NO CHANGE	A LITTLE BETTER	QUITE A BIT BETTER	VERY MUCH BETTER	DOES NOT APPLY
1. At your work (job, housework, school)?	0	1	2	3	4	5	6	7
2. In your social life?	0	1	2	3	4	5	6	7
3. With your close friends?	0	1	2	3	4	5	6	7
4. With your spouse?	0	1	2	3	4	5	6	7
5. With your children?	0	1	2	3	4	5	6	7
6. With your parents?	0	1	2	3	4	5	6	7

APPENDIX 21

GUIDELINES FOR SOCIAL WORKERS

1. What were the problems you were experiencing at the time you were recommended to the neurosurgeon?

2. Where did you hear about this kind of treatment?

3. Was the general procedure of the operation outlined:

4. What kind of benefits were you lead to believe would result? Degree of expectations?

5. Were you told of risks? None? Very risky?

6. Were you given any alternatives?

7. Where did you hear about the surgeon?

8. Did you consider other surgeons?

9. Did you have ample opportunity to ask questions of the surgeon or of your referring M.D. immediately and later?

10. Did anyone else have access to the M.D. for questions? When recommendation was made? When surgery was done?

11. Was there anyone else available with whom you could discuss this operation?

12. Who made the decision for the operation? How long did it take your to decide?

13. Was there disagreement about this decision? If so, did they all finally agree?

14. Was there any pressure exerted on you within the family? Outside the family?

15. Did you notice any change? If so when? How much? (positive-negative)

16. Did you have any regrets?

17. Would you do it again under the same conditions?

18. Present status.

A. Education

1 - Graduate or professional training (individuals who have completed or who have attended one year of a recognized professional course.
2 - College or university graduate (individuals who have completed a four year college or university course leading to a recognized college or university degree).
3 - Partial college training (individuals who have completed at least one year but not a full college course; individuals who have attended at least one year, or who have completed a recognized junior college, technical school, nursing school, etc.).
4 - High school graduate (private preparatory, public, parochial or trade).
5 - Partial high school (individuals who completed grades 10 or 11 but did not complete high school).
6 - Junior high school (individuals who completed grades 7, 8 and 9)
7 - Less than seven years of school
8 - Information not available

B. Occupation

1 - Higher executive, proprietor of large concern, major professional.

2 - Business manager of large concern, proprietor of medium-sized business, lesser professional.
3 - Administrative personnel, owner of small independent business, minor professional.
4 - Clerical or sales worker, technician, owner of little business.
5 - Skilled manual employee.
6 - Machine operator, semi-skilled employee.
7 - Unskilled employee.
8 - Never worked in paid employment.
9 - Not ascertained.

C. Employment - subject is gainfully employed.

1 - Briefly or not at all.
2 - Less than ½ of the time.
3 - Half of the time.
4 - Most of the time.
5 - Virtually all of the time.
9 - Not ascertained.

His/her employment has been limited primarily by:

0 - Not limited.
1 - Going to school.
2 - Household responsibilities.
3 - Job market.
4 - Retirement.
5 - Physical illness.
6 - Psychopathology.
7 - Institutionalization.
9 - Not ascertained.

D. The subject's work performance (whether in job, in household or as student) as compared to optimal performance is best characterized as:

0 - Not applicable.
1 - Marked decline in effectiveness.
2 - Some decline in effectiveness.
3 - Adequate with no change in effectiveness, static.
4 - Some increase in effectiveness.
5 - Variable, fluctuating in degree of effectiveness.

E. The subject's social functioning as compared to optimal performance is best characterized as:

1 - Marked decline in competence.
2 - Some decline in competence.
3 - Adequate with no change in competence, static.
4 - Some increase in competence.
5 - Marked increase in competence.
6 - Variable, fluctuating in degree of competence.

F. Since the operation, subject has:

0 - Remained single.
1 - Married for the first time.
2 - Remarried with previous marriage/s.
3 - Become separated or divorced.
4 - Become widowed.
5 - Remained married for first time.

GUIDELINES

(CONTROL)

CODE #
PRESENT

1. EDUCATION

1 - Graduate or professional training (individuals who have completed or who have attended one year of a recognized professional course).
2 - College or university graduate (individuals who have completed a four year college or university course leading to a recognized college or university degree).
3 - Partial college training (individuals who have completed at least one year, but not a full college course; individuals who have attended at least one year, or who have completed a recognized junior college, technical school, nursing school, etc.).
4 - High school graduate (private preparatory, public, parochial or trade).
5 - Partial high school (completed grades 10 or 11 but did not complete high school).
6 - Junior high school (completed 7, 8 and 9).
7 - Less than seven years of school.
8 - Information not available.

2. OCCUPATION

1 - Higher executive, proprietor of large concern, major professional.
2 - Business manager of large concern, proprietor of medium-sized business, lesser professional.
3 - Administrative personnel, owner of small independent business, minor professional.
4 - Clerical or sales worker, technician, owner of little business.
5 - Skilled manual employee.
6 - Machine operator, semi-skilled employee.
7 - Unskilled employee.
8 - Never worked in paid employment.
9 - Not ascertained.

3. MARITAL STATUS

1 - Single
2 - Married for first time.
3 - Remarried with previous marriage/s.
4 - Separated or divorced.
5 - Widowed.

4. PRESENT TREATMENT (continue on back if necessary).

APPENDIX 23

Sub. I.D. - - -

Surgeon (op) - - -

Imp. Category -

V#	VARIABLE	SCORE CODE	0 (No)	1 (1-3)	2 (4-8)	3 (9+)	4 can't determine	DATA	CARD	COLS.
342	Anticonvulsant								10	27
343	Major Tranquilizer									28
344	Minor Tranquilizer									29
345	MAO									30
346	Tricyclics									31
347	Lithium									32
348	Analgesics (prescrip)									33
349	CNS Stimulants									34
350	Barbiturates									35
351	Other									36

OUTCOME

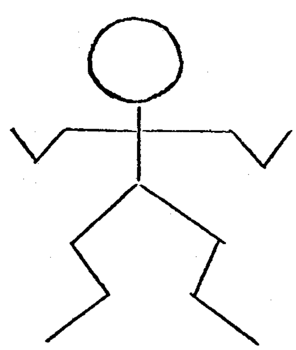
V#	VARIABLE	1 poor	2 good	3 can't determine	CARD	COLS.
352	Anticonvulsants				10	37
353	Major Tranquilizer					38
354	Minor Tranquilizer					39
355	MAO					40
356	Tricyclics					41
357	Lithium					42
358	Analgesics (prescrip)					43
359	CNS Stimulants					44
360	Barbiturates					45
361	Other					46

Examiner________________

PSYCHOSURGERY STUDY
NEUROLOGICAL EXAMINATION

Date of Exam____________

Col	Code				Item
					Case Number
	Right 1	Left 2		Unk. 9	Handedness
					NEUROLOGICAL ABNORMALITY
	Normal 1	Abn. 2	Ques. 3	Unk. 9	Olfaction
	1	2	3	9	Visual Fields
	1	2	3	9	Visual Acuity
	1	2	3	9	Fundi
	1	2	3	9	Pupils
	1	2	3	9	EOM (including Nystagmus)
	1	2	3	9	Facial Sens (Pin & Touch)
	1	2	3	9	Facial Motion (Dysarthria)
	1	2	3	9	Hearing
	1	2	3	9	Tongue Protrusion
	1	2	3	9	Gait (including tandem)
	1	2	3	9	Ataxia L R
	1	2	3	9	Motor Weakness L R
	1	2	3	9	Muscle Tone
	1	2	3	9	Sensory Loss L R
	1	2	3	9	Deep tendon Reflexes
	1	2	3	9	Pathological Reflexes



Cols.	Code	Item
		NEUROLOGICAL ABNORMALITY - SUMMARY.
	No 1, Yes 2, Maybe 3, Unk. 9	Examiner believes that speech difficulty is present
	None 1, Dysa. 2, Dysph. 3, Both 4, Unk. 9	Type of Language Disability
	None 1, Mild 2, Mod. 3, Severe 4, 9	Degree of Disability
	No 1, Lt. 2, Rt. 3, Maybe 4, 9	Hemianopia present
	No 1, Lt. 2, Rt. 3, Both 4, Maybe 5, 9	Hemiparesis
	1 2 3 4 5 9	Hemisensory defect
	1 2 3 4 5 9	Reflex abnormality

COMMENTS

A STUDY OF CINGULOTOMY IN MAN

Hans-Lukas Teuber, Ph.D.,
Suzanne Corkin, Ph.D.,
Thomas E. Twitchell, M.D.

Massachusetts Institute of Technology

Contract No. N01-HU-6-2116

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Table of Contents

OVERVIEW

FULL REPORT

OVERVIEW

For the last seven months (since November, 1975), our group at M.I.T. has studied 34 cases of cingulotomy, an operation aimed at the relief of pain and at the alleviation of various psychiatric conditions by means of interrupting a bundle of nerve fibers connecting the frontal lobes with various so-called "limbic structures" in the forebrain. Compared with the traditional frontal lobotomy, the area of actual tissue destruction is quite limited, and numerous other pathways entering and leaving the frontal lobes are spared. The question is whether any consistent behavioral changes could be expected from this particular procedure.

In trying to answer this question, we drew upon methods and habits of observation developed in a broader context, the study of after-effects of brain injuries in previously healthy men who had sustained penetrating brain wounds in military action. We also called upon our experience with cases of brain trauma incurred in civilian accidents, or of brain damage suffered in the course of illness, in children and adults. These and related studies had been proceeding in our laboratories for nearly three decades, but none proved as baffling as our current attempts at detecting any specific effects of the cingulate lesions.

Perhaps this difficulty should have been expected, since one major outcome of all of our previous studies had been the observation of considerable resiliency of human behavior after small penetrating brain wounds, unless these were critically placed. On the other hand, both earlier and recent claims of therapeutic effects of cingulotomies in cases of long-standing pain or psychiatric illness seemed to demand an assessment and an explanation.

Cases for this study of cingulotomy were all drawn from a single hospital and a single neurosurgeon, and our conclusions, such as they are at this early stage, are of necessity preliminary, even though 18 of the 34 cases were seen both before and after such a surgical intervention, and a less intensive inquiry into the effects of cingulotomy had already been underway in our laboratory for 2-1/2 years before the launching of this accelerated study in November, 1975.

Our survey proceeded by means of extensive individual interviews with patients and their spouses and close relatives (often held more than once); by observations of behavior on a research ward (the Clinical Research Center at M.I.T., and thus clearly independently of the referring physician and his hospital); by repeated reviews of all available medical records (including surgical and psychiatric histories), as well as by means of our giving each patient general physical and neurologic examinations and two dozen psychologic tests. In the 18 patients seen before their operation, preoperative testing was done as well as the postoperative testing which was done in all 34.

From these varied sources we can draw at this stage (June 1, 1976) the following conclusions:

Indications for Cingulotomy

The reasons given for the cingulotomy by the patients themselves, their families and referring physicians are primarily (a) persistent pain (having been refractory to all other treatment attempts, often for up to ten years) (11 cases); (b) depression (resistant to shock treatments and mood-modifying drugs), often with suicidal wishes and suicidal attempts (7 cases.); (c) obsessive and compulsive symptoms of a degree deemed disabling, usually combined with depression (4 cases); and (d) other psychiatric conditions with descriptions varying from severe anxiety neurosis to schizo-affective disorder and borderline schizophrenia (12 cases). One additional patient (a case of persistent pain in a congenital paraplegic) had come to operation but was found to have a badly distorted brain (internal hydrocephalus and partial atrophy of the right cerebral hemisphere), so that the procedure was interrupted after the burr holes had been placed. This patient thus represents the closest approach to a placebo control, but the severe pre-existing anomalies of the patient's central nervous system preclude any firm interpretations. Special control groups were also tested, and their results are described in the full document that follows.

Treatment Preceding the Cingulotomy

Virtually all cases (with the exception of two suicidal patients who were considered uncontrollable in their urge to do away with themselves) had been subjected for a considerable number of years (ranging from a maximum of 40 to a minimum of 3) to a wide range of therapeutic trials, including individual and group psychotherapy, multiple trials on pain-reducing, sedating or mood-modifying drugs, and numerous electroconvulsive treatments. With few exceptions, the so-called pain cases did not differ in that respect from the other 23 patients with psychiatric diagnoses. In fact, pain had appeared in this group in frequent combination with depression, or with various conversion reactions. The accumulated burden of long-standing illness in nearly all cases, and of the manifold and often massive treatments, makes it understandable why the cingulotomy patients were found preoperatively to be below the means for their age group on many of the psychologic tests employed.

Although the diagnostic subgroups we have established are overlapping, and their earlier diagnoses often inconsistent, the reports of therapeutic efficacy of the cingulotomy appear more orderly, if grouped in terms of our diagnostic clusters. If this is done, then the cases with primary complaints of persistent pain stand out: in 9 of the 11 cases studied in depth, patients and relatives claim either complete or near complete relief from pains that had lasted for many years, and in some cases, decades. One inevitably wonders about the possible role of placebo effects, as in all forms of therapy for pain, but the fact remains that all of these patients had opportunities to exhibit placebo responses to earlier treatment attempts, including multiple back operations. None of the patients in this subgroup was thought to require a repeat-cingulotomy (in contrast to many of those patients with primarily psychiatric diagnoses). It should also be noted that 4 of the patients who had been addicted to opiates or related drugs could be taken off these medications without showing symptoms of drug withdrawal. The one exception is the patient with pain, in whom burr holes were placed but the operation interrupted without proceeding to the cingulum lesions. Lastly, it should be pointed out that none of the "pain" cases that had been deemed relieved of their persistent pain had become insensitive to other forms of pain: they all insisted that "new pains" were not affected by the operation; these new pains could be severe but they were never as unremitting or intolerable as the pain that had led them to seek the cingulotomy.

Contrary to expectations based on previous reports, the subgroup of 7 patients, complaining primarily of depression, fared not quite as well in terms of therapeutic outcome, as did those with primary complaints of persistent pain. Nevertheless, 5 of the 7 cases studied by us in depth gave convincing reports of either full or partial relief, whereas 2 cases (with long-standing unipolar depression) thought they had not been helped at all. A notable instance of partial success was seen in a woman with 40 years of manic-depressive psychosis since her late teens, who went into nearly five years remission after her first cingulotomy, then lapsed into manic excitement, was reoperated, and is now considered partially improved. In at least 3 cases, circumstances point at the strong possibility that the patients would have succeeded in committing suicide without an effective therapeutic intervention. With one exception, all patients in this group (and all but one of the 11 in the "pain" group) would recommend the operation to others; <u>all</u> strongly prefer it to electroconvulsive therapy (ECT).

The small cluster of 4 cases presenting predominantly obsessive-compulsive disorders turned out to be quite resistant to their cingulotomies. Neither the patients themselves nor our staff could see any improvement in

2 of the 4 cases; a third case (a highly introspective psychiatric nurse) described herself as having experienced "15% improvement," and the remaining patient - though considering herself unimproved - is described by her husband as complaining less frequently and with less insistence.

The last and most heterogeneous cluster of cases, whose diagnoses ranged from severe anxiety to borderline schizophrenia, had the most varied histories of outcome. In 2 of these 11 cases, the outcome is currently undetermined (both-redoing badly and for this reason did not keep follow-up appointments). In two cases, patients and family claim moderate improvement, and in a further case, there seems to have been a temporary remission which may be difficult to relate with any certainty to the cingulotomy. This was a patient with exposure to psychiatric treatments from age 4-1/2 into her twenties, with numerous hospitalizations. There was reputedly no effect of a first cingulotomy, undertaken because of self-mutilating behavior that had lasted for ten years, but four months after a second cingulotomy, the patient went into what seemed to be a complete remission for ten months. A subsequent third cingulotomy was rated by patient, family and staff, as ineffective. Similarly, no success was reported from all sources in 4 other cases in this group, whereas there were 2 cases, both relatively young patients at time of operation, who seemed to have responded, in one instance, with complete remission to a single cingulotomy (done for recurrent panic reactions in which the patient received hallucinatory commands to kill herself), and in the other instance with at least partial remission for five years following a cingulotomy for what was considered a schizo-affective illness. Because of recurrence of the disorder, the patient then asked for andreceived a multiple-target procedure (bilateral stereotaxic lesions of cingulate, amygdala and substantia innominata, an operation performed in this case by another surgeon); later that year (1975), the patient received a second cingulotomy performed by the surgeon who did all the other procedures in the cases seen in this survey. Despite the multiple and repeated lesions she had received, this patient presented herself as greatly relieved and ready to resume her work as a schoolteacher.

Estimates of "Costs"

In gauging the possible side-effects of these operations, i.e., those neurologic and psychologic sequelae that seem to differ from those intended by the surgeon, repeated analysis of life-history data and of interview material has so far failed to disclose any obvious "costs" of the intervention: the patients as a group show a slight gain in employment after operation, as compared with their preoperative status; there is no evident increase in marital instability, and all patients (except two cases of "borderline schizophrenia") insisted that they were capable of appropriate depth of. feeling (such as anguish after a bereavement following the operation). There were no obvious alterations in sexual activity, as far as this could be ascertained from patients and their spouses. Two patients reported decreased powers of concentration following their operation, but one of them insisted that this was helpful (he had numerous paranoid preoccupations and he said he was now less bothered by them). Interestingly, some of the patients thought that the effects of the operation (particularly in the form of a change in mood) came with some delay, some weeks or months after the surgery, and then either were maintained or subsided. In some instances this change was described as "elation," and in one case, as a heightened irritability. Other patients, especially those with primary complaints of pain, thought instead that the effects of the operation were immediate.

In searching for objective effects of the operation on neurologic status, we found no abnormalities that could not be attributed to the patient's pre-existing illness or his drug treatment or the ECT, with the exception of two cases in which some seizure episodes were recorded without the preoperative history of an ictal disorder.

Looking at the total pattern of results it may be said that there were no lasting effects of the cingulotomy _per se_ on the 24 behavioral tasks sampled in our study, though there were significant effects associated with chronological age and number of ECT. The statistical analyses of behavioral test data focused first on the performance of our patients prior to cingulotomy, as compared with the performance of normal control subjects. We then turned our attention to the consequences of the cingulotomy itself, taking into account the patient's sex, chronological age, and history of ECT. If there were effects of the surgery, one would expect to find them only where we had preoperative test scores to compare with postoperative ones. It was not legitimate to evaluate the surgical procedure in relation to normative standards, because in many cases, patients were inferior to normal control subjects even before cingulotomy. It should also be pointed out that in cases where we have found disproportionate deficits in patients over 40 years of age at the time of testing, or in persons who had experienced more than 50 ECT, the interpretation of the deficits must take into account the related variables of length and severity of illness. Since test performance did not seem to be related to the patients' psychiatric diagnoses, the pain and depression group (N = 11) was combined with the "other psychiatric disease" group (N = 23) for analysis of behavioral test scores.

We tabulated our results for three different time periods: before operation, less than 4 months after operation, and 4 months to 10 years after operation. At each of these intervals the mean I. Q. ratings for cingulotomy patients were all within the normal range. Individuals who were tested before operation and then retested in the early postoperative period showed no change from their preoperative ratings. In contrast, patients who were given their second intelligence test more than 4 months after operation, showed significant rises in Full-Scale, Verbal, and Performance I. Q. ratings.

On a task found previously to be a monitor of general cerebral dysfunction, where the subject tried to detect and trace simple geometric figures hidden in larger, more complex figures, the most striking aspect of the patients' performance was that over all testing periods, only 5 of the 33 patients achieved scores at or above the normal control mean. When these data were analyzed according to time of testing, a different picture emerged for patients tested less than 4 months after operation than for patients tested after that time. Eight of the 12 individuals in the early postoperative group performed this test even less efficiently than they had before the operation. In contrast, the 11 persons tested 4 to 18 months after operation showed a statistically significant rise in tracings correct.

