In 1936, Egas Moniz published his first report on performing a prefrontal leucotomy on a human patient. In this report, he introduced the leucotome, a plunger-like device with a narrow shaft designed to extend a wire loop into the brain. After insertion, the leucotome was rotated rapidly, cutting out a piece of brain tissue. Claiming that prefrontal leucotomy was a simple, safe procedure, Moniz accepted the Nobel Prize in Medicine in 1949 for discovering and introducing the therapeutic value of this procedure in patients with psychoses. Ironically, Moniz was later shot by one of his patients who was experiencing psychoses and who had not yet undergone the leucotomy procedure.

Although the unrefined and brutal nature of the leucotomy, as well as the introduction of antipsychotic drugs such as chlorpromazine, led to the procedure falling out of favor in the mid-1950s, surgical solutions for mental illness and frontal lobe theory were highly debated topics in the early part of the 20th century. Moniz was influenced to begin performing leucotomies in part by a presentation by Yale physiologists Carlyle Jacobsen and John Fulton at the Second International Neurological Congress in London in 1935. This report described how a chimpanzee with both frontal lobes surgically removed became more cooperative and willing to accomplish tasks. Regardless of the degree to which this particular study swayed Moniz, the Neurological Congress provided him with a synthesis of the most recent theories of frontal lobe function and neurophysiology. Shortly thereafter, Moniz began performing prefrontal leucotomies, a practice subsequently adapted to lobotomy and popularized by George Washington University neurologist Walter Freeman in the US.

The pathophysiology of mental illness and its relationship to the frontal lobe were subjects of immense interest in the latter half of the 19th century. Numerous studies emerged during this time on cortical localization and frontal lobe theory, drawing upon various ideas from neurology and psychiatry. Reflecting the intense interest in this region of the brain, the 1935 International Neurological Congress in London hosted a special session on the frontal lobe. Among other presentations, Yale physiologists John Fulton and Carlyle Jacobsen presented a study on frontal lobectomy in primates, and neurologist Richard Brinken presented a case of frontal ablation for olfactory meningioma performed by the Johns Hopkins neurosurgeon Walter Dandy. Both occurrences are said to have influenced Portuguese neurologist Egas Moniz (1874–1955) to commence performing leucotomies on patients beginning in late 1935. Here the authors review the relevant events related to frontal lobe theory leading up to the 1935 Neurological Congress as well as the extent of this meeting's role in the genesis of the modern era of psychosurgery.

**KEY WORDS** leucotomy; psychosurgery; frontal lobe
Early Concepts of Mental Illness and Intervention

Theories of mental illness in the late 19th century emerged from both neurology and psychiatry, which advocated opposing models of pathophysiology and treatment. It was generally agreed that psychoanalysis was not useful for the most severe of mental illnesses, such as schizophrenia, which were thought to be manifestations of pathological processes. By the early 20th century, “intrapsychic conflict,” oxygen insufficiency, sluggish metabolism, leukopenia, and focal infection in the brain had all been put forth as explanations for mental illness.46 The proposed treatments were just as varied. These included sleep therapy, electrotherapy, horse blood infusions into the CSF, hysterectomy, induced hypothermia, and “cerebral stimulation” with sodium cyanide and carbon dioxide. As University of Michigan psychologist Elliot Valenstein would later explain, “in this therapeutic and theoretical vacuum, almost any treatment was tried, providing it had the potential for treating large numbers of patients with a minimum of highly trained staff.”46

Surgical solutions for mental illness arose in the late 1880s, when Swiss psychiatrist Gottlieb Burckhardt performed a series of cortical extirpations in 6 patients presenting primarily with original paranoia and chronic mania.32 One patient who had received a left temporal to pectectomy died, and, in part because of criticism garnered from colleagues at the 1889 Berlin Medical Congress, Burckhardt discontinued the practice. In 1910, Estonian neurologist turned neurosurgeon Ludvig Puusepp performed surgeries in which he severed association fibers between the frontal and parietal lobes in manic-depressive patients.38,45 Other early surgical approaches intended to alter the frontal lobe included injections of malarial blood via trephined sites as well as reintroduction of the patient’s own blood into prefrontal areas.45

