FROM ITS INCEPTION general semantics has had a close affinity with neurology and psychology. This is shown by the adoption by general semanticists of such terms as 'neuro-semantic mechanisms,' 'neuro-symbolic processes,' 'neuro-linguistic environment,' 'neuro-evaluational factors,' and in frequent announcements to the effect that general semantics 'is concerned with the linguistic and semantic mechanisms which function in human nervous systems to condition our knowledge, activities and adjustments in life.' (40) Indeed the very title, Science and Sanity, under which the formulations of general semantics were first systematized, clearly announced Korkybski's intention to integrate the data and constructs of the newly-founded discipline with those of the neurologic and psychologic sciences.

As part of the broad program of working toward the unification of all sciences, this 'intellectual tropism' is to be warmly endorsed. But if semanticists would spare themselves years of barren groping, perplexity, and embarrassment and avoid that devastating nervous disorder designated by Johnson (35) the IFD...
disease, they need to take stock of the numerous semantic difficulties that inhere within the aristotelian language of current-day neurology and psychology. Unless such is done, constructs of dubious validity are certain to be unwittingly embodied within general semantics, there to weaken its structure and render it vulnerable to the first serious onslaught by informed critics.

In the present communication the writer invites attention to a construct currently employed by many neurologists, psychologists, and psychiatrists and seemingly accepted on blind faith by large numbers—perhaps the great majority—of general semanticists: the twin notion that the thalamus is 'the center of emotion' and the cortex, especially that of the frontal lobes, 'the seat of the intellect.' He proposes to demonstrate the dubious grounds on which this elementalistic dichotomy rests and to urge upon his colleagues the necessity of exercising caution lest this prescientific proposition, the chief virtue of which is its engaging simplicity and teachability, become too firmly entrenched.

II

The principal issues with which the writer is concerned may be pointed up by quoting a few random selections from the first edition of *Science and Sanity* (43) in which statements like the following are quoted with apparent approval:

...it is well to distinguish a second characteristic of nervous organization which renders it an organization in levels. (p. 151) The thalamus is a center of affective reactivity to sensory stimuli, while the cortex is an apparatus for discrimination. (p. 268) We are dealing here with types of associative reaction peculiar to the cortical system, correctly opposed to the unqualified affective reactivity of the thalamus. (p. 369)

These notions having been enunciated, so to speak, *ex cathedra*, were promptly and enthusiastically reiterated by many who followed Korzybski. Thus, one consulting psychologist (80) proclaimed,

I have found Korzybski's cortico-thalamic formulations to be of immense value. ...I put him [the patient] to work on his own problems, rewriting his 'thalamic' outburst about his wife's 'past' in extensional terms of what had actually happened. ...I have people write about these hurts, sprinkling their writing with dates and indexes and substituting terms with no 'thalamic' associations. ...I have them do this until they can talk to me and themselves with no noticeable 'thalamic' upset.

Wendell Johnson considers that the genesis of many mental disturbances is as follows: 1. For one or more reasons the individual adopts and strives toward a number of ideals (I) which, in view of his limitations, are excessively high and therefore unattainable or which, in view of their ill-defined character, are incapable of recognition even if attained; 2. Such strivings lead to repeated frustrations (F); and 3. Growing awareness of frustration eventually leads to demoralization (D)—a psychophysiological state which becomes overtly expressed as the signs and symptoms of personality disorder.

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A marital counsellor (53) similarly writes,

... I convinced him [Mr. Z.] that if he wanted to relieve the 'emotional' congestion in the thalamic region he might do so by delaying his reactions, i.e., by making his impulses travel the longer circuit through the 'cortex'. ... If by careful analysis these symbols can be made conscious and free from 'emotional' overloading by 'straining them through the cortex' so that short circuiting is stopped and the 'thalamic congestion' relieved, the results are salutary and the marriage has a chance to survive.

The following is from a recent article (64) intended to elucidate the characteristics of 'extensional behavior'.

For example [an extensional person] will not regard children as small adults, because a little checking of the territory as represented by the children, will reveal that they are unable to behave like adults, because they function mostly on a thalamic level since their cortices are not fully developed.

Unfortunately, neither Korzybski nor certain of the authors quoted by him (e.g., Henri Piéron) had sufficient training in neurologic science to permit rigorous evaluation of the data from which these elementalistic propositions were originally derived. Nor are they to be unduly censured. Many others whose backgrounds in neurophysiology and related disciplines were sufficient to have enabled them to detect the insubstantial character of these concepts embraced them without reservation. In such instances, failure to employ general semantics principles appears to have been responsible, rather than insufficient training for evaluating the clinical and experimental data.

The fact is that much of modern writing in neurology, psychology, psychiatry, anthropology, philosophy, and the social sciences is permeated by references to cortical and thalamic levels of function and their alleged roles in the intellectual and emotional life of the individual. While such references are sometimes explicit, they are far more frequently made by implication; being both unvoiced and unidentified, they carry a high potential for fouling up lines of communication among serious students.

III

Our problem may be stated thus: to what extent does the available evidence warrant the assertion that the thalamus or any of its parts, such as the paleothalamus or hypothalamus, is the dynamic source or seat of 'emotional experience' and the cerebral cortex the 'center of the intellect'?