The findings for one of our tests known to be sensitive to frontal-lobe dysfunction, the Wisconsin Card Sorting Test, showed no difference between the mean number of sorting categories achieved by patients tested preoperatively and the mean for normal control subjects. After cingulotomy the picture was more complex: A comparison of the preoperative scores of 12 patients with their postoperative scores obtained less than 4 months after operation indicated that at the second testing 4 of these patients scored lower, 2 stayed the same, and 6 improved. The 4 whose scores dropped had a mean age of 47 years, whereas those whose scores rose were 15 years younger on an average. Fortunately, it was possible to conduct a follow-up examination of 2 of the 4 patients whose efficiency in card sorting had decreased following cingulotomy, and both had regained their preoperative level of performance. An analysis of <u>all</u> the postoperative card sorting results (whether or not the test had been done preoperatively) revealed that the patients under 40 years of age achieved significantly more categories on an average, than did the patients over 40.

The results for other presumed indicators of frontal-lobe dysfunction were as follows: Cingulotomy patients had impaired verbal fluency scores before operation and showed no change after operation. Instead, performance was related to the number of ECT the patients had previously received; this was also the case for a nonverbal fluency task and for delayed alternation. The findings for the Porteus Maze Test showed no change in the test quotient after operation, and an improvement in the qualitative score due to practice.

Patients with a history of 50 or more ECT were severely handicapped on recent memory tests, both verbal and nonverbal, and on a test of remote memory. Those who had received fewer than 50 ECT, or none, were intermediate in performance, being relatively more impaired on some memory tasks than on others.

Defects in our quantitative tests of somatosensory and motor function were rare, and none was attributable to the cingulotomy.

We must therefore conclude that for this group of patients, in whom the cingulotomy was clearly performed as a last resort, and who had long-standing illness with many other therapeutic trials before surgery, no lasting additional deficits in behavioral capacities can so far be identified after the surgical procedure. On the other hand, shock treatments in excess of 50 were associated with lasting deficits, and many patients said spontaneously that they preferred the surgical approach to ECT. The outcome does not mean that aftereffects of a bilateral cingulotomy imposed on a completely healthy brain would be necessarily undetectable; nor can we exclude the possibility that cingulotomies performed by a different surgeon or in a different setting, on a different set of patients, would not lead to other results than the ones reported here.

Additional follow-up studies and the testing of supplemental control groups (with repeated administration of some of our tests) might further sharpen this picture, as might more detailed assessment of the computer-assisted tomographic X-rays we have obtained in these cases.

In attempting a physiologic interpretation, one can only speculate that the therapeutic effects that were seen in this group, particularly in cases of persistent pain (whenever in excess of placebo effects), might be due to the induction of some change in chemically-specific pathways, possibly at some remove from the area directly approached. Such a working hypothesis would require careful neuropathologic tests in cases coming to autopsy, and correlated animal studies involving the use of the new neurochemical techniques for tracing various neurotransmitter systems, and assaying their contents, following experimental replication of the bilateral surgical lesions in the cingulum bundle. The recent discovery that certain "limbic" brain structures, such as the hippocampus, in mammals, can accept permanent implants of nerve cells secreting various neurotransmitters may serve as an important lead toward therapies that would no longer involve the destruction of cerebral tissue.

FULL REPORT

The pages that follow represent an interim report on an ongoing study of cingulotomies, a procedure performed for relief of persistent pain, and for a variety of psychiatric disorders. The study is based on 34 cases drawn from a single hospital and a single surgeon, and our conclusions, such as they are at this particular stage (May, 1976), must be tempered by the realization that the same surgical procedure, in other hands, or in other clinical settings, may have somewhat different outcomes. Even for the present group of patients, the length of follow-up was of necessity much too brief, for the majority of cases, to permit definitive conclusions: The study was formally launched only seven months ago, in November, 1975, although cases of cingulotomy had been seen, on various occasions, over the preceding 2-1/2 years in our laboratories, against the background of ongoing work dealing with behavioral effects of cerebral lesions in man, as seen after combat injuries incurred in war, or in children and adults with brain damage resulting from accidental. trauma, or from vascular or neoplastic disease.

Much of our earlier and current work on this wider range of cerebral lesions had been addressed to the question of how human brain structures relate to function, that is, not so much how breakdown of function in any particular brain region manifests itself, but how the particular structure works when it does. Nevertheless, the methods and habits of observation acquired over three decades in dealing with this form of human physiology inclined us to look at the bilateral cingulotomies as an additional type of lesion with great potential significance, since it is so unlikely to arise from any other source, except for the sake of this particular therapeutic attempt on the part of some neurosurgeons

Removals of brain tissue from the cingular gyrus (area 24 in Brodmann's map of the human cortex), or interruption of the underlying fiber systems (particularly, the cingulum) were originally introduced in England, in 1948, by Sir Hugh Cairns and his colleagues (Whitty et al., 1952), in an effort to replace the then-customary massive frontal lobotomy ("leucotomy" of Egas Moniz, 1936) by a fractional and less destructive intervention. Apparently, the first operations on the human cingulum bundle were performed upon a suggestion made by John Fulton in a discussion at a meeting of the British Society of Neurological Surgeons in 1947, where he is said to have observed that "were it feasible, cingulectomy in man would seem an appropriate place for limited leucotomy."

Early assessments of the procedure as practiced in England were presented by Cairns' group in 1952 (Whitty et al., 1952), and by Lewin in 1961. In the U.S., Livingston (1953) used cingulotomy in one of the few control studies in which the outcome of that operation in a series of psychiatric cases was contrasted with that of merely placing burr holes. Foltz and White (1962) applied cingulotomy in selected cases of persistent pain, using a surgical approach. which has since been somewhat modified by Ballantine (see Ballantine et al., 1967).

The reasons usually advanced for expecting therapeutic changes from interrupting the anterior cingulum are derived from the hypothesis of Papez (1937), who saw the cingulum as a central component in an anatomic "circuit" thought to subserve emotional experience and expression. The notion of such a "circuit," or a ring of structures surrounding the medial wall of the hemispheres (including cingulum and fornix, hippocampus and amygdala, as well as various subcortical structures, notably the septum and the mamillary body regions Of the hypothalamus, the mamillo-thalamic tract, and the anterior thalamic nuclei) was extended by MacLean (1958) into that of a "limbic system," and further modified by Nauta (1958), who stressed the downward continuation of this "system" into the central grey ("Nauta's limbic midbrain region").

Undoubtedly, these notions, based on work antedating more recent disclosures about chemically specific pathways in the brain, need to be reformulated, with special attention to ascending aminergic systems, whose upward extensions into the cingulate regions are only beginning to be worked out.

Animal experiments involving primarily removals of area 24 and searching for behavioral consequences of such operations, have been relatively sparse and controversial in their outcome (Ward, 1948; Pribram and Fulton, 1954), but several authors have emphasized changes in social interaction and in emotional reactivity, though the facts as well as the interpretations have remained moot. Many would see the cingulum as one of several alternative outflows of the prefrontal cortex, and not only as an upward projection, so that its interruption could be assumed to involve both certain frontal and temporal-lobe functions.

There are virtually no systematic observations on the consequences of such lesions in man, outside of discussions of their clinical use. In describing the effects of surgical interventions in this region of the brain, the statement is typically made that there are therapeutic effects without "losses," or, more specifically, without the undesirable effects often ascribed to the more massive frontal lobotomies.

Initially (i.e., three years ago), our plan had been to restrict the study entirely to those cases in which the procedure had been undertaken for the relief of pain, so that the lesion's neurologic and psychologic consequences, if identifiable at all, might be assessed without the complications that cling to cases of long-standing or acute psychotic illness, upon which the possible effects of the cingulate-area removal would then be superimposed. It soon became apparent, however, that the majority of the patients with persistent pain who had received cingulotomies not only had been resistant to a great many other procedures, but presented typically a complex clinical picture, with multiple psychiatric components. It was therefore decided to make less of a distinction between cases of pain surgery and those which are usually considered instances of psychosurgery, and to include additional cases where the primary indication for the surgical intervention had been diagnoses of depression, severe obsessive compulsive states, disabling anxiety, or other psychiatric conditions, frequently manifested in suicidal wishes and attempts.

Inevitably, then, the entire group studied (see below under Subjects) was not only heterogeneous but had nearly always been exposed to massive earlier treatments, including in the majority of cases prolonged electroconvulsive treatments (ECT) and heavy dosages of sedating, pain-relieving, or otherwise mood-modifying drugs. The frequency of ECT in particular was often astounding, and the sections on behavioral effects of the cingulotomy will have to be read with this fact in mind. In virtually every instance, the cingulotomy seemed to have been a measure of last resort; the patients differed from others with similar diagnoses by representing a group where everything else, in the opinion of consulting physicians, and of the patient and the patient's family, seemed to have failed. In searching for the neurologic and psychologic "costs" of the operation, we therefore had to consider that the operation added its effects not only to those of a persistent illness that preceded it, but to the cumulative impact of the massive earlier treatment efforts, which by themselves seemed to be interfering with certain higher functions, and often to an extent where it appeared futile to expect that the effects of cingulotomy as such might have become discernible, within the welter of other handicaps that already weighed upon the patients as they entered upon this surgical course.

We did, in fact, manage to see 18 of the 34 patients, both <u>before</u> and <u>after</u>

their cingulotomies, but the cautionary remarks just made still apply: In no case was it possible to see any of these patients before the onset of the condition that ultimately led to the surgery, so that it remains inappropriate to consider the present group as one in which the effects of cingulotomy per se, imposed on a previously healthy central nervous system, could be singled out and analyzed. Nor can we exclude the role of the particular surgeon and his influence on the patient and on the patient's family, quite aside from the operation itself. As our analyses of personal interviews with the patients and with members of their family indicate, the vast majority of this particular surgeon's patients speak of him with expressions of deep gratitude, and often reverence. The descriptions tend to borrow terms from a religious context: One hears of a miracle, a rebirth, of finding oneself again, or of having one's life restored, and the surgeon as healer appears in these accounts with a special aura, reflecting much of the manner in which he interprets his procedures both before and afterwards to patients and relatives, together with the unusual degree to which he concerns himself with the day-by-day postoperative adjustment of his patients. One therefore wonders, as in the earlier days of this type of surgery, whether burr holes without brain tissue destruction might have had similar therapeutic effects (unless one accepts the early study of cingulotomy by K.E. Livingston, in 1953, in which such a placebo control was in fact applied and found ineffective).

On balance, then, one gets the impression, in this particular instance, of a procedure rather sparingly applied in what, on the testimony of patient and family, are otherwise desperate situations. Neither the formal testing, nor the more qualitative assessments through history review and detailed interviews, reveals any uniform side effects or obvious "costs" of the operation, in the 34 cases studied so far, but the therapeutic effects of the procedure (whether described by patient or relatives, or assessed by our staff) vary greatly with the nature of the condition that had led to the use of this form of surgery.

METHOD

Subjects

Cingulotomy Patients

Surgery in the cingulate region had been practiced in various attempts at relieving pain and at alleviating psychiatric conditions in the early 50s in England (Whitty, Duffield, Tow, & Cairns, 1952) and in the United States (Livingston, 1953). A stereotactic variant of this procedure (Ballantine, Cassidy, Flanagan, & Marino, 1967) was the one applied in the cases reported here. The total sample consisted of 34 patients who underwent anterior cingulate lesions, bilaterally, all performed by one neurosurgeon. These included 18 consecutive patients, who were operated upon between July 23, 1974, and March 5, 1976, and were tested both pre- and postoperatively. The preoperative testing took place from 1 to 19 days before operation, and the postoperative testing from 3 days to 18 months after operation. Seven of these patients were tested on more than one occasion postoperatively in order to determine whether selective drops in performance seen in the early postoperative period were maintained in follow-up study. Sixteen additional patients were tested postoperatively only, from 2 months to 10 years after cingulotomy. On the basis of their preoperative diagnoses, the 34 patients can be divided into two groups. The first consisted of 11 patients operated upon for the relief of persistent, non-neoplastic pain, which was described as coupled with depression in all but one case. The most common complaint was of back pain, but there were two cases of lower abdominal pain, and one case of pain in an amputation stump. In the second diagnostic group there were 23 patients operated upon for other psychiatric disorders, which included anxiety and depression, manic-depressive psychosis, obsessive-compulsive neurosis, schizophrenia, and personality disorder.

Table 1 gives the number of patients in the two diagnostic groups according to the time of testing. In all, 12 men and 22 women were tested; three men with pain and depression refused testing, as did 1 man with obsessive-compulsive neurosis and depression.

As seen in Table 2, the patients with pain and depression had a mean age of 36 years at the onset of their severe pain, and they were 48.4-years-old, on an average, when they underwent their first (and only) cingulotomy. The interval between onset of illness or complaint and the first cingulotomy was essentially the same for the two groups, but patients with "other psychiatric disease" were 15 years younger at the time of onset, if we define this as the time when they first sought professional help for their disorders, or when they had a so-called "breakdown." Thus, their serious problems began at age 21 on the average, and their first cingulotomy took place at a mean age of 36.8 years. At the time they participated in our investigation, the pain and depression group was significantly older than the "other psychiatric disease" group, their mean ages being 51.4 years and 38.0 years, respectively.

Thirteen of the 14 patients with "other psychiatric disease" who were tested both pre- and postoperatively had one cingulotomy; the other patient had two procedures. Of the 9 patients with "other psychiatric diseases" who were tested postoperatively only, 4 had two cingulotomies, 4 had three cingulotomies, and 1 had two radio-frequency cingulotomies coming before and after an operation by another surgeon, which involved bilateral thermal destruction of the amygdaloid nucleus, substantia innominata, and cingulate gyrus.

There are a number of other items in the medical histories of these patients that may be relevant to the interpretation of our behavioral test data. Prior to the first cingulotomy, 26 of the 34 patients in our sample received electro-convulsive therapy (ECT). Of those who were given ECT, 4 also had insulin subcoma treatments, 2 also had deep sedation therapy, and 1 also had Indoklon convulsive therapy. In addition, 4 of the 11 patients (36%) operated upon for pain and depression had coexisting central nervous system (CNS) trauma or disease, as did 7 of the 23 (30%) in the group with "other psychiatric disease."

The mean educational level of the patients with pain and depression was 11.2 years (range: 5 to 16 years). All 11 were married. The patients with "other psychiatric disease" had been to school for an average of 13.0 years (range: 7 to 18 years). Ten of them were single, nine were married, and four were separated or divorced. A comparison of employment histories for the 12-month period preceding and that following cingulotomy indicated that 1 woman and 2 men in the group with pain states were employed prior to operation, and 2 women and 2 men afterward. Six women and 6 men with "other psychiatric disease" held jobs during the year before their first cingulotomy, and 9 women and 5 men were employed during the year after that or subsequent cingulotomies.

Patient Control

A 34-year-old, single woman with myelomeningocele, paraplegia, and depression underwent burr holes and ventriculography preparatory to a stereotactic cingulotomy for the relief of intractable thoracic pain, secondary to paraplegia. Ventriculography, however, revealed moderate hydrocephalus, greater on the right than the left, with obvious distortion of brain anatomy, to a point where cingulotomy could not be performed with accuracy. Postoperatively, the patient was told merely that the procedure had gone well, but had been modified. She, therefore, represented the single instance of a true control subject, whose response to the procedure could be used to address the question of placebo effect. Unfortunately, she was not a suitable control patient for the behavioral test analyses, because her performance both pre- and postoperatively reflected a severe abnormality of the non-dominant hemisphere. This was confirmed by a subsequent CT scan, which showed a congenital decrease in diameter and volume of the right hemicranium, with resulting smallness of the right hemisphere, especially in the parietal region. There was also extensive hydrocephalus and some focal cortical atrophy. Nevertheless, she was comparable to the cingulotomy patients in educational level, having received a high school diploma at age 18 from the Massachusetts Hospital School. Her only gainful employment preoperatively was a temporary part-time job, typing envelopes. Postoperatively, she worked as a volunteer in the gift shop of a rehabilitation hospital where she was a patient. She had never been given ECT, but prior to the aborted cingulotomy, she had undergone 26 other major surgical procedures, including a thoracic laminectomy with insertion of a dorsal column stimulator, which had failed to relieve her pain.

Normal Control Groups

The main group of controls included 22 Korean War veterans, who came to M.I.T. from all regions of the United States to serve as normal subjects in a study of the long-term effects of head injury. For the second phase of that investigation, normative data were obtained from 12 other individuals who lived in the greater Boston area, and were participants in the Normative Aging Study being done through the Outpatient Clinic of the Boston Veterans Administration In some of the tests used in the present investigation, data were available for either the control group of 22 or the group of 12 normal controls, and on other tasks all 34 subjects had been tested. Since these individuals were all men, ranging in age from 34 to 49 years (mean: 40.4 years), and because control data were lacking for certain tests used in the cingulotomy study, 24 additional control subjects were tested. These included 16 women, with a mean age of 35.1 years (range: 24 to 58 years), and 8 men, with mean age of 56.9 years (range: 32 to 65 years). The educational experiences of the total group of 58 normal control subjects just described included some instances of school dropouts at age 7 at one extreme, and two men who attended graduate school at the other, so that there was considerable overlap between patient and control groups in this respect, with the control group perhaps being slightly superior.

In anticipation of a difference in the performance of women and men on the three motor tests (tapping rate, Thurstone tapping, and grip strength), we obtained data from a separate group of 12 right-handed women, having a mean age of 38.3 years (range: 24 to 58 years).

As far as we could determine by questioning them, none of the normal control subjects had sustained a serious head injury, had been knocked unconscious, or had evidence of other brain trauma or disease.

Histories and Taped Interviews

Thirty-two of the 34 cingulotomy patients, and the one burr hole control case, were interviewed by one of us (HLT), the interviews being taped, with the patients' knowledge and permission (since Fall 1975), and subsequently transcribed. Repeated interviews were obtained in 12 of these 32 cases. In addition, spouses or close relatives, whenever accessible, were also interviewed in the same manner. The transcripts of all interviews were excerpted, and after consideration of the patients' behavior during their admissions to the M.I.T. Clinical Research Center, and a careful study of all available physicians' records and hospital notes (including referral letters and reports of previous psychiatric assessments) capsule histories were prepared (see below, in text and Appendix), assessing in so far as possible each individual patient's pre- and postoperative status.

The conduct of the interviews was fairly informal. Typically, they began with explanation (by HLT) of the function of the M.I.T. Clinical Research Center, emphasizing that the Center and its staff were independent of the referring physician. Patients were told that our attempts at understanding their individual conditions, their reasons for having considered cingulotomy, and their own evaluations of their procedures were of the greatest importance in arriving at a reasonably complete picture of this type of surgery. They were particularly urged to compare the surgical intervention with any other treatments they might have received before or afterwards.

Toward the end of the interview, which normally took at least one hour (as did the interviews with the patients' relatives or spouses), the persons interviewed were always asked (in the postoperative cases), whether they considered the outcome as having greatly benefitted their condition, moderately (or transiently) benefitted, or as having left the condition unchanged (or made worse). In a separate question, we asked the person interviewed whether they would or would not recommend the operation to others.