Origins of Frontal Lobe Theory

By the time these interventions were being developed, the field of investigation of the frontal lobe was already established. The injury of a Vermont railroad worker, Phineas Gage, in 1848 was one of the earliest cases to expose frontal lobe associations with decision making, judgment, and personality.29 Gage suffered an injury in which a tamping iron 3 cm in diameter passed through his left frontal lobe. A contemporary imaging study by Damasio and colleagues suggests that Gage’s injury was more extensive, however, and included the bilateral ventromedial prefrontal cortices.12 After initially denying that Gage suffered from any deficits as a result of his injury, his treating physician John Harlow later amended his interpretation of the case in a speech before the Massachusetts Medical Society in 1868, concluding that Gage had in fact experienced intellectual impairment and personality changes after the incident.29 Contemporary analysis corroborates that Gage indeed incurred deficits in rational decision making and emotional processing.12

The period between 1870 and 1890 marked the “golden age” of cerebral localization. In 1870, Gustav Fritsch and Eduard Hitzig used electrical stimulation to identify the motor cortex, which suggested the possibility of further functional specialization of the cortices.11,20 Numerous subsequent studies emerged elucidating cortical relationships with cognitive behavior and sensory and motor function.4 Other studies examining neurological deficits produced by structural alterations such as injury, tumor, or experimentation followed. In the late 1890s, American surgeon Charles Phelps attributed mental changes to the left, but not right, frontal lobe and prefrontal areas after analyzing hundreds of cases of pistol shot wounds.37,47 As detailed by Benton, animal studies by Friedrich Goltz and Jacques Loeb in the early 1900s demonstrated that bilateral frontal lobe removal but not ablations of the prefrontal cortex in dogs resulted in “an alteration in character.”46 According to Benton, Shepherdy Franz contributed a series of works from 1902 to 1912 on unilateral and bilateral prefrontal ablations that demonstrated that animal subjects experienced no loss of function after unilateral extirpations, and Leonardo Bicanchi subsequently demonstrated that bilateral prefrontal ablations in dogs and primates led to profound changes in personality but failed to evoke sensory or motor deficits. Meanwhile, early surgical procedures on the frontal lobes were documented from 1930 through 1939 in significant studies by Babcock,3,6 Brickner,6 Germar and Fox,22 Penfield and Evans,36 Ackerly,1 Karnosh,27 and Jefferson (as detailed by Finger).17 Because of the intense interest in this subject, the International Neurological Congress, with honored guest Ivan Pavlov, convened in London in 1935 to discuss epilepsy, physiology, and pathology of CSF and the functions of the frontal lobe.

The 1935 International Neurological Congress

Planning Group Meeting

In September 1933, the program committee responsible for planning the 1935 International Neurological Congress convened at the Royal Society of Medicine in London. The last Neurological Congress had taken place in London in 1913, before World War I deferred subsequent meetings.28 The planning group chaired by New York neurologist Bernard Sachs selected frontal lobe function as a topic for the 1935 conference.50

Second International Neurological Congress

From July 29 to August 2, 1935, attendees assembled at University College London for the Second International Neurological Congress (Fig. 1).8 French neurologist Henri Claude presided over the frontal lobe session.36,50 Major presentations included work by French neurosurgeon Clovis Vincent, who delivered a paper titled “Modification of function observed after surgical intervention on the frontal lobes,” and neurologist Richard Brickner, of the New York Neurological Institute, who presented a case of bilateral frontal lobectomy for meningioma performed by Johns Hopkins neurosurgeon Walter Dandy. Brickner had assumed care of Dandy’s patient 1 year after the surgery and was responsible for neurologist and psychological examination of this individual. In addition, Yale neurophysiologist John Fulton and his associate, Carlyle Jacobsen, presented “The functions of the frontal lobes: a compara-
tive study in monkeys, chimpanzees, and man” at the sym-
posium.\(^{10,21}\) Fulton had graduated from Harvard Medical
School in 1927 and subsequently completed a neurosurgical
internship at Peter Bent Brigham Hospital in Boston
under the auspices of Harvey Cushing. After working in
the laboratory of Charles Sherrington at the University of
Oxford, Fulton joined Yale in 1929, where he became the
Sterling Professor of Physiology and founded the nation’s
first primate research laboratory.\(^{13,31}\) At the London Neu-
rological Congress, Fulton and Jacobsen reported on the
behavior of 2 chimpanzees, Becky and Lucy, after unilat-
eral frontal lobectomy and subsequent contralateral lobec-
tomy. Becky in particular demonstrated a marked change
in personality, absent of temper tantrums and “experimen-
tal neuroses” after the second surgery.\(^{4,35}\)