Neurological Examination

The neurological examination utilized the standard procedures for evaluation of cranial nerve function, motor function (strength, tendon reflexes, plantar responses, resistance to passive movement, presence or absence of involuntary movements, etc.), coordination, sensation (pinprick, light touch, position and vibration), and gait and station. In addition, we used additional tests that we have found useful in detecting more subtle abnormalities of posture and movement. These included tests to assess the ability to dissociate head and eye movements, both on command to look in a certain direction and on tracking a moving target, to purse the lips, puff out the cheeks both together and separately, and to move the tongue to right and left and up and down. We looked very closely for any alteration in posture of the hand and/or fingers when the patient sat with arms outstretched and eyes closed. Particular attention was given to any fragment of a grasp reflex or avoiding response elicited by contact stimulation of the hand, and even the slightest degree was recorded if detected. For testing hand and finger dexterity, a series of alternating pronation-supination of the hand and flexion-extension of the fingers of increasing difficulty and emphasizing each hand alone and simultaneously with the other hand were used. The ability to rapidly oppose the thumb to each finger was also assessed. Any synkinetic movements or postures induced by these movements were recorded. Finally, in addition to noting the gait and the ability to tandem walk, we asked each subject to walk on toes or heels to bring out any abnormal dystonic posture of the upper extremities.

Behavioral Tests

In order to assess the possible effects of bilateral lesions of the cingulum bundle, tasks were chosen to sample behaviors thought to be dependent upon the integrity of the areas that this pathway interconnects. It has been known for some time that there is a fronto-limbic pathway in monkey (Adey and Meyer, 1952; Nauta, 1964), which originates in frontal granular cortex and is distributed via the cingulum bundle to the gyrus fornicatus (composed of the gyrus cinguli, retrosplenial cortex, and parahippocampal gyrus). This system probably connects in turn with the circuitry of medial temporal cortex from the gyrus cinguli (Pandya and Domesick, unpublished), which receives afferents from various subcortical limbic structures (Andén, Dahlstrom, Fuxe, Larsson, Olson, and Ungerstedt, 1966; Conrad, Leonard and Pfaff, 1964; Domesick, 1972; Hedreen and Chalmers, 1972). Thus, we set out to search for signs ordinarily associated with frontal-lobe or temporal-lobe dysfunction, and to look for impairment found after lesions of cingulate cortex. We also included test items sensitive to any lesions of the cerebral convexity, regardless of locus, or to changes in overall intelligence or personality. All measures were quantitative, permitting an objective description of any deficits that might be found.

Some of the tests were not given before operation, but only afterward, because preoperative testing often took place in the patients' hospital rooms just prior to cingulotomy, and thus testing time was limited and working space was rarely sufficient for proper display of certain test materials. Other tasks were excluded from the preoperative battery, because the necessary apparatus was not portable, or because the one form of the test could not be used in repeated testings and was therefore saved for the postoperative evaluation.

Overall Intelligence

Wechsler Adult Intelligence Scale (WAIS) and Wechsler-Bellevue Intelligence Scale, Form II. For the past few years, the WAIS and Form I of the Wechsler Memory Scale have been administered, whenever possible, to patients undergoing cingulotomy by the psychologists at the hospital where the operation was performed. When these scores were available for patients in our study, they were released to us and incorporated in our analyses of overall intellectual function and immediate memory (see section on memory tests to follow). At the time of postoperative testing at M.I.T., patients were given Form II of the Wechsler-Bellevue Intelligence Scale (which is sometimes used as an alternate form of the WAIS), together with Form II of the Wechsler Memory Scale.

Non-specific Effects

Hidden Figures Test. Gottschaldt's (1926, 1929) embedded figures had been made into a timed pencil and paper test in which the subject tries to detect and trace simple geometric figures that are hidden in larger, more complex geometric figures (Teuber and Weinstein, 1956). The five parts of the test were usually completed in about 20 minutes. Since impairment on this task has been found to be a sign of general cerebral dysfunction, poor performance being seen with lesions in any lobe of either hemisphere (Teuber, 1975), we expected the placing of lesions in the cingulum bundle bilaterally to result in a poorer score. postoperatively than preoperatively.

Tests Sensitive to Frontal-Lobe Dysfunction

Wisconsin Card Sorting Test. The patient was required to sort a pack of 128 stimulus cards (Grant and Berg, 1948), and in doing so to shift periodically from one sorting principle to another (i.e., from number to form to color). His or her only clues were the examiner's saying "right" or "wrong" after each response. Milner (1963) has found this task to be sensitive to dorsolateral frontal-lobe lesions in man.

Verbal Fluency. Two verbal fluency tests were given: In one, Thurstone's Word Fluency Test (Thurstone, 1944), the patient was allowed five minutes to write down as many words as possible beginning with the letter "S," and four minutes to write down as many four-letter words as possible beginning with the letter "C," In the other task, one devised by Newcombe (1969), the patient named aloud as many objects, animals, or birds alternated with colors as possible, 60 seconds being allowed for each of the three lists. Individuals with dominant frontal-lobe lesions do poorly on the written version (Milner, 1964), whereas any left-hemisphere lesion, anterior or posterior, may produce a deficit in this oral word fluency test (Newcombe, 1969).

Nonverbal Fluency. In an attempt to provide a nonverbal analogue of the verbal fluency tasks that would sample right frontal capacities, a test was devised in which the patient was given a number of colored plastic cylinders and squares and told to construct as many structures as possible in five minutes using four pieces in each structure. Preliminary data from cases of head injury have been encouraging in that scores were not highly correlated with those attained by the same subjects on the measures of verbal fluency described above.

Recency. Although patients with frontal-lobe lesions perform normally on most traditional memory tasks, Corsi (cited by Milner, 1971) found that the ability to remember where an item came in a series was disturbed after frontal lobectomy. In particular, he showed that left frontal-lobe lesion produced a deficit on a verbal recency-discrimination task, whereas right frontal-lobe lesions caused impairment on a non-verbal recency discrimination task. For our investigation, we (S. Corkin, M.P. Bryden, and S.M. Edley) devised a verbal memory task in which memory for content could be compared with memory for the order of items in a series. In each of the two equivalent forms of this test, subjects were read eight lists of 16 nouns, each list dealing with a particular semantic category, such as occupations or items on a farm. After each list was read, the subject was asked four questions to test his or her memory for content (for example, "Which did I _say,_ rake or plow?") and four questions to test his or her memory for order (for example, "Which did I say first, plumber or beautician?").

Delayed alternation. It is a well-documented fact that excision of frontal cortex in monkey (specifically the dorsolateral region) results in impaired performance on delayed alternation tasks (Jacobsen, 1936; Mishkin, 1957). However, the question remains open as to whether an analogous deficit exists after frontal-lobe lesion in man. Pribram, Ahumada, Hartog, and Roos (1964) found psychiatric patients to be impaired on delayed alternation after bilateral frontal lobotomy when compared with unoperated psychiatric patients, but Chorover and Cole (1966) showed that failure on such problems following brain lesion was non-specific, occurring as often in a non-frontal group as in a frontal group. These studies are inconclusive, however, because Pribram et al. did not establish a preoperative baseline of performance or examine lesion control subjects, and because the results of Chorover and Cole could be related to severity of lesion, thus masking any effects of locus. Our cases of bilateral cingulotomy were given simple, double, and triple alternation procedures with 10-second or 20-second delays as follows: 10-second simple, 10-second double, 20-second simple, 20-second double, 10-second triple. Testing proceeded in each of the five conditions until the subject responded correctly on 10 consecutive trials or until 50 trials had been completed.

Porteus Maze Test. Our selection of the Porteus Maze Test (Porteus, 1965) was prompted by Landis and Erlick's (1950) report of impaired performance on this pencil and paper task in the early stages after frontal lobotomy. Fortunately, there were three separate versions of this test, so that repeated examination could be done with practice effects minimized. For each set of mazes, two scores were obtained: a test quotient (TQ), said to be roughly comparable to an I.Q. rating (though based on rather inadequate norms), and a qualitative score, which mainly took account of instances of rule breaking (e.g., cutting corners, touching a line, or lifting the pencil off the paper), but also penalized the subject for drawing wavy lines.

Tactual stylus maze. Although any patient with a right-sided cortical excision may be impaired in learning a tactual stylus maze, those with right frontal-lobe removals are the most severely handicapped (Corkin, 1965). We chose to include this task in our survey, not only because it is an indicator of frontal-lobe dysfunction, but also as a means of assessing the patient's efficiency in learning unfamiliar spatial. material. Training for the 11 normal control subjects (Corkin, 1965) proceeded to a criterion of 3 consecutive errorless runs or until 50 trials had been completed. For the cingulotomy patients the criterion of learning was the same, but the maximum number of trials was extended to 90.

Memory Tests Sensitive to Temporal-lobe Dysfunction

Wechsler Memory Scale, Form I and Form II. Because this scale consisted of a heterogeneous group of subtests, very heavily weighted with verbal items, the resulting memory quotient was misleading. We therefore chose to focus our analyses on three individual subtests: memory passages (stories), associate learning (words), and visual reproduction (geometric drawings). In addition to immediate recall of the stimulus material called for in the memory scale, we obtained delayed recall of the same material, approximately one-and-a-half hours after the first (and only) presentation, the latter scores being more sensitive detectors of memory deficit in patients with unilateral temporal lobectomies (Milner, 1958).

Visual-verbal Recurring Figures Test. This task involved the continuous recognition of four-letter words, three-digit numbers, and three-letter nonsense words (Milner, "Memory," in Milner and Teuber, 1968). Recurring stimuli were intermingled randomly with non-recurring in a deck of 144 cards; the net score was the total number of recurring stimuli correctly recognized as -such, minus the total number of false positive responses. Net scores were obtained for each of the three types of stimulus material as well.

Visual-nonverbal Recurring Figures Test. The stimuli for this task, a nonverbal analogue of the Visual-verbal Recurring Figures Test described above, were geometric drawings and irregular abstract (nonsense) drawings (Kimura, 1963). The procedure and scoring system were similar to those for the verbal test, the deck in this case consisting of 160 cards.

Rey-Osterrieth Complex Figure Test. Subjects were given unlimited time to copy a complex line drawing, and then one hour later, without having been warned, were asked to draw it again from memory. The Taylor figure (Taylor, 1969) was given preoperatively and the Rey-Osterrieth figure postoperatively (Rey, 1942; Osterrieth, 1944). Both the copy and the delayed recall were scored quantitatively, according to a system devised by Rey and refined by Taylor. This procedure permitted a comparison of visuo-spatial capacities not dependent upon recent memory, with those that were.

Faces and Houses. This task involved the forced-choice recognition of black and white photographs of men's faces and of houses (Yin, 1970). In the first half of the test, 12 unfamiliar faces intermixed with 12 unfamiliar houses were presented one at a time, right-side-up for inspection. There followed 12 pairs of faces intermixed with 12 pairs of houses, all right-side-up, the subject being asked to choose the one in each pair that he had been shown in the inspection series. The procedure in the second half of the test was identical to this, except that new stimuli were used, and all faces and houses were shown upside-down. Four scores were obtained: recognition of faces right-side-up and upside-down, and recognition of houses in the two orientations.

Famous Faces. News photographs of 85 public figures from the 1920s through the 1970s were shown to the subject, who then tried to name the individuals and to state why they were famous (Marslen-Wilson and Teuber, 1975). All photographs on which the subject failed were later shown again, the examiner supplying situational and letter prompts to facilitate recall. The number of famous persons correctly identified without and with prompts was recorded.

Sensory and Motor Tests

Two-point discrimination, position sense, and grip strength. Quantitative measures of the two-point discrimination threshold on the palm (Corkin, Milner and Rasmussen, 1970), position sense in the fingers (Taylor, unpublished, but see Corkin et al.), and grip strength were taken to supplement the neurological examination.

Tapping. Two tapping tests were given. One measured the patient's maximum rate when tapping for 10 seconds with each index finger alone and with the two tapping simultaneously. The other test, devised by Thurstone (1944) required the patient to tap four adjacent targets in sequence with a stylus for 30 seconds per trial, both unimanually and bimanually, the movement sequences in the latter condition being different for each hand. Using a task somewhat similar to this one, Faillace, Allen, McQueen, and Northrup (1971) found postoperative deficits in patients with bilateral lesions of the cingulum bundle carried out for the relief of intractable pain.

Personality Assessment

Eysenck Personality Inventory (E.P.I.). The E.P.I. (Eysenck and Eysenck, 1968) is an untimed paper and pencil test consisting of 57 questions to which our patients answered "yes" or "no," to reflect their usual way of acting or feeling. Two parallel forms were used, providing pre- and postoperative values of three independent scores: neuroticism, extraversion, and a falsification detector. Published test-retest reliabilities range from .80 to .97 and split-half reliabilities from .75 to .91. The extraversion and neuroticism scores correlate highly with similar scores obtained with other objective personality tests.

RESULTS

Selected Abbreviated Histories and Taped Interviews

For the purpose of history review and analysis of interviews, we grouped the cases for the qualitative section into those who received the operation primarily for relief of pain, those who received it for depression, those with obsessional and compulsive disorders, and, lastly, a residual group with various other psychiatric indications, including such designations as schizophrenia. The diagnoses acquired by most of these patients during the protracted course of their illness were in fact strikingly varied and not particularly suitable for consistent groupings, except for the cases referred for pain, although, as we had pointed out previously, most of the pain cases also had various psychopathologic features.

Nevertheless, it seemed useful to present, first, the results of history review and interviews for 11 cases in which the operation was performed for the relief of persistent pain, and then for each of the other three groups. For the subsequent description of general physical and specialized neurologic examinations and of the numerous psychological tests, the subgroups were recombined, and the reports are given, at this stage, by individual procedures rather than by patients or groups.

The picture that emerges is one of nearly uniform therapeutic success, often maintained for years in most of the cases referred for pain, in contrast to a much more varied outcome, both by the patients' own estimates and by those of the survey staff, for those bearing other initial diagnoses. On the other hand, the results of neurologic and psychologic examinations did not turn up more than scattered and temporary reductions in performance that could be attributed to the operative procedure. Wherever the patient's performance fell below that of various matched controls, the preponderance of evidence pointed at the combined effects of their pre-existing illness and their earlier treatments as the cause.

Cases Referred for Persistent Pain

Patients referred for cingulotomy because of pain frequently presented, on further exploration, a mixed picture of pain and depression, or pain and conversion reactions, but this variability in their preoperative state seemed to have little bearing on the outcome after surgical intervention. We are giving eleven capsule histories (see appendix) based on review of available hospital records and on interviews, usually tape-recorded with patients and relatives, to illustrate the nature of these cases. Three of the histories are given here, within the text. We are also adding one case of (unplanned) placebo control (operation terminated after burr holes were placed).

P1. Case M.A. Presenting complaint: pain (with some depression?) This 52-year-old housewife received a cingulotomy in January 1975, and was seen twice, two months and fifteen months postoperatively. She had six pregnancies, with three ending prematurely in early and painful abortions. Low back pain is said to have started after the last of these spontaneous abortions when patient was 36 years old (in 1960), thus 15 years ago. Had three spinal fusions, one cordotomy, and had an electrostimulator implanted into her cord (stimulator had to be removed because of adhesions). For about three years, in the 1960s, was supposedly feeling better, following one of the back operations -- then relapsed. Was given placebo trial by one surgeon (injection of vehicle, without drug, into intervertebral space) who had considered her for cordotomy. Patient responded with claims of near-complete relief and walked (having been bedridden at that stage in her illness). Following the placebo trial, this particular surgeon refused to perform the cordotomy; patient therupon changed physicians. Reports having been totally disabled by her back pain prior to the cingulotomy, claims relief was immediate and complete afterwards. Roth patient and husband deny any side effects and recommend the procedure unreservedly to others.

The case had been complicated just one month before the cingulotomy, by an intercurrent hepatic encephalopathy, during which the patient was in coma for several days. Patient seems fully rehabilitated, is continuing her specialty training in speech and hearing, and has returned to work, not having worked for most of a decade preoperatively because of pain. In spite of the intercurrent encephalopathy, the patient seems to show no lasting losses on her postoperative tests. Although she had received many drugs, she never had ECT.

P4. Case L.H. Possibly clearest instance of pain as main indication for the procedure: Painful amputation stump, without history of previous escape into illness, or of depressions, or conversion reactions. No ECT. Accidental loss of left hand and wrist in 1966 (now 49 years old). Patient and records report that he developed persistent and disabling pain in the stump, unrelieved by multiple nerve blocks and many types of drugs. Claims immediate and complete relief from the stump pain following cingulotomy in June 1969. Now works at same hospital (as maintenance man), where he had operation. Vigorously uses a metal hook on left arm, affixed to the previously painful stump.

P7. Case P.E. A 52-year-old housewife with a complicated early medical history, claims malaria as a child and kidney trouble with pain in lower abdomen and left flank (i.e., same distribution as later trouble), from 6 to 11 or 12 years of age. Menses regular from 13 to 20, but becoming quite irregular after marriage -- "spotting" in mid-cycle. Two abortions in third month. Childless while trying to have children (patient states), finally adopted a child. Some evidence of dyspareunia. Abrupt onset of main trouble in 1966, patient found one day she could not void, was catheterized, then had this trouble on and on with almost daily interventions, incessant complaints of pain in lower abdomen. Eventually developed bladder infections, had bladder removed, ileal loop installed, etc. Exclusively seen by urologists and neurologists; only in last three years before cingulotomy (i.e., from 1973 to 1976), by psychiatrist. Patient also developed phlebitis of left leg; nearly entire days were spent in the bathroom; all sexual activities had stopped. Cingulotomy as last resort, recommended by psychiatrist, "for pain," on February 3, 1976. Patient claims immediate relief of the severe abdominal pain -- as she puts it -- "first real relief in ten years of continuous suffering." Asserts pain still there but "vague" -- not that "crippling" -- can do exercises, walks every day (had been bedridden before) -- "I have a new life." Still on some pain-relieving and mood-elevating drugs -- patient's husband equally in favor of the operation; denies any side effects or "costs," i.e., psychological losses due to the intervention, although patient volunteers that at first (postoperatively) she found herself less able to concentrate, got distracted ("hypnotized") by rhythmic noises, and had trouble arranging housework, but patient is quite sure that this is now getting better.

Summary for Cases In which Pain Was Presenting Complaint

All in all, nine of the eleven patients (and their relatives wherever they were available for confirmatory interviews) report conspicuous and generally lasting relief from pain that had been a major feature in the patient's condition for periods ranging from three to over twenty years. These pains were described as having been refractory to all kinds of drug therapy, to various forms of spinal fusion operations, to the implantation of electrostimulators into the cord, and to lateral cordotomies. The patients' own descriptions do not point at any obvious losses in either the richness of their affective lives nor in their intellect, except for one description of transient lowering in powers of concentration. In four cases, there was a complete cessation of drug dependence, without the usual withdrawal syndromes.

It should also be underlined that in all those instances where the patients suffered subsequent injuries (fractures or sprains), or developed arthritis or bursitis, or had surgery for other reasons, they said they experienced "normal" pain, but a kind of pain different from the "crippling," nagging pain that had led to the cingulotomy. Anguish, such as in bereavement, was apparently normally experienced and expressed, in spite of the cingulotomy. The rather far-reaching relief claimed by these patients from their preoperatively persistent pains seemed quite independent of the degree of admixture of depressive or hysterical features. However, in one case, an earlier procedure (injection of vehicle without drug into an intervertebral space) had established the patient as a strong placebo responder, and in at least two other cases (one male, one female), the pain seemed to be very much tied in with marital (sexual) conflicts.

On examination (interviews and observations on the ward, at M.I.T.'s Clinical Research Center) none of the patients available for this study showed any obvious signs of inappropriately elevated affect, i.e., the pain relief did not seem to betoken any persistent euphoria. On the other hand, the patients frequently expressed not only gratitude to the surgeon, but used rather solemn language (a miracle -- my life restored) which had religious connotations. Return to gainful employment was frequent; in at least two instances, there was evidence that the surgeon had made the necessary arrangements for employment himself, rather than delegating these matters entirely to-a professional social service.

It remains conceivable, in the absence of more systematic placebo controls (burr holes without subsequent cingulotomies) that some of the patients might have responded to the burr holes alone, especially those with a history of earlier conversion reactions, or obvious flights into illness, but this is unlikely to be true for the entire series. In sum, a remarkable outcome, underscored by the fact that not one of the eleven cingulotomy patients needed a repeat procedure. In this and in several other respects, these "pain" cases are in striking contrast to the other subgroups with cingulotomy in this general series.

Primarily Depressive Illness (With or Without Suicidal Attempts)

Three examples of cases with primarily depressive illness are presented here in greatly abbreviated form. The entire set of case histories for patients with depression will be found in the appendix. Perusal of these and other histories will make it abundantly clear that the referral diagnoses were often arbitrary and sometimes contradictory. Some "pain" cases could have been listed as depressions, and there were elements of depression in many of the remaining cases (obsessive-compulsives and other psychiatric conditions).

D1. Case C.E. A 61-year-old woman who on evidence of record has suffered from a severe manic-depressive psychosis with numerous depressions for the last 40 years. This patient has been under treatment, in and out of hospitals, since her early twenties; she has received at least 80 ECTs, and was one of the first patients tried extensively on lithium (as a volunteer at the Clinical Research Center of the NIH). Following a first cingulotomy in 1971 (five years ago), she was considered by herself in complete remission; she resumed her work as a church organist and got herself busy in community affairs. However, close observation suggested a moderately manic temperament which was reflected in the vehemence with which she defended the operation she had received and inveighed against those who she thought were its critics. She was and is deeply devoted to the surgeon for whom she does various types of volunteer work. While under observation at the CRC in 1974, three years after the first cingulotomy, she entered into another manic phase and soon thereafter had to be re-hospitalized and was given a second cingulotomy; has been on somewhat rocky course since then but again resumed her work as organist and as volunteer hospital worker. Still is being considered as very much improved by relatives and hospital staff after having been deemed refractory to all treatment attempts from her twentieth year onward.

D4. Case H.P. A 36-year-old file clerk in a city hospital who is considered as suffering from unipolar chronic depression with suicidal impulses and several quite convincing suicidal attempts. He quit college after two years, apparently because of the onset of his depression when he was in his early twenties, about 15 years ago. Lethargic and quite amnesic; sleeps a great deal, shows marked (drug-induced) Parkinsonism. Had two cingulotomies, one each in 1966 and 1973, with little or no apparent improvement, though patient's mother thinks he has become more lethargic. The patient believes this is more likely due to the cumulative effect of drugs. States he has been thinking less of suicide.

D5. Case McD. K. A 24-year-old woman with diagnosis of severe depressive reactions and history of several nearly successful attempts at suicide. Complicated by grand mal epilepsy and automatisms. History reveals onset of odd experiences (unilateral subjective distortions of the body) at age 12; developed frank seizure disorder in later teens, probably on familial basis -- father, one brother, one uncle had seizures. Got ECT for suicidal attempt and for depressed and confused behavior at 20. Seizure condition apparently aggravated by the ECT (e.g., had more frequent and severe attacks, also a recurrent memory of being at her old house "on a hot August night, when I was 12 -- hearing the trash barrels being moved noisily in the back"). Cingulotomy was resorted to in August 1975 because her suicidal impulses were deemed out of control. She states that cingulotomy alleviated these impulses, though not entirely. Holds post as technician in a hospital. Rather in contrast to most other patients in the series, says cingulotomy acted on her like an ECT, because she could not remember familiar names or faces afterwards for several weeks (possibly because cingulotomy was superimposed on a pre-existing temporal-lobe disorder). Other patients spontaneously contrast ECT, with its effects on memory, with cingulotomy, which they say has no such effects. Patient considers herself very much helped; works regularly and shows strong rapport with surgeon, and with examiners.

Summary for Cases with Depression as Primary Diagnosis

All in all, the seven cases presenting primarily with depression had a varied outcome, although five of the seven are called "successes" by the patients themselves and would have to be considered therapeutic successes by the interviewer. Of these five, three seem to have entered upon complete remission; one additional case had been in near-complete remission for three years after a first cingulotomy and then became manic, but is now considered partially recovered after a second operation. A remaining case amongst the five was complicated by pre-existing epilepsy, but is considered less suicidal by herself and by the examiners and should thus be rated as at least partially improved. On the other hand, one case of severe unipolar depression did not seem to have responded even temporarily to the operation and another did not respond to two operations three years apart, though again that patient might be somewhat less suicidal at the present time.

However, it must also be noted that the seven cases in this small series are all characterized by the fact that they had been consistently refractory to ECT, and that heavy medication with a great variety of agents had not produced enough relief, so that the operations were elected, in virtually every instance, as a measure of last resort.

Primarily Obsessive-Compulsive Conditions (With or Without Depressive Features)

This small cluster of cases (four in all) is characterized by the presence of obsessions and compulsions as major features in the referrals and throughout their earlier medical records. Nevertheless, other cases could have been added to this cluster, particularly from the residual group (Other Psychiatric Conditions) which follows. this section. We are here presenting two of the cases with primarily obsessional symptoms. These cases, together with the other two, can also be found in the appendix.

OC1. Case A.L. This 51-year-old housewife had acquired a variety of psychiatric diagnoses over the past 20 years, ranging from obsessive-compulsive state to postpartum psychosis to depression and chronic undifferentiated schizophrenia. She had more than 36 ECTs beginning 10 years ago and received three cingulotomies, the first two when 49, and the third and last when 50 years old. She and her husband give concordant descriptions of a crippling day-by-day preoccupation with germs and dirt around the house, with corresponding washing and cleaning compulsions, and a somber feeling tone. She presented the same picture while under observation at the CRC. Nearly two decades of psychotherapy, medication with mood-elevating drugs, and over 36 ECTs, were said to have been without significant effect. Patient and husband state that patient suffered severe but partially reversed memory losses after ECT; one of the shock treatments was followed by a prolonged seizure, and EEG now shows temporal-lobe focus primarily on right. There is marked (drug-induced) Parkinsonism.

Effect of first cingulotomy is described as having given one month of partial relief ("my fear of germs and dirt was still there but didn't bother me so much"), but this partial relief was not maintained. Subsequent treatments are said to have left her unchanged (according to patient herself) or very slightly improved (according to husband) who says that she complains less often and less insistently. Both patient and husband prefer these operations to ECT. Husband would recommend this operation to others, patient not so sure.

OC3. Case S.M. A 52-year-old married woman working four days a week as a psychiatric nurse, with obvious depression, though bearing a transfer diagnosis of "severe obsessional illness." Seen twice, 15 months apart, she gives history of obsessive fears of hurting others, now turned into a fear of worrying about drug dosages (while working on psychiatric service), and frequent ruminations about suicide. There has been at least one rather convincing suicide attempt. Onset of trouble at 27, i.e., more than 20 years ago, but more severe in her mid-forties, described as deeply resistant to psychotherapy, to massive drug treatment, and to over 34 ECT and 30 insulin coma treatments.

Says she had no benefit from a first cingulotomy (age 49) but states emphatically that there were not any negative effects either. Had another series of ECT after that first operation, says these treatments affected her differently. "They gave me a more general memory defect: Earlier treatments made me forget recent events, but this new series acted like an eraser." That is, she forgot more remote and fundamental information, such as drug dosages (!) and other professional information. Had second cingulotomy at 50; says after that "again, it seemed like nothing had happened, but then, as time went by, I began to notice that I didn't require too much medication and what medication I did have -- worked very well. And I began to feel that my life had been given back to me. Unfortunately, this only lasted about, oh, less than a year." She says the fear did not come back, but the depression did, is now back on Thorazine. Patient would now assess the cingulotomy as having given "15 per cent improvement." Husband is more guarded about the value of the operation in his wife's case, but both patient and husband feel it was worthwhile to try. Patient's complaints about memory defect are compatible with test results. Nevertheless, she has gone back to work after the second operation (not having worked before) and is still on her post as psychiatric nurse four days a week. Both she and her husband are firm that her reading habits haven't changed. Still reads voraciously -- serious novels, and psychiatric textbooks. To interviewer, seems 'very moderately improved.

Evaluation of Effects in Obsessional-Compulsive States

Disorders involving obsessions and compulsions are notoriously refractory to treatment; for that very reason, these conditions used to be considered as primary indications for various forms of fractional frontal-lobe surgery, such as frontal-cortical undercutting. It comes therefore as somewhat of a surprise that the four cases in this series showed so much less response to cingulotomy than did the various "pain" cases. The group is very small, and all four patients exhibited severe depression as well as obsessive fears and compulsive reactions, but three of the four patients state emphatically that they were unchanged by the operation and one describes her present improvement as slight ("15%").

However, the morbid conditions had lasted in all four cases for at least a decade, and in two, for more than 40 years; the operations were preceded in all instances by protracted therapeutic efforts of all kinds, and were chosen only after all else had failed. In at least one of the four instances, and possibly two, the operation may have prevented a suicide, but such conjectures are always moot. As to the psychological "costs" of the operation in this special series, it is impossible to dissociate the postoperative effects from the accumulated effects of earlier somatic treatments, particularly from drugs and ECT.

All Other Psychiatric Conditions (Including Severe Anxiety-Neurosis, Borderline Schizophrenia, and Paranoid Schizophrenia)

The last subgroup which comprises 11 cases (see appendix) was constituted by combining all of the remaining transfer diagnoses, ranging from severe anxiety neurosis to borderline schizophrenia and paranoid schizophrenia. On scrutinizing the abbreviated case histories, esp., the four illustrative cases given here in the text, it will be obvious that these diagnostic labels had been used loosely, and often inappropriately, throughout the course of these patients' illnesses.

<u>NS8. Case K.M.</u> Called in records depressed but was seen by us preoperatively in a panic state, with primary psychotic experiences (everything strange, closing in, voices calling her to commit suicide). A boyish-looking, boyishly-dressed young woman of 22 (in 1976); onset of trouble in early teens, about 1965-66,

while in school. Much torn, then, between needs for social contact and for seclusion, while developing a nameless "pain" that grew inside her over the years. Much experimentation with illicit drugs (especially heavy use of LSD), from late teens onward; by her admission, often in an attempt to give herself the impression that she could gain control over her own bizarre internal states (by turning them on and off with drugs); she wonders at the paucity of visual hallucinations, in her drug experiences, over the years. Went into considerable decompensation about three years ago (at 19), voluntarily admitted self to state hospital to avoid committing suicide. Heard voices commanding her to kill herself. Some 30 ECTs without apparent benefit. Cingulotomy in mid-1975 seen by her as desperate attempt to prevent her self-destruction; enormously grateful, says it immediately abolished "that pain." Took one year postoperatively at community college, then started working as automobile mechanic (!), plans further. engineering training, travels, works for various causes, claims a lesbian relationship with a roommate.

At this stage, patient strikes one as being an impressive success -- disclaims any suicidal ideas or unusual experiences for nearly two years. Scores extremely well postoperatively on all tests. Praises operation, says surgeons could have done anything with her in the desperate state she was in. But wants to see ECT curbed, and particularly wishes people would not think it had to be tried before proceeding to cingulotomy.

<u>NS10. Case P.P.</u> A 24-year-old unmarried woman with a perplexing history of psychiatric treatment beginning at age 4-1/2 (!), and carrying diagnostic labels of schizophrenia and severe compulsions (self-mutilation). Examined after second, and, again, after last of three cingulotomies (cingulotomies July 12, 1973; November 12, 1973; February 11, 1975). Most dramatic case in series, since she would have been deemed greatest success story, if follow-up had been stopped

while she seemed to be in full remission, beginning four months after the second cingulotomy, and maintained for about ten months.

From early childhood, but especially after birth of only sibling, a younger brother (who is clearly the mother's favorite), patient considered impossible to manage by mother; had nightmares, clung to her, was seen for a long period (possibly over a year) by child psychologist when patient was 4-1/2, then by other therapists, before the end of her first decade. Began to scratch up her arms, when frustrated, in early teens, cut wrists at 12-1/2, was hospitalized continuously for two years in an adolescent ward of a psychiatric hospital. Continued to cut and burn her breasts and forearms on numerous occasions, had over 100 ECTs, and all kinds of drug treatments without success.

After first cingulotomy, showed no change, nor after second. Still cut and burned self, returned to a psychiatric hospital, but four months after the second operation, and without any warning, signed herself out of hospital (against medical advice), said it was silly to cut and burn oneself, went home, took medical assistant's training program of her own choice, passed it, and then began on a course of plastic (cosmetic) surgery for the self-inflicted scars on her forearms, to prepare self for job interviews. Could not tolerate the skin grafts, told interviewer that she couldn't understand how it came about that before (her remission) she just "had to" cut or burn herself whenever she felt tense and then felt "great -- it didn't hurt one bit -- but the plastic surgery now hurts more than I can take." Abruptly walked out of the plastic-surgical treatment, and relapsed: again borrowed lit cigarettes to press glowing ends against her arms and breasts, broke windows to cut self with bits of glass, etc.

Had third cingulotomy early in 1976, without apparent benefit; developed seizures (threegeneralized convulsions, all without warning, so far, in first three months of 1976). Totally discouraged, as are the patient's family; no longer praising the operation, in contrast to earlier interviews, in which both patient and patient's mother and father, all independently, spoke of the operation as the only answer.

NS11. Case T.M. An overweight married woman (200 pounds) of 37 without facial expression and a flat voice, bearing a history of mental illness of insidious onset. Her records describe her as schizophrenic and depressive; hallucinations; fear. She relates being afraid of playmates as a child, then describes a week of "time dislocation" -- "everything out of synch," while alone in California, at beginning of her twenties, presumably a primary psychotic episode. Gives the entire history in remarkably orderly and precise fashion, says she prepared herself for the interview; "should be good at giving account of herself," she says, since she is a school teacher, and has "gotten over" her illness now.

Married at age 22; soon after that, during her first and only pregnancy, increasing suspiciousness and agitation. Had three to four ECTs and was, as she says, "wiped out," came out of the treatments screaming and irrational; was committed to mental hospital for two years. Had numerous neurologic and EEG examinations because of a skull fracture as a four-year-old child (says skull had been cracked like an eggshell), but nothing definite was found that would relate her trouble to an early cerebral injury.

Had first cingulotomy when 30 (because of suicidal tendencies), felt tremendous relief -- said to surgeon "Thanks for giving me back my life." Still had suspiciousness, she says, but no longer felt "as if encased in a plastic cube." No side effects, patient insists, except perhaps her weight gain (gained 80 pounds in half a year post-op), but thinks it might have been also one of her drugs (Triavil). Vividly describes voracious appetite -- raiding of icebox for snacks and ice cream at various times during the day and night. Reached 242 pounds, then tried to diet, now 220, as against a pre-op weight reported as 143. Also developed mild petit mal attacks after first cingulotomy, fully controlled by Dilantin.

Says she functioned fairly well for five years as schoolteacher (had finished college and taken courses beyond that, qualifying her for a teacher's diploma). But got worse again, started drinking heavily in the later part of 1974. Heard of a neurosurgeon in California using a special procedure, went out West with husband to seek an operation from this surgeon. Both patient and husband were indignant, they say, when procedure was delayed for a committee review of her case, then received a "multiple-target stereotaxic procedure," in January 1975, viz., bilateral lesions in cingulate, amygdala and substantia innominata. States that immediately after this she was no longer suspicious about people -- was amazed about that "because I had had that (the suspiciousness) since I was seven years old" -- but still had the fear. Went back to her psychiatrist on the East Coast (who suggested one more cingulotomy), received this third operation (second cingulotomy) in the same year (August 1975). After that felt entirely "cured" for three months, then awoke one morning early in November 1975 and felt she was sick again. Was "horrified and discouraged -- felt not herself," throughout November and first two weeks of December, and then, gradually, "it cleared up." And "since that time I haven't been sick" (nearly five months now).

Questioned about side effects patient mentions weight gain after first cingulotomy but adds, again, that this might have been related to a change in her medications. Also, the seizures: ca. 30-40 petit mal attacks, starting three to four months after first cingulotomy; she did not report them to her physician for another two months, then was put on Dilantin, and attacks stopped altogether within another three months. Is emphatic in denying any emotional flattening (in spite of unemotional face!), tells of death of her mother, this January (1976); still trying to cope with this bereavement.

Had 27 ECTs in 1966-68 and 60 insulin coma treatments in 1968. Asked for her views of the operations she has had (and whether she would recommend them to others), she makes the following emphatic statements: "I would tell them to snap it up as quick as they could. It's a godsend, it is, I cannot say enough about them (i.e., operations). I don't know why they work or how they work, but they are a true godsend, they gave me back my life." Regarding evaluations of these procedures by independent groups (such as the M.I.T. lab), patient says: "It's important to me and I'll tell you why I feel that way. Because I think that of any experience a person might have in their lifetime, I think mental illness is the worst one -- you may not agree with me but speaking from my own experience, I, I've been there, and I'm still not completely well, but I'm able to try, to really try to build a life. But mental illness is one of the most devastating horrible conditions that a person can be subject to, and I would do anything that I could do to help somebody not to feel that way, -- I really, really mean that -- and at any time, if you need my services for anything, I'll be more than happy to come in, because I feel that I would like to help others, like I've been helped." This patient does remarkably well on our tests despite the multiple surgery.

NS12. Case W.P. A 39-year-old tall but emaciated man, with masked face and (presumably drug-induced) Parkinsonism, remarkably taciturn, who had cingulotomy 14 months ago, after some twenty years of trouble. Medical records describe his condition as paranoid schizophrenia, but also as chronic undifferentiated schizophrenia; chronic depression and paranoia. Apparently had a "break" while in his late teens (at 18-19) in U.S. Marine Corps. Got into disciplinary difficulties (went absent without leave, was very rebellious); was for six months in Naval Neuropsychiatric Center in Philadelphia, and for three extra years in a military stockade. Patient describes self as "very high (then) all the time, and belligerent -- they tried every day to make me admit that I was sick (i.e., the physicians in NP hospital) and I wouldn't--." Now thinks, in retrospect, that he was quite ill and should have admitted it. Wife and patient got married when both were 22, patient was working as janitor for telephone company, wife as clerical worker in office. Patient then a good athlete (according to wife), weight-lifter, always working out -- but after birth of first of their children (a daughter, now 14) patient changed, became a recluse, couldn't stand people, weight dropped by 80 pounds to 140 pounds, developed severe ulcerative colitis, became suspicious of all strangers, and had explosive tempers. Also had to go to bathroom to move his bowels over 12 times a day, ostensibly because of the colitis, at times had accidents (i.e., lost bowel control). Moreover, developed diabetes in his mid-twenties (patient's mother had also done so in middle age), needs daily insulin injections. Also, before cingulotomy, for several years, quite alcoholic ("drinking to get drunk," according to wife), usually 12 to 18 bottles of beer or their equivalent in one day. Showed very poor response to the manifold drug treatments and to ECTs of which he had at least 27. According to wife, patient "lost memory" following ECT to point where he couldn't recognize a car he had just bought.

After cingulotomy (in February 1975), tremendous change -- went on an "absolute binge" of social calls (patient says, for one month; wife, for three months) -- always wanted to go out, to call on people -- then this slackened (wife says they ran out of people to visit, but patient indicates some of his fears came back; he didn't and still doesn't want to test, he says, whether his suspiciousness has really left him). Patient produces the intriguing statement that perhaps (his suspiciousness) had been "disguised by the elation." He cannot explain the "elation" after his cingulotomy but is very definite it was there and then gradually subsided. Gives vivid example of a neighbor whom he says he'd mistrusted and disliked for years (preoperatively), and still does mistrust and dislike, but does not dwell so much on it -- is not driven by it. Patient says main side effect of cingulotomy is that he "cannot focus as much on anything (as before), but in my case that is healthful" (sic); cannot concentrate and that helps against the "monomania," as he calls it.