**Impact on Moniz and the Impetus for Psychosurgery**

Although his expertise lay in cerebral angiography—
he was nominated for the Nobel Prize in 1928 and 1933
for this work—Egas Moniz was captivated by talk of the
frontal lobes at the London Neurological Congress.\(^{48}\) It
has been suggested that Moniz questioned Fulton during
the discussion period and asked whether the procedure
performed on the primates could be extended to treating
psychiatric illness in human patients, perhaps as a less
destructive leucotomy.\(^{4,25,38}\) Whitaker suggests that while
other attendees absorbed the harmful consequences of
frontal surgeries, Moniz instead identified an opportunity
to exploit such deficits for psychosurgery.\(^{48}\)

Shortly after the Neurological Congress, Moniz pro-
ceeded with his initial attempts at leucotomy in humans.
He assigned the psychopathological centers of mental ill-
ness and “psychic activity” to the frontal lobes and used
this theory to support prefrontal leucotomy, at first imple-
mented by injecting pure ethanol, beginning in late 1935
into 1936, and then by the use of the leucotome.\(^{23}\) Moniz’s
hands were crippled by gout, and he was not a neurosur-
geon, so he relied on the assistance of his surgical col-
league, Almeida Lima. Moniz rationalized that disrupting
the frontal lobe, which “stored [ideas] in the nerve fibers
between brain cells,” would resolve the problem of “fixed
and persistent” patterns of cells responsible for producing
psychoses.\(^{2,26,33,48}\) In his view, the problem was not one of
an anatomical alteration or localized to a particular area. It
has been suggested that Moniz, buoyed by the acceptable
outcomes garnered in his first few operations, used these
results to justify not only the procedure itself, but also this
particular theory of psychopathology.\(^{25}\)

Contemporary analysis has disputed whether the sup-
posed conversation between Moniz and Fulton at the Neu-
rological Congress took place. Historian Jack Pressman
has emphasized that Fulton’s work provided “confirma-
tion, not inspiration” for Moniz, who “was searching for
a neural basis of emotions with a model based largely on
the nineteenth century framework of habits,” as opposed
to the more sophisticated principles used by Fulton and
his colleagues.\(^{38}\) In other words, Moniz may have been
searching for a theory to fit his procedure. Discrepancies
among accounts generated from the meeting as well as
from Moniz himself further complicate our understand-
ing of the conference’s impact. Moniz produced his first
report on leucotomy in 1936, in which he published the
results of his first 20 patients and described the origins
of his work; Moniz did not cite Fulton and Jacobsen, but
instead referred extensively to Brickner’s study, conclud-
ing that “even after extirpation of the two frontal lobes,
there remains a psychic life which, although deficient, is
nevertheless appreciably better than that of the majority
of the insane.”\(^{33,49}\) Multiple authors have further cor-
raborated this notion that Moniz was more interested in
Brickner’s patient who, after bilateral frontal ablation for
olfactory meningoia, developed a flattened affect but re-
mained intellectually intact.\(^{19,30,38}\) The historian El-Hai has
explained that, although neurosurgeons had always been
concerned with patients’ functional outcomes, the advent
of psychometric testing in the 1920s and 1930s provided
a means of assessing psychological sequelae from neu-
surgical procedures. The aforementioned patient dis-
cussed by Brickner was one of the first cases subject to
such analysis, which would support subsequent utility for
psychosurgical applications.\(^{14}\) For Dandy’s part, despite
the relevance of his patient to Moniz at the symposium, he
seems to have had little to do with lobotomy throughout
his career. However, Pressman has cited correspondence
between Freeman and Moniz in 1946 in which the former
“boasted that even the great neurosurgeon Walter Dandy
… performed one,” as if to further justify the procedure
on the basis of Dandy’s stellar reputation.\(^{36}\)

Another speaker at the Neurological Congress, re-
nowned neurosurgeon and neuroscientist Wilder Pen-
field of the Montreal Neurological Institute, presented a
patient who underwent frontal lobe removal for a large