Test results show an initial drop after operation and a subsequent rise (on retesting a year later). Probably partially improved, at this stage. Says he is not ready to go to work. Ulcerative colitis is much better (even on X-ray evidence) -- but patient stopped drinking (completely), a considerable achievement.

Evaluation of Effects of Operation in Cases of Severe Anxiety, Borderline Schizophrenia, and Paranoid Schizophrenia

It is difficult to make summarizing statements about this fourth and last subgroup. The multiple and somewhat arbitrary diagnostic labels make it impossible to maintain that we are dealing with anything but a residual category of patients. Two or possibly three of these cases could have been placed under the rubric of depression, and at least one could have been classified as obsessional. All twelve had mood disorders, and their-mood was typically down, but the most successful of these cases (K.M.) undoubtedly represents more than an ordinary depression, with her hallucinatory and bewildering experiences, during a panic reaction. Even the severely suspicious person (W.P.), though obviously depressed as well, differs from cases of unipolar depression, by his rages, the obsessional quality of his relation to others, and the fairly convincing history of paranoid ideas.

Yet although the term schizophrenia was often used as a diagnosis in the records of this case and in four other cases of the twelve as well (T.M., K.M., H.K., and P.P.), the description fits poorly, since none presented themselves to us with the cardinal symptom of thought disorder. It seems almost as though the surgeon himself (and the physicians who made their referrals to him), had selected against such cases, possibly because of a hunch that schizophrenics might do poorly. No matter how chosen, the twelve cases in this final cluster had quite varied outcomes so far, from a (possibly life-saving) therapeutic success (now maintained for two years) in K.M., or a near-complete remission (but for less than a year, so far) in another case (T.M.), to no benefit whatever in a case of severe anxiety with obsessional features (D.R.). A rough count would yield the following balance: striking improvement in two (K.M., T.M.); transient improvement followed by drop to preoperative status, P.P.; partial improvement in two, W.P., B.E.; no change or worse now, in the remaining six.

Before turning to more general comments on the caseload as a whole, we give here an additional history, for a patient, who represented an inadvertent control case for the subgroup with complaints of pain.

An Accidental Control Case

Placebo Control. Case W.M. A 35-year-old woman in a wheelchair with a history of pain in neck and shoulder region, has congenital paraplegia (mid-thoracic section), congenital myelomeningocele, internal hydrocephalus. An anxious, suspicious patient, very attached to surgeon, but unusually apprehensive about the CRC and its staff. Gives history of pain in upper back (has no sensation below waist), starting when 18 to 19 years old, after high school graduation. Was tried on all types of pain-relieving drugs without success. Had cord stimulator implanted which had to be removed again because it was not tolerated. Had burr holes for cingulotomy drilled in October 1975; surgeon interrupted procedure without placing lesion in cerebral tissue, because brain was SO distorted (by internal hydrocephalus and abnormally small size of right hemisphere), that no secure landmarks could be discerned. Patient knows that procedure had to be somewhat modified, but insists she had "some relief, 75 per cent," though marred by what she claims was a "withdrawal syndrome;" says her pain-relieving drugs were withdrawn or at least changed postoperatively, and she could not tolerate that (!). Had a fall two months postoperatively in which she separated third and fourth vertebrae, needed a collar; neck pain partially reactivated. Still would recommend cingulotomy to others, expresses deep gratitude to surgeon. Since then had further "return of her pain."

Concluding Comments on the Case Histories and Interviews

In looking back upon the entire series it is evident that the so-called pain cases stand out. By their own evaluation, that of their relatives and that of our research staff, at least nine of the eleven seemed to have been considerably relieved of long-standing and disabling pain. How can this be explained? One could argue for at least an admixture of placebo effects, but the very last case (just abstracted) would rather seem to detract from such an explanation. Patient W.M. claimed transient and partial ("75 per cent") relief but <u>did</u> relapse in contrast to the other patients, and, again in contrast to those with actual cingulotomies, she did not tolerate an enforced abstinence from her pain-relieving medications.

On the other hand, there is little evidence from these histories that the cingulum bundle should be looked upon as a specific "pain pathway." It is the preoccupation with a persistent pain, that seems to be abolished or at least relieved by the surgical intervention. Conceivably, this effect is somewhat non-specific, acting upon motivational substrates in a manner not too dissimilar from ECT. It must again be underscored that the "pain" cases seen in this series were almost all burdened with grave hypochondriacal tendencies, and that they had repeatedly sought drastic forms of medical intervention before coming to the cingulotomy as their last try for relief. Nevertheless, it remains remarkable that not one of the eleven cases sought a second cingulotomy, much in contrast to the patients bearing other diagnostic labels who frequently sought and received multiple operative procedures.

It may be significant that among these other cases, the two who consider themselves most definitely helped were those who described their own psychotic experiences as a source of unbearable "pain" or "anguish" (K.M. and T.M.), whereas more ordinary forms of depression had a mixed outcome, and the few obsessive-compulsive patients in this series did rather poorly (as they tend to do with most forms of therapy). Overall, one can describe the "outcome" (in terms of therapeutic intent) for the entire series, at this early stage, as follows: (a) The patients' self-evaluations were obtained for only thirty-two of the thirty-four cases, since two patients (who were in the last diagnostic cluster) were apparently too ill to keep follow-up appointments. The self-assessments after a cingulotomy (or after the last cingulotomy in cases of repeated operations) reveal a rating of "greatly improved" for 18 (of 32) cases; partially or temporarily improved, 6; unchanged (one patient said "worse"), 8.

(b) If the same global assessment is requested of the patients' close relatives (wherever they were available for interview), we obtain the following picture: For 12 different patients the assessment given is that of great improvement; the improvement is considered partial or transient, for another 3; and definitely unimproved, 6. (One must note that information of this sort had been obtained for only 21 of the 32 cases.)

(c) Lastly, 22 of the patients, in response to the question of whether they would recommend the operation to others, said they would recommend it (often adding, if by their own surgeon!), and 6 said they would not recommend it; one patient preferred to say that the family should see various consultants first. (However, that same patient felt this had been done quite properly in his own case, and that he had improved.)

(d) The interviewer, who observed the patients and wherever possible their relatives, individually and together at the CRC, and who had access to all transfer records, rated the overall outcome (of all those personally examined) as follows: definitely improved (essentially, in remission), 14 cases, of which

12 had primarily complained of pain (see above); partial or temporary improvement: 11 cases; and unchanged or worse, the remaining 7 cases. These figures must be considered against the background of all of the individual histories which indicate with few exceptions that these patients and their families had exhausted other forms of customary treatment before the surgeon had been approached.

Obviously, such global assessments of outcomes are made uncertain by the relatively short duration of our follow-up, and by the known limitations that cling to such judgments, which cannot form a substitute for a proper evaluation of therapy by means of untreated or differently treated control groups. Yet whatever their validity, these estimates of gain in some cases, and of partial gain or no gain in others, should be considered against an assessment of the "Costs" of the operation: the presence or absence of unintended neurologic or behavioral effects that might stand revealed by means of appropriate tests. It is to these results of neurologic and psychologic examinations that we shall now turn.

Neurological Examination

Prior Neurological Disease

A number of patients had a past history of disease affecting the brain. A history of previous head injury was obtained in eight patients. Their injuries ranged in severity from concussion to probable contusion and laceration of the brain associated with prolonged unconsciousness. Five patients had a prior history of seizures. Two of these had temporal lobe seizures, well controlled in one and only partially controlled in the other. One patient had had febrile seizures in infancy. One had had a prolonged seizure during a course of ECT, and an EEG at that time revealed spikes in the right temporal leads. The other patient had had two generalized convulsions, perhaps the result of a traumatic encephalopathy. One patient had a previous history of treated neurosyphilis. One patient had had an hepatic encephalopathy.

Results of Neurological Examinations Following Cingulotomy

There was no unequivocal evidence that cingulotomy produced any neurological symptoms or signs in the patients reported here. With the exception of two patients, any neurological deficits were easily related to the patients' primary disease, side effects of psychotropic drugs, or previous neurological disease. In those patients examined both before and after cingulotomy, neither changes in neurologic status nor new abnormal signs were detected.

Twelve patients (10 with psychiatric disease and 2 with pain-depression) had completely normal neurological examinations.

In 7 patients the only abnormalities were related to the primary disease which led to eventual cingulotomy. All 7 of these patients were in the pain-depression group and the neurologic deficits were those of root or nerve dysfunction.

In 11 patients (all psychiatric disease) the neurologic abnormalities were those of drug-induced parkinsonism or dyskinesiae. All of these patients had been on various combinations of psychotropic drugs over a long period.

One patient (psychiatric disease) with a history of temporal-lobe epilepsy had a slight right facial weakness and diminished vibratory sensation in the right hallux. (C.T. scan revealed very small bilateral cingulate lesions.)

Another patient in the pain-depression group revealed a bilateral hearing loss. This had been present for many years and was, apparently, the result of congenital syphilis.

Thus, in 32 of the 34 patients studied, either no neurologic abnormalities could be detected, or when present, could be related to prior disease of the nervous system or drug-induced dyskinesia or parkinsonism. No neurologic abnormalities in this group could be attributed to the cingulotomy.

In only 2 patients was the nature of the neurologic deficit more difficult to ascertain. One of these patients exhibited some cogwheel rigidity and dystonic posturing induced by heel walking, which most likely was related to previous long-term chlorpromazine therapy. More difficult to explain were additional abnormalities consisting of reflex sucking and grasping. It was tempting to relate these findings to the bilateral cingulate lesions which extended to the genu of the corpus callosum and into the superior frontal gyri as shown in a C.T. scan. Yet a number of other patients in our series had similar lesions by C.T. scan without exhibiting any trace of abnormal neurologic signs. Indeed, the patient with the most extensive lesions had a normal neurologic examination. We have not been accustomed to finding release of reflex grasping and sucking following long-term therapy with psychotropic drugs. Whether these findings were in any way related to the extensive ECT that this patient received, is again conjectural, for other patients who received even more ECT did not exhibit the exaggerated reflex grasping and sucking. Nor could we correlate these findings with the combination of therapies (chemical, convulsive, and surgical), for, again, other patients in the series with these combined treatments did not have these signs. Unfortunately, we did not have the opportunity to examine this patient prior to surgery and the nature of the enhanced reflex grasping and sucking remains undetermined for the present.

The other patient whose neurologic abnormalities were more difficult to explain had an anisocoria with the left pupil larger than the right, slight clumsiness of alternating movements in the left hand (the preferred hand), and increased flexion of upper extremities on heel walking. This patient had a history of drug abuse in the past and continued to take large amounts of amphetamines at the time of examination. This patient's C.T. scan revealed small bilateral cingulate lesions and asymmetry of ventricular size. Abnormalities of pupil size had been observed intermittently prior to cingulotomy. We suspect that the slight clumsiness could be related to amphetamine usage. Again, we had not had the opportunity of observing this patient prior to cingulotomy, so cannot comment on the: presence or absence of slight distonic flexion of the elbows that occurred when the patient walked on her heels. In our experience this most often occurs as a residual of a very mild congenital diplegia but such an etiology could not be unequivocally ascertained in this case.

Post-operative Seizures

Six patients had seizures after cingulotomy. Only two of these patients were without an antecedent history of-seizures or head injury. One of these had only one seizure and another had a total of three over a period of months -following a third cingulotomy; The remaining four patients all had a past history of head injury, and two of them had a history of one or two seizures prior to the cingulotomy. In one of these two the only seizure after cingulotomy occurred following over-rapid barbiturate withdrawal. The remaining two patients with a past history of head injury had never had previous seizures. One of these patients had two generalized convulsions post-cingulotomy. In the other patient there was only a questionable history of seizure following cingulotomy.

Behavioral Tests

Looking at the total pattern of test results it may be said that there were no lasting effects of the cingulotomy *per se* on the 24 behavioral tasks sampled in our study, though there were significant effects associated with chronological age and number of ECT. The statistical analyses of behavioral test data focused first on the performance of our patients prior to cingulotomy, as compared with the performance of normal control subjects. We then turned our attention to the consequences of the cingulotomy itself, taking into account the patient's sex, chronological age, and history of ECT. If there were effects of the surgery, one would expect to find them only where we had preoperative test scores to compare with postoperative ones. It was not legitimate to evaluate the surgical procedure in relation to normative standards, because in many cases, patients were inferior to normal control subjects even before cingulotomy. It should also be pointed out that in cases where we have found disproportionate deficits in patients over 40 years of age at the time of testing, or in persons who had experienced more than 50 ECT, the interpretation of the deficits must take into account the related variables of length and severity of illness. The search for sex differences in the results for our particular sample of patients revealed only two measures (aside from the motor tests) on which significant differences between the scores of men and women were found. Both were memory tests (the Visual-verbal Recurring Figures Test, and Faces and Houses), and on both the women were superior. On a third test, Famous Faces, the men scored 8 points above the women, which was not a significant discrepancy, but one that prompted us to add 8 women to the otherwise all male control group. Since test performance did not seem to be related to the patients' psychiatric diagnoses, the pain and depression group was combined with the "other psychiatric disease" group for analysis of behavioral test scores. These findings will be outlined in detail below.

One of the cingulotomy patients, a woman in her early thirties with chronic undifferentiated schizophrenia and depression of 10 years duration, achieved a Full-Scale I. Q. rating of 59 the day before her first of three cingulotomies. Attempts to test her after each of the surgical procedures typically found her behavior so inappropriate to the task at hand that no meaningful data could be obtained. On one occasion, however, she was able to perform a few of our tests, but her scores were so inferior that their inclusion in the group means would have produced spurious results. Her data therefore have been omitted from the analyses to follow. It is of interest that this woman graduated from a parochial high school in Boston at age 17, before the onset of her psychiatric disease, and ranked 47th in a class of 89, with a grade average of 75.4. These figures indicate that her premorbid level of intellectual function was probably in the average range, suggesting a considerable drop in the course of her illness, an observation consistent with an earlier and more detailed report on a post-lobotomy group by Rosvold and Mishkin (1950), who had access to pre-morbid scores.

Overall Intelligence

<u>WAIS and Wechsler-Bellevue, Form II.</u> The mean I. Q. ratings for 33 cingulotomy patients, grouped according to time of test, are shown in Table 3. It should be noted that all mean scores were within the normal range. Patients who were tested before operation and then retested in the early postoperative period showed no change from their preoperative ratings. In contrast, those who were given their second test more than four months after operation, showed

significant rises in Full-Scale, Verbal, and Performance I.Q. ratings ($p<.01$, $p<.01$, and $p<.02$, respectively). No statement can be made with regard to changes in the mean intelligence ratings for the group tested postoperatively only; their scores are given here merely to show that in this respect the three groups were comparable at the time of postoperative testing.

Non-specific Effects

Hidden Figures Test. The 22 men and 8 women who served as normal control subjects for this task were successful at finding and tracing 29.6 of the hidden figures, on an average (range: 5 to 54). The most striking aspect of the patients' performance was that over all testing periods, only 5 of the 33 patients achieved scores at or above the normal control group mean, the range of the patients' scores being 2 to 49. When these data were analyzed according to time of testing, however, a different picture emerged for patients tested less than four months after operation than for patients tested after that time. Eight of the 12 individuals in the early postoperative group performed the Hidden Figures Test even less efficiently than they had before operation, though the fall of 2.7 in mean number correct was not significant. In contrast, the 11 persons retested 4 to 18 months after operation showed an average increase of 7.6 on this test, a statistically significant rise ($p<.001$). This improvement was not due to the fact that it was the third time 6 of the 11 patients had taken the test, because the other 5, tested only once previously, showed a comparable mean gain of 6.8.

Tests Sensitive to Frontal-lobe Dysfunction

Wisconsin Card Sorting Test. In order to minimize practice on this test before operation, the procedure was discontinued as soon as the patient achieved 6 sorting categories, if this came before 128 cards had been used. After operation, the patient was allowed to sort all the cards, thus extending the maximum number of categories to 11. There was no difference between the mean number of sorting categories achieved by 17 patients tested preoperatively (mean: 4.45) and the mean for 12 normal control subjects (mean: 4.92), nor was there a difference in preoperative mean for patients under 40 years of age (mean: 4.47) as compared with those over 40 (mean: 4.42). These means were in turn comparable to that of Milner's (1963) non-frontal patients with selective cortical removals for relief of focal epilepsy (mean: 4.6). The preoperative performance of our patients was also equal or superior to the number of categories completed by Malmo's (1974) non-operated psychiatric groups, whose mean scores ranged from 2.94 for alcoholics to 4.42 for psychoneurotics. After cingulotomy, the picture was more complex: A comparison of the preoperative scores of 12 patients with their scores obtained less than four months after operation indicated that at the second testing 4 of these patients scored lower, 2 stayed the same, and 6 improved. The 4 whose scores dropped had a mean age of 46.5 years, whereas those whose scores rose had an average age of 32.3. Fortunately, it was possible to conduct a follow-up examination of 2 of the 4 patients whose efficiency in card sorting had decreased following cingulotomy. In both cases, the number of categories completed was the same as it had been before the operation, tentatively suggesting that the loss seen primarily among middle-aged individuals in the early postoperative period was transient. In order to pursue this hunch, an effort will be made to retest the 2 other such patients after more time has elapsed since their cingulotomies. An analysis of all the postoperative card sorting results (whether or not the test had been done pre-operatively) revealed that the 16 patients under 40 years of age achieved 6.53 categories on an average, whereas the 17 patients over 40 achieved 3.65, the difference between these two means being significant at the .02 level of confidence.

Verbal fluency. Even before operation our sample of patients was inferior to normal control subjects in four of the five verbal fluency subtests (Table 4). Inspection of the data indicated that the 4 patients who had never received ECT (the "no ECT" group) were comparable to the normal control subjects in performance, suggesting that it was those who had been given ECT who were responsible for the low mean scores. It was possible to test this notion statistically with the postoperative results where there were 8 patients in the critical no ECT group. These patients were also comparable to the controls on four of the five subtests, the exception being S-words. Moreover, patients in the less-than-50 ECT group were significantly superior to those in the more-than-50 ECT group on three of the five subtests, S-words ($p<.025$), objects ($p<.025$), and birds/colors ($p<.025$). These differences did not appear to be confounded by age, and there were no alterations in verbal fluency attributable to the cingulotomy *per se.*

Nonverbal fluency. This test was administered postoperatively only, at which time performance was related to the number of ECT that the patient had previously been given. The 8 individuals who had been spared ECT did not differ from the 20 normal control subjects in the number of correct structures made in five minutes, the mean scores being 10.4 and 13.6, respectively. Patients who had received fewer than 50 ECT were significantly worse than controls (mean: 9.3, $p = .01$) as were patients who had undergone 50 or more ECT (mean: 8.4, $p<.005$).

Recency. All subjects, patients as well as controls, made more "order" errors than "content" errors on both forms of this test, but there were no group differences for either category of errors when the data were analyzed for effect of age, number of ECT, or for time of testing.

Delayed alternation. The 17 patients who were tested on the delayed alternation task before cingulotomy reached criterion, on an average, in 2.5 of the 5 alternation conditions. This performance was significantly inferior to that of the normal control subjects, who achieved the necessary 10 consecutive correct responses in an average of 4.3 conditions ($p<.01$). The 17 patients were equally inefficient at discovering the patterns of alternation after operation, but whennumbers of ECT were taken into account, the only significant difference was between the two extreme groups, that is between the controls (mean: 4.3) and those patients who had received more than 50 ECT, whose mean score was 2.4 ($p<.005$).

Porteus Maze Test. The average test quotient (TQ) for 17 patients tested preoperatively was 112.1, and when the lowest score (which was 0) was excluded, the mean TQ rose to 119.1. Both of these means were far superior to the mean. TQ of 103 achieved by Landis and Erlick's 22 candidates for psychiatric surgery when tested before operation. Moreover, their patients showed a deterioration in performance when the *same* form of the test was readministered in the early postoperative period. Our patients, in contrast, showed no such drop in maze-tracing ability less than 4 months after operation on a *different* set of mazes from the one they had been given before operation. Similarly, the TQs of the cingulotomy patients whose postoperative testing occurred more than 4 months after operation were the same as their preoperative scores.

A separate qualitative score (Q-score) was also calculated for the Porteus Maze Test, a high score being indicative of poor performance. On this measure our patients, at the time of preoperative testing, were worse than were Landis and Erlick's surgical candidates before operation, the two means being 43.9 and 31.9, respectively. The cingulotomy group showed a small *elevation* of the

Q-score in the early postoperative period, which though not statistically significant was none the less notable, because Landis and Erlick's patients, both unoperated and operated, had a reduction in Q-score with repeated testing. It has been pointed out that this measure is more affected by practice than is the TQ, and, consistent with this, our own patients who were tested 4 to 18 months after cingulotomy showed a mean decrease of 21.1 points ($p<.02$), i.e., an improvement.

Tactual stylus maze. Patients were not trained on the tactual stylus maze before operation. The data obtained postoperatively indicated that both in terms of trials to criterion and number of errors, the patients were remarkably inefficient, compared to normal controls, in finding the correct path from start to finish. Part of this disparity in performance was no doubt due to the lower mean age of the normal subjects as compared with that of the patients (22.2 versus 41.8 years), but there was also an effect of number of ECT on this task (Table 5). In addition to the significant difference found between the normal control and the no ECT groups (trials: $p<.01$; errors: $p<.025$), there were also significant differences between the less-than-50 ECT group and the more-than-50 ECT group (trials: $p<.01$; errors: $p<.05$).

Memory Tests Sensitive to Temporal-lobe Dysfunction

Wechsler Memory Scale, Form I and Form II. We first looked to see if there was a difference between patients under 40 years of age and patients over 40, in their ability to recall (either immediately or after a one-and-a-half hour delay) the material from three subtests of the Wechsler Memory Scale: the two stories, the word pairs, and the geometric drawings. Somewhat surprisingly, there were no differences related to age either before or after operation. Moreover, the only significant change noted from pre- to postoperative assessment was a greater accuracy in recalling the Form II geometric drawings after operation, a finding explained by, the fact that these are easier to reproduce from memory than are the Form I drawings given preoperatively (Milner, personal communication). Finally, to complete the picture of negative results, there was no relationship between the number of ECT the patients had received and their performance on the Wechsler Memory Scale subtests that we analyzed.

Visual-verbal Recurring Figures Test. This postoperative memory test was the only one on which cingulotomy patients under 40 years of age were superior to those over 40, the younger group achieving a higher net score for words ($p<.005$), nonsense syllables ($p<.025$) and the total of the three parts ($p<.025$). Only the recognition of three-digit numbers, the most difficult material, was not affected by age. Thus, the subsequent analysis of the mean total score in relation to ECT compared patients who had been spared ECT with those who had gotten 50 or more, these two groups being comparable to each other in age (but older than the less-than-50 ECT group). A small but significant difference ($p<.05$) was found in the expected direction, that is, those who had been treated with ECT showing less capacity for verbal learning.

Visual-nonverbal Recurring Figures Test. As implied in the preceding section, the scores on this test were not affected by the patient's chronological age. However, those who had undergone ECT were significantly poorer than the normal control subjects in recognizing the geometric and nonsense figures after operation (NCS *versus* less-than 50 ECT, $p<.005$; NCS *versus* more-than 50 ECT, $p<.0005$). There was further evidence of a greater defect for the more-than-50 than for the less-than-50 ECT group ($p<.05$).

Rey-Osterrieth Complex Figures Test. Preoperative testing (with the Taylor figure) was limited to 4 cases, because of time constraints. All 4 individuals were able to copy the complex drawing satisfactorily, but 2 of the 4 (one 37 years old, and the other 54) showed a marked defect in delayed recall before cingulotomy. It was possible to retest those 4 patients with the Rey-Osterrieth figure approximately two months after operation. At that time, their copy scores were all fairly satisfactory, as before, but the delayed-recall score seemed to reflect the success or failure of the cingulotomy: One woman who was deemed greatly improved (Case P.E.) achieved a normal delayed-recall score comparable to her preoperative performance, and another woman (Case B.E.) who was partially improved raised her delayed-recall score by several points, though not out of the defective range. In contrast, two other patients who appeared to be unhelped by the surgical procedure, showed drops in their delayed recall of the complex figure, Case D.R. going from a poor score to a worse score, and Case P.Wa. going from a normal score to one clearly indicative of a deficit.

The total postoperative group of 25 patients had a mean copying score of 29.8, which was the same score as one achieved by patients tested in follow-up after right temporal lobectomy (Taylor, 1969), and thus indicated an impairment in our cingulotomy cases. For the delayed-recall condition, their mean score of 12.9 was below the reported means for patients with right temporal-lobe removals (early postoperative, 15.3; follow-up 13.8). However, on this measure, the disturbance in our patients did not seem to be related to history of ECT. Since preoperative data were available for only 4 cases, the poor performance of our postoperative group need not reflect any effects of the operation.

Faces and Houses. There was a steady increase in total errors on this postoperative test when our subjects were ranked as follows: normal controls (mean : 10.95), no ECT (mean: 13.39), less-than-50 ECT (mean: 14.69), more-than-50 ECT (mean: 16.84)--NCS *versus* less-than 50 ECT, $p < .02$; NCS *versus* more-than-50 ECT, $p < .01$. Looking at the breakdown of scores for the four conditions (faces upright and inverted, houses upright and inverted) it was clear that the normal pattern of greater ease in recognizing faces right side up than upside down was also seen in all three patient groups. In contrast, normal subjects and patients as well had equal house-recognition scores for the two orientations.

Famous Faces. This remote-memory test was given only after cingulotomy, and the general theme of the results was the same as we observed for the recent-memory tests described above. In those patients whose past treatment had included ECT, the ability to identify famous public figures broke down. This was true for both conditions of the test: recognition evoked immediately by a black-and-white news photograph, or later with the help of verbal prompts for those items previously missed. There were no differences in performance between the normal control group and the no-ECT group. However, the differences between the no-ECT and less-than-50 ECT patients were striking (without prompts: $p < .005$; with prompts: $p < .005$). The two ECT groups were equally impaired on the Famous Faces test.

Sensory and Motor Tests

Two-point discrimination and position sense. Our quantitative tests of somatosensory function were usually given only after operation when deficits were rare. Two elderly patients, one 65 years old and the other 71, had slight defects in two-point discrimination on the right hand. Two other patients in the pain group who had complained of back pain had position sense deficits on the right hand. In the "other psychiatric disease" group, two patients had position sense loss on the left hand, one of them having complained of a general left-sided sensory-motor disturbance, the nature of which was never identified. Finally, one additional patient in the pain group had severe position sense defects on both hands before operation and showed slight improvement in the left-hand score but not the right after cingulotomy. The absence of such defects in the remaining cases strongly suggested that the somatosensory disturbances that were observed were not a result of the brain operation.

Grip strength and tapping. Because the apparatus required for these three motor tasks was not easily portable, only patients examined at the M.I.T. Clinical Research Center were given these tests. As a result, our comparison of pre- and postoperative scores was limited to five cases. Two of these showed noticeable improvement on all tasks, one remained the same, and the last two were unchanged on some measures and showed a slight falling off on others.

The next question that concerned us in analyzing the motor test data was whether postoperative patients who exhibited tardive dyskinesia or drug-induced parkinsonism were inferior to the other postoperative patients who did not show these symptoms. Although the results for both men and women revealed a trend in the predicted direction, the number of cases in each of the four groups was small and none of the differences was statistically significant. Nevertheless, the postoperative group as a whole, divided according to sex, was inferior to the normal group in grip strength and on both tapping tasks. There were several factors, other than the cingulotomy, that together might have accounted for this finding. First, all but three of the patients were taking psychotropic medication and/or sedatives at the time of testing. Second, many of them had led sedentary lives for a number of years, and although healthy, were not particularly vigorous individuals. Finally, although the examiner always tried to motivate the patients to undertake the motor tasks with a competitive spirit in order to elicit their optimum level of performance, it appeared that in some cases the patients would not or could not take up the challenge. In contrast, the women and men who served as normal control subjects for the motor tests were all highly motivated and openly competitive.

Personality Assessment

Eysenck Personality Inventory (E.P.I.). Eleven patients were given the E.P.I. before and after cingulotomy. A comparison of the two sets of scores did not show any pattern in the data related to time of testing or to the presumed therapeutic success or failure of the surgical procedure. One set of scores that particularly stood out was that of Case A.C., who was not helped by the cingulotomy, yet attained extroversion and neuroticism scores in the normal range both before and after operation. Such a finding makes. one question the appropriateness of the E.P.I. for a patient sample such as ours.

We then considered the postoperative results of 30 patients, divided according to the four diagnostic groups used in our analysis of the taped interviews: persistent pain (n = 9), depression (n = 7), obsessive and compulsive symptoms (n = 3), and other psychiatric conditions (n = 11). The breakdown of extroversion and neuroticism scores in this manner showed the pain cases to be more extroverted (mean: 13.6) and less neurotic (mean: 11.7) than the depressed group (extroversion: 10.1; neuroticism: 15.4) or the obsessive-compulsive group (extroversion: 10.7; neuroticism: 16.7). Patients with other psychiatric conditions were more like the pain patients in this respect (extroversion: 11.9; neuroticism: 12.7). None of the inter-group differences was statistically significant, however.

Summary of Neurological Findings and Behavioral Test Results

One of the contributions of this investigation was to point out that candidates for cingulotomy came to their preoperative neurological and psychological evaluations with prior evidence of neurological illness and with measurable deficits in cognitive function. Fifteen of the 34 patients in our sample had a past history of disease affecting the brain, which included head injury, seizures, neurosyphilis, and hepatic encephalopathy. In addition, the patients who were given behavioral tests before operation were, as a group, inferior to our normal control subjects on tasks measuring detection of visual figures, verbal fluency, delayed alternation performance, grip strength, and tapping rate. Thus our evaluation of the cingulotomy itself could only be done with tasks on which we had preoperative scores to compare with post-operative ones. Analyses of this sort revealed drops in performance on the Hidden Figures Test and the Wisconsin Card Sorting Test in the early postoperative period, but subsequent testing indicated that these losses were only transient, as the preoperative level of efficiency was regained or surpassed at the time of follow-up. This finding was in line with the rises in Full-Scale, Verbal, and Performance I.Q. ratings seen in patients tested from 4 to 18 months after cingulotomy. It should be emphasized that there were no lasting disturbances in test performance that could be attributed to the brain operation *per se,* nor were there changes in neurologic status or new abnormal signs detected in those patients examined neurologically both before and after cingulotomy. There were however two patients, without an antecedent history of seizures or head injury, who developed seizures after cingulotomy.

Our statistical analyses of the behavioral test data also took into account the patient's history of ECT. We found that individuals whose prior treatments had included ECT were inferior to normal control subjects and to patients who had been spared ECT, and this inferiority was apparent on the following measures: verbal and nonverbal fluency, delayed alternation performance, tactual maze learning, continuous recognition of verbal and nonverbal material, delayed recall of a complex drawing, recognition of faces and houses, and identification of famous public figures. In some cases, the degree of deficit was related to the number of ECT received, patients who had been given more than 50 ECT being significantly worse than those who had sustained fewer than 50. The interpretation of these deficits must take into account the fact that such massive doses of ECT were typically administered to patients who had been seriously ill for a considerable number of years, factors that in their own right might have contributed to the deficits found.

Outlook

In sum, contrary to our expectations when this survey was begun, the cingulotomy procedure by itself did not visibly impair the patients' capacity to perform a wide range of tasks in the laboratory or in real life. What handicaps appeared seemed attributable to the patients' pre-existing illness, or to their various other treatments (especially, ECT), or both. These results must not be taken to mean that a destructive lesion in the human cingulum, and in tissue surrounding this tract, would be necessarily a totally benign procedure, if such a lesion were to be imposed on previously healthy brain. Yet the results here described do not exclude the possibility that lasting effects of such a lesion might be quite difficult to detect by presently available neurologic or behavioral methods, even though the lesions are large enough to be seen in computerized x-ray photographs (C.T. scans). The undeniable therapeutic effects that were seen in some cases, most convincingly in those patients who had complained of persistent pain, and least in the predominantly obsessional and compulsive patients may well represent a mixture, in unknown proportions, of placebo effects, and perhaps (relatively non-specific) neurochemical alterations, not necessarily at the point of surgical attack, but in areas to which the cingulum and adjacent fiber bundles project. Sprouting of injured fibers, and shifts in neurotransmitter balance, or even the development of some denervation supersensitivity might all play a role.

Such speculations will require additional neuropathologic studies in cases coming to autopsy, as well as animal experiments, employing the new fluorescent techniques for the identification of various neurotransmitter systems. Lastly, the suggestion made in our initial section, where we introduced the idea of possible tissue implants, instead of tissue destruction, ought to be considered. The recent discovery that aminergic cells can be introduced into portions of the limbic brain of adult animals opens the possibility of finding ways to modify function by adding structure rather than by taking it away. Vigorous animal experimentation would have to be undertaken before this proposal could merit clinical trials.

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TABLE 1. NUMBER OF PATIENTS ACCORDING TO DIAGNOSIS AND TIME OF TESTING

DIAGNOSIS	TIME OF TESTING	
	PRE- AND POSTOP,	POSTOP, ONLY
PAIN AND DEPRESSION	4 (3 MEN, 1 WOMAN)	7 (3 MEN, 4 WOMEN)
OTHER PSYCHIATRIC DISEASE	14 (4 MEN, 10 WOMEN)	9 (2 MEN, 7 WOMEN)

Table 2. Age parameters related to history of illness or complaint and to cingulotomy.

Diagnoses	Age at onset of Illness or Complaint (Years)		Duration of Illness or Complaint Until First Cingulotomy (Years)		Age at First Cingulotomy (Years)		Age at time of Present Investigation (Years)	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Pain and Depression (N = 11)	36.0	18-59	12.4	4-38	48.4	33-66	51.4	35-71
Other Psychiatric Disease (N = 23)	21.0	4-50	15.8	3-40	36.8	20-63	38.0	20-65

Table 3. Mean I.Q. ratings (and ranges) for 22 patients tested before and after cingulotomy and for 11 tested only after cingulotomy.

No. of Patients	Time of Test	Wechsler I.Q. Rating: Full Scale	Verbal	Performance
10	Preoperative	103.1 (89-117)	105.3 (91-121)	99.8 (88-110)
	Less than 4 mo. Postoperative	105.5 (99-115)	106.1 (94-118)	103.2 (88-111)
12	Preoperative	96.8 (73-114)	101.8 (79-122)	91.2 (73-115)
	4 to 18 mo. Postoperative	105.3 (88-124)	108.8 (89-125)	100.5 (72-122)
11	More than 4 mo. Postoperative	107.6 (87-127)	108.9 (93-136)	102.0 (71-126)

TABLE 4. COMPARISON OF MEAN VERBAL FLUENCY SCORES ACHIEVED BY PATIENTS <u>BEFORE</u> CINGULOTOMY, WITH THE MEANS OF NORMAL CONTROL SUBJECTS (NCS).

Test	Group NCS	Group Patients	Difference	P
Thurstone				
Words beginning with S	54.5	32.2	22.3	.001
Words beginning with C	18.2	9.9	8.3	.005
Newcombe				
Objects	28.3	23.2	5.1	N.S.
Animals	21.9	15.7	6.2	.001
Birds/colors	15.8	12.1	3.7	.01

TABLE 5. TACTUALLY-GUIDED MAZE LEARNING AS RELATED TO HISTORY OF ECT.

GROUP	N	MEAN AGE	MEDIAN TRIALS* TO CRITERION	MEAN ERRORS
NORMAL CONTROL	11	22.2	26 (MAX. 50)	90.5
NO ECT	6	46.8	75 (MAX. 90)	250.5
LESS THAN 50 ECT	10	34.0	65 (MAX. 90)	235.4
MORE THAN 50 ECT	11	44.2	90 (MAX. 90)	369.5

*MEDIANS, INSTEAD OF MEANS, WERE CALCULATED FROM THE DATA ON TRIALS TO CRITERION, BECAUSE THERE WAS A CONSIDERABLE NUMBER OF PATIENTS WHO ATTAINED THE MAXIMUM SCORE OF 90 TRIALS.

APPENDIX

P1. Case A.M. --presenting complaint: Pain (with some depression?).

This 52-year-old housewife received a cingulotomy in January '75, and was seen twice, two months and fifteen months postoperatively. She had six pregnancies with three ending prematurely in early and painful abortions. Low back pain is said to have started after the last of these spontaneous abortions when patient was 36 years old (in 1960), thus 15 years ago. Had three fusion operations on her spine, one cordotomy, and had an electrostimulator implanted into her cord (stimulator had to be removed because of adhesions). For about three years in the '60s was supposedly feeling better, following one of the back operations--then relapsed. Was given placebo trial by one surgeon (injection of vehicle, without drug, into intervetebral space), who had considered her for cordotomy. Patient responded with claims of near-complete relief and walked (having been bedridden at that stage in her illness). Following the placebo trial, this particular surgeon refused to perform the cordotomy; patient thereupon changed physicians. Reports having been totally disabled by her back pain up to the cingulotomy, claims relief was immediate and complete afterwards. Both patient and husband deny any side effects and recommend the procedure unreservedly to others.

The case had been complicated, just one month before the cingulotomy, by an intercurrent hepatic encephalopathy, during which the patient was in coma for several days. Patient seems fully rehabilitated, is continuing her specialty training in speech and hearing--and has returned to work, not having worked for most of a decade preoperatively because of pain. In spite of the intercurrent encephalopathy the patient seems to show no lasting losses on her postoperative tests. Although she had received many drugs she never had electroshock convulsive treatments.

P2. Case C.V. This 56-year-old housewife received her cingulotomy in 1967 for pain and depression, i.e., seven years before follow-up study at the CRC. Her complaints prior to operation were low back pain beginning in the mid-1950s and trouble with urination. Poor historian since she had electroshock treatments (at least 89 treatments preoperatively according to record); now claims large memory gaps for the late '50s and most of the '60s, consistent with effects of ECT. Says (and husband confirms) that her pain changed in quality immediately after cingulotomy, pain seemed to get less serious, "I still get pains but they don't worry me so much." States emphatically that she is quite capable of "normal" pain, e.g., recently fell on stairs and bruised her leg, an accident followed by several days of pain. Also, denies any reduction in affect, grieved (appropriately) after the operation for her pet dog when it had been run over. Possible side effect of operation: gained a lot of weight postoperatively (now 204 pounds), eats a great deal of food outside of mealtimes and during night. Says she is more tolerant of people (i.e., since the operation). Is amnesic for operation but attributes this to shock treatment. Had been on heavy dosages of Demerol and Valium but stopped all medication postoperatively without difficulty (i.e., _no_ withdrawal syndrome).