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**FIG. 1.** The attendees at the Second International Neurological Congress, 1935. Individuals of interest (in first seated row) include John Fulton (4th from left), Egas Moniz (19th from left), Bernard Sachs (23rd from left), Ivan Pavlov (24th from left), Otto Marburg (27th from left), and Wilder Penfield (first standing row, 10th from right). London Panoramic Company. Image courtesy of The Queen Square Archives. Photograph is in the public domain.
tumor. This case’s influence on Moniz has been cited in somewhat cursory fashion, grouping its impact with that of Brickner’s patient, however, because of his research group’s groundbreaking contributions to the field of cortical localization, Penfield’s views on psychosurgery are worthy of consideration. Sedney and Bernstein concluded that “the intentional surgical alteration of personality or the individual psychology of a patient was unacceptable to Penfield, who never pursued this area in spite of his generally aggressive surgical treatments…” The authors further cite a conversation in which Penfield accused Freeman of “doing a dangerous thing” with regard to psychosurgery.

Vincent’s presentation on prefrontal surgeries, with particular emphasis on the lack of deficits observed after such a procedure, may have also persuaded Moniz to consider leucotomy after the frontal lobe symposium, although Moniz himself denied such influence. Last, in a conclusion that precludes attribution to other parties, it has been suggested that Moniz mulled the possibility of using surgery to treat psychoses more than 2 years before his initial surgeries. Walter Freeman characterized the impact of the Neurological Congress several years later, explaining that the conference provided a “summing up of knowledge [that] paved the way for… Moniz to carry into practice his ideas (already developed during the preceding two years).” Freeman was careful to suggest that Moniz was already inclined to perform such surgeries and that the conference further validated his work.

The presentation by Fulton and Jacobsen at the 1935 Neurological Congress was reminiscent of a scene that played out at the Seventh International Medical Congress in London in 1881, a seminal event in medicine attended by the likes of Horsley, Lister, Pasteur, Virchow, and Osler. During the physiology section meeting, Englishman David Ferrier and German Friedrich Goltz paraded their experimental subjects, a macaque and a dog, respectively, working on projects related to World War II, directed his attention to the latest developments on the frontal lobes and psychosurgery in 1946. According to Pressman’s analysis, Fulton’s major grievance with “the lobotomists” was that they lacked a sufficient understanding of frontal lobe neurophysiology, which compromised the validity of their surgical procedures. Freeman persisted, however, and by the mid-1950s had performed more than 2000 lobotomies by his own hand.

Moniz’s Influence on Freeman

The presentation by Fulton and Jacobsen at the 1935 Neurological Congress was reminiscent of a scene that played out at the Seventh International Medical Congress in London in 1881, a seminal event in medicine attended by the likes of Horsley, Lister, Pasteur, Virchow, and Osler. During the physiology section meeting, Englishman David Ferrier and German Friedrich Goltz paraded their experimental subjects, a macaque and a dog, respectively, in front of a crowd— as Jacobsen and Fulton had done with their chimpanzees—to demonstrate their opposing views of localization theory. This display, as expected, fostered argument about the significance of the frontal lobes; Ferrier’s view, which endorsed specialized functional areas, would emerge triumphant. This particular event has been cited as a watershed moment leading to the modern era of psychosurgery. In a similar parallel, Pressman concluded that “by all accounts, the specific link between psychosurgery and mental disorders was forged at the Second International Neurological Congress” in London.38,41

Conclusions

Amid much debate and consternation, leucotomy or lobotomy, while imprecise and brutal, had for a time offered a seemingly viable therapy for intractable psychiatric illness when no other treatments were available. The shared history among Moniz, Fulton, and Freeman regarding psychosurgery essentially began at the International Neurological Congress in 1935. Thus, the framing of a body of ideas about frontal lobe theory—cultivated across many institutions and individuals over many years—that occurred at the conference yielded the beginnings of the modern era of psychosurgery practice.
Early history of prefrontal leucotomy

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Disclosures
The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions
Conception and design: Menacho. Acquisition of data: Boettcher. Drafting the article: both authors. Critically revising the article: both authors. Reviewed submitted version of manuscript: both authors. Approved the final version of the manuscript on behalf of both authors: Menacho.

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