P3. Case D.J. This 62-year-old former steelworker presents a history of low back pain, conversion reactions, and depressions. History records more than 200 electroconvulsive shock treatments. Patient claims severe memory trouble, gives vague history of several accidents while at work, resulting in persistent lumbosacral pain. Also describes a period of one month with total loss of voice (confirmed by wife); record defines this as conversion reaction. Had ten months of psychiatric hospitalization when back pain was treated as a manifestation of depression, had two back operations and numerous tryouts on drugs. The cingulotomy in '65, he states, took the "nagging quality" away from his pain. Wife gives similar history of pain in this patient for 40 years. Patient himself considers operation an unqualified success, wife is somewhat more guarded, says patient still takes a good deal of medication against pain and voices many of his former complaints to her, though with less urgency. Patient and wife were placed postoperatively by surgeon as caretakers on a country estate, express great appreciation for this direct rehabilitative intervention.

P4. Case L.H. Possibly clearest instance of pain as main indication for the procedure: Painful amputation stump, without history of previous escape into illness, or of depressions, or conversion reactions. No electro-shock treatments. Accidental loss of left hand and wrist in '66 (now 49 years old). Patient and records report that he developed persistent and disabling pain in the stump, unrelieved by multiple nerve blocks and many types of drugs. Claims immediate and complete relief from the stump pain following cingulotomy in June '69. Now works at same hospital (as maintenance man), where he had operation. Vigorously uses a metal hook on left arm, affixed to the previously painful stump.

P5. Case M.B. A 74-year-old housewife seen in 1973 when she was 71 years old. Onset of osteoporosis in '62, laminectomy for back pain in '66, cingulotomy, in June '69. Patient reports partial relief--even though some pain persisted "it had lost its sharpness--no longer as if a knife were stuck into my back--" Still has severe arthritis--takes some Dalmane daily--but praises operation. Never had ECT.

P6. Case M.C. Record review only--not interviewed by HLT. Described in records as case of intractable pain--etiology manic-depressive (!). Born April 3 1939, cingulotomy April 6 1972. Age at onset of illness ca. 24, age at operation 33. Had about 30 ECT or more. Still on pain-relieving and mood-modifying drugs. Outcome uncertain.

P7. Case P.E. A 52-year-old housewife with a complicated early medical history, claims malaria as a child and kidney trouble with pain in lower abdomen and left flank (i.e. same distribution as later trouble)--from 6 to 11 or 12 years of age. Menses regular from 13 to 20 but becoming quite irregular after marriage--"spotting" in mid-cycle. Two abortions in third month. Childless while trying to have children (patient states), finally adopted child. Some evidence of dyspareunia. Abrupt onset of main trouble in '66, patient found one day she could not void--was catheterized--had this trouble on and on with almost daily interventions, incessant complaints of pain in lower abdomen. Eventually developed bladder infections, had bladder removed, ileal loop installed, etc. Exclusively seen by urologists and neurologists, only in last three years before cingulotomy (i.e., from '73 to '76), by psychiatrist. Patient also developed phlebitis of left leg; nearly entire days were spent in the bathroom; all sexual activities had stopped. Cingulotomy as last resort, recommended by psychiatrist, "for pain," on February 3 '76. Patient claims immediate relief of the severe abdominal pain--as she puts it--"first real relief in ten years of continuous suffering." Asserts pain still there but "vague''--not that "crippling"--can do exercises, walks every day (had been bedridden before)--"I have a new life." Still on some pain-relieving and mood-elevating drugs--patient's husband equally in favor of the operation; denies any side effects or "costs," i.e., psychological losses due to the intervention. However, at end of April '76, postoperative testing indicates some drop from pre- to postoperative scores on hidden figures and on sorting tests, on tests of fluency and delayed alternation. Possibly in line with that, patient volunteers that at first (postoperatively) she found herself less able to concentrate, got distracted ("hypnotized") by rhythmic noises, had trouble arranging housework--but patient is quite sure that this is now getting better.

P8. Case P.E. A 61-year-old married woman who received cingulotomy in January '72 for persistent low back pain, seen twice, three years and five years postoperatively. Patient hurt back diving at age 18 --had numerous surgical procedures for low back pain and many kinds of drugs but no ECT. Vividly recalls cingulotomy, says relief immediate but getting still better three to four months later. However developed other pains such as a bursitis for which she again takes pain-killing drugs but stresses that to her these "new" pains are less disabling than the old one had been. Says of the operation "It helped the pain it was supposed to cure, not new ones." Denies side effects or losses (and so does husband) but has had a series of dizzy spells for which she now takes Dilantin. Patient describes operation and its effects "like a miracle." Has had car accident two years ago (i.e., three years postoperatively), incurring some shoulder pain from that (possibly related to litigation)--but nothing like the old pain. According to husband reacted strongly (i.e., appropriately) to a recent bereavement. Emphatically denies affective changes--went back to work.

P9. Case P.Wi.. A 49-year-old married man who received cingulotomy in October '70 for pains in chest and abdomen,. nearly continuous since age 20 or 21, after discharge from Navy, when he started a pattern of vomiting and complaining of pains in stomach. Received numerous ulcer operations and was hospitalized once or twice a year throughout most of the preoperative period since his early 20s. Maintained frequently (usually for several days) that he could not take anything by mouth; developed definite addiction to morphine (by own admission, and evidence of record). Was put on methadone, probably just before cingulotomy, and then taken off all drugs, postoperatively, without withdrawal symptoms--is still off drugs. Definitely relieved, he says, and wife concurs--"It was a miracle--I had been in constant pain." Still vomits at times (wife: "He'll be all right if he can upchuck what's bothering him."). Patient says he still has vague uneasiness in pit of stomach, at times--but no longer the pain. Lives on full VA pension.

P10. Case P.Wa. A 50-year-old man who received his cingulotomy in February '76 for low back pain, with suicidal gestures and depression. Is also definitely addicted, primarily to amphetamines. Reports sudden onset of back pain at work as bartender, twelve years ago. Had various operations on back, also gall bladder removal--got addicted to morphine and Dexedrine. To most examiners gave impression of strong hysterical and depressive components in his complaints--is somewhat evasive about effects of cingulotomy in his case. Not sure it helped but would recommend it to others--evidently resents being deprived of Dexedrine and Percodan. Had six ECT in '63, and another twelve right after cingulotomy--complains of memory loss. Says less pain post-op if he watches out (i.e. avoids certain awkward movements)--but wants to be reassured he'll still need the drugs he craves. Needs re-evaluation at later stages, in a further follow-up.

P11. Case T.R. This 43-year-old former truck driver, carpenter and welder had a cingulotomy in October '74 for chronic low back pain and depression. Left 5th grade, to go to work as a child, had alcoholic father. Drove trucks from age 16 to 22; had to quit because of numerous accidents which sound as though he drove vehicle off road during blackouts. About 12 years ago (i.e., '64) fell off ladder, since then constant back pain for which he received laminectomies and many drugs, says himself he thought he had been "over-medicated"--also had more than 150 shock treatments, apparently without relief. Patient describes cingulotomy with unusual vividness as follows: "They drilled the holes in my forehead--they cut the nerves over my right eye--and my legs stopped paining immediately (patient snaps fingers). And I told him (the surgeon). He said, all right, now we'll take care of your back. And he cut the other nerve--in five days I was walking out--that's how great it was. I had no more pain in my back and leg, and I haven't had any since--right there on the operating table--first the leg and then the back--I just felt terrific." Interviewer: "Because the pain was gone or just terrific in general?" Patient: "All over; I just felt good after; give you a chance to live again." Questioned about possible side effects, he relates that passing-out spells started two weeks postoperatively--would have two to three a day without warning, always fell on his face. These stopped a few months after the patient had been put on Dilantin. These attacks, however, may have represented a recurrence of an earlier (pre-op) seizure disorder. Has now stopped Dilantin of own accord without recurrence of attacks (had stopped taking drugs after cingulotomy). Questioned about new "pains," says he had cartilage removed about one year ago from left leg, that hurt him "normally" but not at all like the old (chronic) back and leg pains--"that pain was living hell." Describes how before operation, he laid steps for a neighbor and had no fear of failure "I was too full of drugs for that." Now he hesitates when doing carpentry, feels more responsible, he thinks. His story is thus the opposite of what one might expect (relatively more recklessness after operation, whereas he shows less!).

D1. Case C.E. A 61-year-old woman who on evidence of record has suffered from a severe manic-depressive psychosis with numerous depressions for the last 40 years. This patient has been under treatment, in and out of hospitals, since her early 20s; she received at least 80 electroconvulsive shock treatments, and was one of the first patients tried extensively on lithium (as a volunteer at the Clinical Research Center of the NIH). Following a first cingulotomy in '71 (five years ago), she was considered by herself as in complete remission; she resumed her work as a church organist and got herself busy in community affairs. However, close observation suggested a moderately manic temperament which was reflected in the vehemence with which she defended the operation she had received and inveighed against those who she thought were its critics. She was and is deeply devoted to the surgeon for whom she does various types of volunteer work. While under observation at the CRC in '74, three years after the first cingulotomy, she entered into another manic phase and soon thereafter had to be re-hospitalized and was given a second cingulotomy; has been on a somewhat rocky course since then but again resumed her work as organist and as volunteer hospital worker. Still is being considered as very much improved by relatives and hospital staff after having been deemed refractory to all treatment attempts from her 20th year onward.

D2. Case D.E. This 66-year-old married man, a former school custodian, has been considered a case of unipolar and severe depression since his early 20s for more than 40 years. Received between 150 and 200 electroshock convulsive treatments, had a first of three cingulotomies in '69, his second in '70 and a third in '75. After the first operation (within the hour) said to his wife "My depression is gone" but less than an hour later said "It's closing in again, it's back." After second procedure (same year) said to have been essentially relieved for five years, and back at work, quite regularly; then lapsed again into depression. After third and last procedure, again said to be in remission. Both patient and wife independently praised the cingulotomy but are much opposed to ECT primarily because of its effects on memory.

D3. Case E.N. Not seen by HLT. Lives on West Coast now, visited by SHC: A case of suicidal depression and anxiety; onset of illness said to be at age 10--but went through college (with difficulties), started graduate school (in sociology). Still angry, suicidal, claims to be unimproved by her cingulotomy in July '74 (born September 1 '41). Had some 50 ECT pre-operatively and another 40 ECT post-op. Claims not to have been helped by any procedure including the cingulotomy. Impression of lack of improvement is shared by her West Coast psychiatrist.

D4. Case H.P. A 36-year-old file clerk in a city hospital who is considered as suffering from unipolar chronic depression with suicidal impulses and several quite convincing suicidal attempts. He quit college after two years, apparently because of the onset of his depression when he was in his early 20s, about 15 years ago. Lethargic and quite amnesic; sleeps a great deal, shows marked (drug-induced) Parkinsonism. Had two cingulotomies, one each in '66 and '73, with little or no apparent improvement, though patient's mother thinks he has become more lethargic. The patient believes this is more likely due to the cumulative effect of drugs. States he has been thinking less of suicide.

D5. Case McD. K. 24-year-old woman with diagnosis of severe depressive reactions, and history of several nearly successful attempts at suicide. Complicated by grand mal epilepsy and automatisms. History reveals onset of odd experiences (unilateral subjective distortions of the body) at age 12; developed frank seizure disorder in later teens, probably on familial basis--father, one brother, one uncle had seizures. Got ECT for suicidal attempt and for depressed and confused behavior, age 20. Seizure condition apparently aggravated by the ECT (e.g., had more frequent and severe attacks, also a recurrent memory). Cingulotomy was resorted to in August '75 because her suicidal impulses were deemed out of control. She states that cingulotomy alleviated these impulses though not entirely. Holds post as technician in a hospital. Rather in contrast to most other patients in the series, says cingulotomy acted on her like an ECT, because she could not remember familiar names or faces afterwards for several weeks (possibly because cingulotomy was superimposed on a preexisting temporal-lobe disorder). Other patients spontaneously contrast ECT, with its effects on memory, with cingulotomy, which they say has no such effects. Patient considers herself very much helped; works regularly and shows strong rapport with surgeon, and with examiners.

D6. Case R.L. This 32-year-old married woman who received a cingulotomy in December '74 had acquired various psychiatric diagnoses such as manic-depressive; schizo-affective; and, suicidal. She was not seen by interviewer during her allegedly psychotic states. Postoperatively she presented herself as an articulate young woman, quite overweight (200 pounds) who related her history with great lucidity and feeling. Married, age 16, had first trouble at 20 or 21 (marital strain; also started heavy alcohol abuse, and got obese). Had various forms of psychiatric treatment, such as individual psychotherapy, group therapy, and unknown numbers of ECT while in mental hospitals.

Was deemed suicidal when depressed, made one very convincing suicidal attempt. Had five pregnancies in seven years, one ending in premature birth (baby died day after delivery), when patient was around 20. This event may possibly have triggered her acute difficulties. Husband has been described as taciturn and unfeeling; by his own admission, he is also quite alcoholic. Patient sought cingulotomy as last resort--noted at first little effect but her mood became elevated while she was at CRC (she ascribes this to the friendly CRC atmosphere, which she contrasts with that of the mental hospitals where she had previously been an inpatient, but the change in her mood may have been coincidental). On discharge from the CRC she "hit an alcoholic low." Gives convincing picture of alcohol affecting her much more strongly postoperatively than preoperatively. Then stopped drinking about six months post-op, joined Alcoholics Anonymous; claims she never drank again. Says, also, no matter how badly she felt while on this binge post-op, she never once thought of doing away with herself (in contrast to pre-op preoccupation with suicide). Started taking supplemental courses to finish high-school diploma and succeeded in doing so, took job in dress shop as saleswoman, has had two raises. Now feels she "has emerged as herself. Where would I be (without cingulotomy)--before nothing touched me" (apparently did quite poorly on mood-elevating drugs). Extremely grateful to surgeon. Husband confirms impression of success, denies side effects, says "She is more responsible." Patient's postoperative test performance shows considerable gains over her pre-op performance.

D7. Case Z.K. A rather heavy-set unmarried country girl of 26, coming from a highly religious Catholic farm family in the Middle West who gives a history of having had a "breakdown" in her second year in college. Had multiple hospitalizations, has been on various mood-elevating drugs, received over 100 ECT when barely 20 years old. Called a severe unipolar depression in most of her medical records. Possibly first mood disorder in early teens (12 years old). Many religious preoccupations; during six to seven hospitalizations diagnosis of depression sometimes replaced by schizo-affective psychosis. Was considered resistant to all other treatments till she received her cingulotomy in July '75. She describes outcome as "fantastic," relates it to interviewers in strongly religious terms, as a rebirth. Apparently had arguments with a priest beforehand who opposed the surgery--now she wants to crusade for it. Works since the early postoperative period in a somewhat protected employment as file clerk in a record room. Thinks her religious feelings have been deepened, but also claims to react more naturally than before to people around her; has her first boyfriend. Apparently in full remission for 3/4 year, should be followed up for a longer period.

<u>OC1. Case A.L.</u> This 51-year-old housewife had acquired a variety of psychiatric diagnoses over the past twenty years, ranging from obsessive-compulsive state to postpartum psychosis to depression and chronic undifferentiated schizophrenia. She had more than 36 ECTs beginning ten years ago and received three cingulotomies, the first two when 49, and the third and last when 50 years old. She and her husband give concordant descriptions of a crippling day-by-day preoccupation with germs and dirt around the house, with corresponding washing and cleaning compulsions, and a somber feeling tone. She presented the same picture while under observation at the CRC. Nearly two decades of psychotheraphy, medication with mood-elevating drugs, and over 36 ECTs, were said to have been without significant effect. Patient and husband state that patient suffered severe but partially reversed memory losses after ECT; one of the shock treatments was followed by a prolonged

seizure, and EEG now shows temporal-lobe focus primarily on right. There is marked (drug-induced) Parkinsonism.

Effect of first cingulotomy is described as having given one month of partial relief ("my fear of germs and dirt was still there but didn't bother me so much"), but this partial relief was not maintained. Subsequent treatments are said to have left her unchanged (according to patient herself) or very slightly improved (according to husband) who says that she complains less often and less insistently. Both patient and husband prefer these operations to ECT. Husband would recommend this operation to others, patient not so sure.

OC2. Case G.J. This 29-year-old single woman presents with diagnoses of compulsions and depression, reports irresistible thoughts about various ways of hurting people, by stabbing them, putting poison into their food, etc., for nearly 11 years, resistant to psychotherapy, to drugs and over 48 shock treatments. Had cingulotomy eight months before follow-up interviews, claims not even temporary alleviation of her trouble. Also gives story of depressive disposition, evident since her childhood, and marked during teens (always preferred rainy days). One brother needed shock treatments for depression when only 14 ("he was almost desperate"). Patient finished high school, worked in insurance office till about four years ago but not since. Preoccupations take form of always figuring out how to hurt others "So that I can keep myself from doing it." Since patient thinks there has been no real change after cingulotomy, she would not recommend it to others, but she fears ECT more. Cannot identify any side effects of the operation except that she noted irregular menstrual cycles afterwards. On tests, is quite low on hidden figures, both before and after cingulotomy, somewhat worse after cingulotomy than before ondelayed alternation.

<u>OC3. Case S.M.</u> A 52-year-old married woman working four days a week as a psychiatric nurse, with obvious depression, though bearing a transfer diagnosis of "severe obsessional illness." Seen twice, 15 months apart, she gives history of obsessive fears of hurting others, now turned into a fear of worrying about drug dosages (while working on psychiatric service), and frequent ruminations about suicide. There has been at least one rather convincing suicide attempt. Onset of trouble, at 27, i.e., more than 20 years ago, but more severe in her mid-forties, described as deeply resistant to psychotherapy, to massive drug treatment, and to over 34 ECT and 30 insulin coma treatments.

Says she had no benefit from a first cingulotomy (age 49), but states emphatically that there were not any negative effects either. Had another series of ECT after that first operation, says these treatments affected her differently. "They gave me a more general memory defect: earlier treatments made me forget recent events, but this new series acted like an eraser." That is, she forgot more remote and fundamental information, such as drug dosages (!), and other professional information. Had second cingulotomy at 50; says after that "again, it seemed like nothing had happened, but then, as time went by, I began to notice that I didn't require too much medication and what medication I did have--worked very well. And I began to feel that my life had been given back to me. Unfortunately, this only lasted about, oh, less than a year." She says the fear did <u>not</u> come back, but the depression did, is now back on Thorazine. Patient would now assess the cingulotomy as giving "15 per cent improvement." Husband is even more guarded about the value of the operation in his wife's case, but both patient and husband feel it was worthwhile to try. Patient's complaints about memory defect are compatible with test results. Nevertheless, she has gone back to work after the second operation (not having worked before) and is still on her post as psychiatric nurse four days a week. Both she and her husband are firm that her reading habits haven't changed. Still reads voraciously--serious novels, and psychiatric textbooks. To interviewer, seems very moderately improved.

<u>OC4. Case U.R.</u> A 64-year-old housewife who is amnestic for the operation, (cingulotomy, July 23, 1975). Kept asking husband afterwards "why do I have these (burr) holes?" Developed a fear about needles, in her late teens, over 40 years ago, and of cesspools (people falling into them), much more recently, ca. 2 years ago. Increasingly irritable and depressed, searching for hidden needles, around the house, since her twenties. Married at age 22, trouble aggravated when told she was going to have twins, in early '35, when she was 24. When patient was 63, cingulotomy was decided upon as only possible alternative to commitment to state hospital. At that time, patient had developed habit of telephoning around town and across country, inquiring of people whether anyone had fallen into a cesspool. Had been diagnosed for most of the last thirty years as obsessive-compulsive or severe depression. Had over fifty ECT as well as psychotherapy and various drugs, at different times, but none of that seemed to help. Patient and her husband both seemed to think that the ECT in particular produced increasingly severe memory defects (which may account for the patient's claimed inability to remember the cingulotomy). Husband relates, however, a period of temporary improvement when patient in 1972 needed major abdominal surgery (had 54 inches of intestine removed, after a spontaneous intestinal blockage, according to husband): "for 6-8 weeks afterwards, everyone was amazed how well she was" (according to husband). Patient has no personal recollection of that abdominal operation nor of its aftermath, either. Patient deems cingulotomy

as without effect, husband thinks there is moderate improvement: "same preoccupation, but less intense." Prefers it to ECT and would recommend operation to others.

NS1. Case A.C. A 30-year-old professional gambler (bookmaker) not seen by interviewer but described in records as being a case of "acute and chronic anxiety neurosis." Born in 1946, ill at 22, cingulotomy at 28 (December 1, 1974). Has degree in finance from N.Y.U; claims an unsuccessful career turned into a successful one postoperatively (?), but had one seizure post-op (now on Dilantin) and still takes a great variety of drugs (Librium, Thorazine, Valium, Halidol, Elavil). Outcome undetermined.

NS2. Case B.E. This 55-year-old married woman, mother of three children, carries a double diagnosis of "chronic schizophrenia" and "intractable seizure disorder." Onset of trouble when 28, at end of second pregnancy--patient claimed at various times an overdose of ether (during delivery) as the cause of her subsequent seizures, but there also is an independent history of severe otitis media on right, and chronic (right) mastoiditis since age 24. From age 26 onwards, had daily brief "absences," and occasional falling to right. Bilateral EEG spikes and slow waves with more disturbance over right temporal region. CAT scan shows distortion of ventricles consistent with right anterior temporal lobe atrophy or scarring. In addition, and possibly since age 28, but increasingly over the years, patient has auditory hallucinations: Voices either repeat what she or others are saying or contradict what is being said. Patient's attacks are now (1975-76) fairly well controlled by Dilantin and Mysoline, but voices were so distressing that she could not work,--in fact, she acted (pre-op) as if very hard of hearing. Cingulotomy in early 1976, three months before follow-up interview. Patient, three months post-op, is still hearing voices, she says, but "I tell them to shut up--I know they are from the devil--I can put up with them." Patient somewhat contradictory in her own evaluation of the benefits of the procedure but says she would recommend the operation because "I believe in my doctor" (the surgeon). Expresses gratitude and confidence--says how much she enjoys being back at work (works again, after many years of being out of work--turns collars several days a week in a dressmaking shop). Impression: some improvement; certainly not a typical schizophrenic case, but an epileptic, very likely consequent to right temporal lobe abscess. Seems very moderately improved in her outlook, but follow-up period quite short (three months).

NS3. Case H.F. This 53-year-old man of Syrian extraction, now a Clerk of Court, gives complex history of a long-standing neurotic condition, with pains in back and neck, anxiety and depression; some of this has at times been considered (by others) as related to an unhappy marriage. Withdrew from law school soon after war, had over 50 electroconvulsive treatments and 15 insulin coma treatments. Cingulotomy in November '74--after separation from wife and before divorce became final. Patient claims considerable relief from pain and depression whereas patient's sister, while agreeing with the improvement, assigns the main cause of this relief to patient's divorce. However patient gives quite elaborate history of coming round after operation and no longer needing any medication for pain relief. Also reports he might have gotten rather irritable about one month postoperatively but this lasted only some weeks and then abated. Now quite active in local politics in his town.

Note: Patient presents self primarily as a case of recurrent pain, but medical records and family stress the depressive features of his condition, or call him neurotic.

NS4. Case D.M. A 28-year-old man who had worked as quality controller in a photo plant but is now unable for a year to go on working, with various diagnoses in his records including "severe personality disorder, passive-aggressive personality," "depression," "alcoholism." In addition, had severe right frontal penetrating injury as child (hit by a car), with a tantalum plate fitted a year later onto right frontal bone defect, but no seizures till one month before follow-up interview in 1976. History of severe alcoholism from ages 21-25 approximately, evidently against background of severe depression. At least three suicidal attempts, all fairly convincing. Patient presents with tremors of upper extremities and continual slow grimacing of face at rest, but stopped during expressive movements of face. Had first cingulotomy (because of what was considered an uncontrollable suicidal urge) in February '75; immediately afterwards, tremors and facial movements, and, patient said, his depression lifted. He then stopped all medication (had had multiple sedatives and mood-elevating drugs, as well as over 80 ECTs); promptly relapsed. Second cingulotomy resorted to after further suicide attempt, in December 1975. Patient not sure it really lifted the depression; still thinks of suicide, has taken another overdose since last seen; grimacing and tremors have returned and are with him most of the time. These abnormal movements are not quite like the more typical tardive dyskinesiae (from continual use of psychotropic drugs), since the movements seem to have an almost voluntary component. Patient gives impression of being at the end of his rope but still praises cingulotomy "because it can help--did help temporarily--" and scorns ECT: "All it does is make you forget."

NS5. Case D.R. A 37-year-old married woman with multiple phobias, and what husband and referring physicians describe as crippling anxiety. Tremendously worried over schedules (meals, arrivals and departures at home; unable to go into store because of irresolution when faced with selection of purchases), many different drugs (especially Parnate, pre-op). Had cingulotomy in February '76, which made her, according to her own and her husband's impression, "worse"--says she has become intolerant of Parnate (which she is said to have tolerated well pre-op, and with some benefit). However, there is an inconsistent feature in her story: Both she and her husband relate independently how carefree she was on a vacation trip with three other couples, for ten days, less than a month post-op. This carefree feeling and demeanor left her promptly when she returned home. Onset of trouble said to date back at least eight years when patient 27--had multiple forms of drug treatment, psychotherapy, less than ten ECTs.

NS6. Case H.K. According to records (patient not seen by HLT) a woman born August 16, 1935, now bearing diagnosis of chronic undifferentiated schizophrenia. Had two cingulotomies, August 14, '73, and September 14, '74. No staff assessment of outcome. Patient seems to consider herself unimproved, SHC had impression of slight improvement between the two operations. Outcome undetermined.

NS7. Case H.S. A 26-year-old unmarried and unemployed young woman with various diagnoses on record, ranging from "borderline schizophrenia" to "narcissistic personality," also "chronic anxiety," and "depression," and "mother dependence." Actually, a major feature is addiction to amphetamine. Onset of troubles when about 16, but poor historian (stories overlaid by fragments from many earlier psychiatric interviews). Claims that her mother had been psychotic for years but mother's psychosis (with hallucinations), according to our patient, began with amphetamine overuse, for weight control. Patient herself is clearly addicted to amphetamine, which she originally got in order to combat (successfully) a tendency to obesity; still manages to get 45 mg and perhaps more per day, apparently by threatening suicide. On many other drugs besides. Quite intelligent (six years college, but did not graduate). Poor rapport, evident anhedonia, but no evidence of illogical thinking. States she will commit suicide, unless second cingulotomy (which is being planned) would help. Considers that operation her "last chance--" but says so in a totally unemotional tone--"I wasn't meant to be." Suicidal gestures frequent but not altogether convincing.

NS8. Case K.M. Called in records depressed but was seen by us pre-op in a panic state, with primary psychotic experiences (everything strange, closing in, voices calling her to commit suicide). A boyish-looking, boyishly dressed young woman of 22 (in '76); onset of trouble in early teens, about '65-'66, while in school. Much torn, then, between needs for social contact and for seclusion, while developing a nameless "pain" that grew inside her over the years. Much experimentation with illicit drugs (especially heavy use of LSD), from late teens onward; by her admission, often in an attempt to give herself the impression that she could gain control over her own bizarre internal states (by turning them on and off with drugs); wonders at the paucity of visual hallucinations, in her drug experiences, over the years. Went into considerable decompensation about three years ago (with 19), voluntarily admitted self to state hospital to avoid committing suicide. Heard voices commanding her to kill herself. Some 30 ECTs without apparent benefit.

Cingulotomy in mid-'75 seen by her as desperate attempt to prevent her self-destruction; enormously grateful, says it immediately abolished "that pain." Took one year post-op at community college, then started working as automobile mechanic (!), plans further engineering training, travels, works for various causes, claims a lesbian relationship with a roommate.

At this stage, patient strikes one as being an impressive success--disclaims any suicidal ideas or unusual experiences for nearly two years. Scores extremely well post-op on all tests. Praises operation, says surgeons could have done anything with her in the desperate state she was in. But wants to see ECT curbed, and particularly wishes people would not think it had to be tried before proceeding to cingulotomy.

NS9. Case L.M. An obese, 32-year-old unmarried and unemployed woman, inarticulate to the point of near muteness, with a history of over 10 years of various hospitalizations, including years in state hospitals for what has been described both as "chronic undifferentiated schizophrenia." and as "depression." Had three cingulotomies in August '74, October '74, and November '75, without apparent success. Onset of frank illness at beginning of twenties with destructive rage states, irrational speech, inability to care for herself. Pre-op already profoundly regressed; rarely testable; out of contact, occasionally asks for candy or cigarettes in a repetitive monotonous manner. Profoundly hypokinetic (presumably, drug-induced). Parents indicate some moderate improvement after first cingulotomy--patient talked to parents, for first time in years--but improvement not maintained for more than a few months; no real improvement after second and third operation (according to her parents). Patient cannot give any history, cannot be tested except with operant methods.

Parents say they don't know what to do. Had numerous shock treatments but number undetermined. On many different drugs. By everybody's impression unimproved.

<u>NS10. Case P.P.</u> A 24-year-old unmarried woman with a perplexing history of psychiatric treatment beginning at age 4 1/2 (!), and carrying diagnostic labels of schizophrenia and severe compulsions (self-mutilation). Examined after second, and again after last of three cingulotomies (cingulotomies July 12, '73; November 12, '73; February 11, '75). Most dramatic case in series, since she would have been deemed greatest success story, if follow-up had been stopped while she seemed to be in full remission, beginning four months after the second cingulotomy, and maintained for about ten months.

From early childhood on, but especially after birth of only sib, a younger brother (who is clearly the mother's favorite), patient considered impossible to manage by mother; had nightmares, clung to her, was seen for a long period (possibly over a year) by child psychologist when patient was 4 1/2, then by other therapists, before the end of her first decade. Began to scratch up her arms, when frustrated, in early teens, cut wrists when 12 1/2, was hospitalized continuously for two years in an adolescent ward of a psychiatric hospital. Continued to cut and burn her breasts and forearms on numerous occasions, had over 100 ECTs, and all kinds of drug treatments without success.

After first cingulotomy, showed no change, nor after second. Still cut and burned self, returned to a psychiatric hospital, but four months after the second operation, and without any warning, signed herself out of hospital (against medical advice), said it was silly to cut and burn oneself, went home, took medical assistant's training program of her own choice, passed it, and then began on a course of plastic (cosmetic) surgery for her self-inflicted scars on her forearms, to prepare self for job interviews. Could not tolerate the skin grafts, told interviewer that she couldn't understand how it came about that before (her remission) she just "had to" cut or burn herself whenever she felt tense and then felt "great--it didn't hurt one bit--but the plastic surgery now hurts more than I can take." Abruptly walked out of the plastic-surgical treatment, and relapsed: again borrowed lit cigarettes to press glowing ends against her arms and breasts, broke windows to cut self with bits of glass, etc.

Had third cingulotomy early in '76, without apparent benefit; developed seizures (three generalized convulsions, all without warning, SO far, in first three months of '76). Totally discouraged, as are the patient's family; no longer praising the operation, in contrast to earlier interviews, in which both patient and patient's mother and father, all independently, spoke of the operation as the only answer.

NS11. Case T.M. An overweight married woman (220 pounds) of 37 without facial expressions and a flat voice, bearing a history of mental illness of insidious onset. Her records describe her as schizophrenic and depressive; hallucinations; fear. She relates being afraid of playmates as a child, then describes a week of "time dislocation"--"everything out of synch," while alone in California, at beginning of her twenties, presumably a primary psychotic episode. Gives the entire history in remarkably orderly and precise fashion, says she prepared herself for the interview; should be good at giving account of herself, she says, since she is a schoolteacher, and has gotten over her illness now.

Married when 22; soon after that, during her first and only pregnancy, increasing suspiciousness and agitation, Had three to four ECTs and was, as she says "wiped out," came out of the treatments, screaming and irrational;

was committed to mental hospital for two years. Had numerous neurologic and EEG examinations because of a skull fracture as a four-year-old child (says skull had been cracked like an eggshell), but nothing definite was found that would relate her trouble to an early cerebral injury.

Had first cingulotomy when 30 (because of suicidal tendencies), felt tremendous relief--said to surgeon "Thanks for giving me back my life." Still had suspiciousness, she says, but no longer felt "as if encased in a plastic cube." No side effects, patient insists, except perhaps her weight gain (gained 80 pounds in half a year post-op), but thinks it might have been also one of her drugs (Triavil). Vividly describes voracious appetite--raiding of icebox for snacks and ice cream at various times during the day and night. Reached 242 pounds, then tried to diet, now 220, as against a pre-op weight reported as 143. Also developed mild petit mal attacks after first cingulotomy, fully controlled by Dilantin.

Says she functioned fairly well for five years as schoolteacher (had finished college and taken courses beyond that, qualifying her for a teacher's diploma). But got worse again, started drinking heavily in the later part of 1974. Heard of a neurosurgeon in California using a special procedure, went out West with husband to seek an operation from this surgeon. Both patient and husband were indignant, they say, when procedure was delayed for a committee review of her case, then received a "multiple-target stereotaxic procedure," in January 1975, viz., bilateral lesions in cingulate, amygdala and substantia innominata. States that immediately after this she was no longer suspicious about people, was amazed about that "because I had had that (the suspiciousness) since I was seven years old"--but still had the fear. Went back to her psychiatrist on the East Coast (who suggested one more cingulotomy), received this third operation (second cingulotomy) in the same year (August 1975). After that felt entirely "cured" for three months, then awoke one morning early in November '75 and felt she was sick again. Was "horrified and discouraged--felt not herself," throughout November and first two weeks of December,--and then, gradually, "it cleared up." And "since that time I haven't been sick" (nearly five months now).

Questioned about side effects patient mentions weight gain after first cingulotomy but adds, again, that this might have been related to a change in her medications. Also, the seizures: ca. 30-40 petit mal attacks, starting three to four months after first cingulotomy; she did not report them to her physician for another two months, then was put on Dilantin, and attacks stopped altogether within another three months. Is emphatic in denying any emotional flattening (in spite of unemotional face!), tells of death of her mother this January ('76); still trying to cope with this bereavement.

Had 27 ECT in '66-'68 and 60 insulin coma treatments in '68. Asked for her views of the operations she has had (and whether she would recommend them to others), she makes the following emphatic statements: <u>"I would tell them to snap it up as quick as they could.</u> <u>It's a godsend, it is, I cannot say enough about them (i.e. operations).</u> <u>I don't know why they work or how they work, but they are a true godsend, they gave me back my life--"</u> Regarding evaluations of these procedures by independent groups (such as the M.I.T. lab), patient says: <u>"It's important to me and I'll tell you why I feel that way.</u> <u>Because I think that of any experience a person might have in their lifetime, I think mental illness is the worst one--you may not agree with me but speaking from my own experience I, I've been there, and I'm still not completely well, but I'm able to try, to really try to build a life.</u> <u>But mental illness, is one Of the most devastating horrible conditions that a person can be subject to, and I would do anything that I could do to help somebody not to feel that way,</u> --I really mean that--and at any time, if you need my services for anything, I'll be more than happy to come in, because I feel that I would like to help others, like I've been helped." This patient does remarkably well on our tests despite the multiple surgery.

NS12. Case W.P. A 39-year-old tall but emaciated man, with masked face and (presumably drug-induced) Parkinsonism, remarkably taciturn, who had cingulotomy 14 months ago, after some twenty years of trouble. Medical records describe his condition as paranoid schizophrenia, but also as chronic undifferentiated schizophrenia; chronic depression and paranoia. Apparently had a "break" while in his late teens (with 18-19) in U.S. Marine Corps-. Got into disciplinary difficulties (went absent without leave, was very rebellious); was for six months in Naval Neuropsychiatric Center in Philadelphia, and for three extra years in a military stockade. Patient describes self as "very high (then), all the time, and belligerent--they tried every day to make me admit that I was sick (i.e., the physicians in NP hospital) and I wouldn't--" Now thinks, in retrospect, that he was quite ill and should have admitted it. Wife and patient got married when both were 22, patient was working as janitor for telephone company, wife as clerical worker in office. Patient then a good athlete (according to wife), weight-lifter, always working out--but after birth of first of their children (a daughter, now 14), patient changed, became a recluse, couldn't stand people, weight dropped by 80 pounds to 140 pounds, developed severe ulcerative colitis, became suspicious of all strangers, and had explosive temper. Also had to go to bathroom to move his bowels over 12 times a day--ostensibly because of the colitis, at times had accidents (i.e., lost bowel control). Also developed diabetes in his mid-twenties (patient's mother had also done so in middle age), needs daily insulin injections. Also, before cingulotomy, for several years, quite alcoholic ("drinking to get drunk," according to wife), usually 12 to 18 bottles of beer or their equivalent in one day. Showed very poor response to the manifold drug treatments and to ECT of which he had at least 27. According to wife patient lost memory following ECT to point where he couldn't recognize a car he had just bought.

After cingulotomy (in February '75), tremendous change--went on an "absolute binge" of social calls (patient says, for one month, wife, for three months)--always wanted to go out, to call on people--then this slackened, (wife says they ran out of people to visit, but patient indicates some of his fears came back; he didn't and still doesn't want to test whether his suspiciousness has really left him). Patient produces the intriguing statement that perhaps (his suspiciousness) had been "disguised by the elation." He cannot explain the "elation" after his cingulotomy but is very definite it was there and then gradually subsided. Gives vivid example of a neighbor whom he says he'd mistrusted and disliked for years (pre-op), and still does mistrust and dislike, but does not dwell so much on it--is not driven by it. Patient says main side effect of cingulotomy is that he "cannot focus as much on anything (as before), but in my case that is healthful" (sic); cannot concentrate and that helps against the "monomania," as he calls it.

Test results show an initial drop post-op and a subsequent rise (on retesting a year later). Probably partially improved, at this stage. Says he is not ready to go to work. Ulcerative colitis is much better (even on X-ray evidence)--but patient stopped drinking (completely), a considerable achievement.

Placebo Control. Case W.M. A 35-year-old woman in wheelchair with a history of pain in neck and shoulder region, has congenital paraplegia (mid-thoracic section), congenital myelomeningocele, internal hydrocephalus. An anxious, suspicious patient, very attached to surgeon, but unusually apprehensive about the CRC and its staff. Gives history of pain in upper back (has no sensation below waist), starting when 18 to 19 years old, after high school graduation. Was tried on all types of pain-relieving drugs without success. Had cord stimulator implanted which had to be removed again because it was not tolerated. Had burr holes for cingulotomy drilled in October 1975; surgeon interrupted procedure without placing lesion in cerebral tissue, because brain was so distorted (by internal hydrocephalus and abnormally small size of right hemisphere), that no secure landmarks could be discerned. Patient knows that procedure had to be somewhat modified, but insists she had "some relief, 75 per cent," though marred by what she claims was a "withdrawal syndrome;" says her pain-relieving drugs were withdrawn or at least changed postoperatively, and she could not tolerate that (!). Had a fall two months postoperatively in which she separated third and fourth vertebrae, needed a collar; neck pain partially reactivated. Still would recommend cingulotomy to others, expresses deep gratitude to surgeon. Since then had further "return of her pain."

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