Upon first encounter it might seem a relatively simple task to reach an answer to this question. Sober reflection, however, soon points up some formidable difficulties, not the least of which spring from certain hidden assumptions upon which the more manifest propositions themselves depend. These may be identified as follows: (a) the concept that the nervous system functions in terms of
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'levels'; (b) the implication that 'emotion' is a phenomenon sufficiently distinct from 'intellect' (or 'intelligence') to leave no doubt as to which is under inquiry at any given moment; (c) the concept that brain 'centers' genuinely exist as circumscribed anatomic correlates of neural functions; (d) the concept that consistent and objectively verifiable distinctions exist between 'visceral' and 'somatic' organs within the body in general and between the 'autonomic' ('sympathetic') and 'cerebrospinal' divisions of the nervous system in particular; and (e) the belief that verifiable differentiations exist between the 'voluntary' and 'involuntary' activities of the organism and that 'intellectual' functions are by nature 'willed' whereas 'emotions' are by nature 'involuntary' affairs. In almost all serious discussions of the matter, these occult assumptions sooner or later emerge. For this reason, they are relevant and cannot properly be separated from our inquiry.

Desirable though it may be, we cannot here enter upon an exhaustive inquiry into all the hidden assumptions identified above. An extended examination of the concepts of brain 'centers' and 'voluntary' and 'involuntary' activity must be deferred for a later article of this series. In the present paper we shall confine ourselves to the most pertinent material only, recognizing that even in this much must be left unsaid.

IV

THE CONCEPT OF 'LEVELS.' The principal theme of this doctrine is that the nervous system has acquired in the course of phylogenetic development successive 'levels' of control such that under ordinary circumstances a 'higher' level regularly exerts an inhibitory influence over functions residing within or mediated by the next 'lower' level. The propositions concerning cortical and thalamic functions with which we are concerned are but a special case of this broader concept.

According to the 'level' doctrine, the neocortex of the cerebral hemispheres—the nervous system's most recent acquisition—now constitutes the 'highest' level and as such is the major source of inhibition of the next 'lower' levels, namely, the corpus striatum and the 'emotionally-charged' thalamus. In turn, the corpus striatum and the thalamus are supposed to exert inhibitory influences over sensory and motor patterns mediated at still 'lower' neural levels—e.g., the substantia nigra, nucleus ruber, corpus subthalamicum, formatio reticularis, and certain other nuclei of the anterior mid-brain. The latter in their turn are conceived of as inhibiting certain nuclei in the medulla; and so on down to the 'lowest' pools of sensory and motor neurons in the brain stem, spinal cord, and sympathetic ganglia.

The doctrine was formulated in 1876 by Hughlings Jackson who asserted that contemporaneously with the loss of function of a center there is a rise in activity of the next 'lower' center. The centers of the 'lower' physiological levels seemed to Jackson (34) to be 'considerably independent of the directive influ-
ence of the higher levels, although much under their negative inhibitory influence.' The 'level' theory has undoubtedly served a useful role in furthering comprehension of the nervous system in health and disease. However, some of its more serious limitations and deficiencies have recently become apparent and new general formulations now appear to be in the making.2

Within the past fifteen years a number of significant observations not previously possible in human neurophysiology and physiologic psychology have been made incidental to (i) psychosurgical procedures used in the treatment of psychotic and psychoneurotic states and (ii) surgical procedures directed against certain clinical disorders (e.g., paralysis agitans, hemichorea, athetosis and ballismus) characterized by excessive movements. While much ground yet remains to be cleared, inferences arising from such observations are rapidly compelling a critical re-examination of the conventional 'level' doctrine. The ultimate necessity of this was foreseen some years ago by Lorente de Nó (45) and others.

(i) Psychosurgery. The operation of prefrontal lobotomy (leucotomy) was introduced by Egas Moniz (65) of Lisbon in 1935. In essence, it consists of interruption of the subcortical white matter of both frontal lobes at a level just in front of the anterior horns of the lateral ventricles (Fig. 1a). The most salutary effects appear to be obtained when the fibers running through the medial and inferior portions of the frontal lobes are severed.3

In attempting to explain the salutary results of psychosurgery, clinicians have frequently contended that in the psychologically aberrant subject the thalamus, as the 'center of emotions,' has somehow gained ascendancy over the frontal cortex and is unduly 'driving' it:

Above all, there is the emotional component which invests the symptoms and the ideas with a disabling force and completely prevents the

3 In this respect, the 'level' concept is comparable to euclidean geometry, newtonian mechanics, the 'telephone theory' of nervous function, and numerous similar scientific formulations which have been and still remain useful in limited frames of reference but which can no longer be regarded as the touchstones of comprehension they were once thought to be.

3 Several modifications of the original operation have been devised in the endeavor to minimize the undesirable side-effects on the patient's post-operative personality, to improve the over-all results, and to make the operation accessible to the large numbers of patients who might profit from it. These include Pool's (70) cortical topectomy (extirpation of Areas 9 and 10 of the cortex, bilaterally); Penfield's (69) gyrectomy (removal of various gyri of the prefrontal and promotor regions); Scoville's (82) undercutting of the cerebral cortex of the mesial surface of the frontal lobes (especially areas 9, 10, 24 and 32); the thalamotomy (destruction by electrocoagulation of small areas in the dorso-medial nucleus of the thalamus) of Spiegel, Wycis et al. (85); and Fiamberti's (23) transorbital leucotomy (section of the frontal lobe through the roof of the orbit). Up to the present time, over 6,000 patients have been subjected to one or more psychosurgical procedures. As a consequence, a fair estimate of what can and cannot be accomplished may now be said to have been reached.
Figure 1. Principal Anatomic Considerations in Psychosurgery. (a) Line of incision (arrow) employed in the 'standard' prefrontal lobotomy. The frontal stalk transmits, among others, fibers coursing between the dorso-medial nucleus of the thalamus and the frontal lobes. These, together with various other neurons, are severed. (b) The better-known fibers coursing from the thalamus to the frontal lobes. (c) The better-known fibers coursing from the frontal lobes to the thalamus and other subcortical nuclei. A.N = anterior thalamic nucleus; Ca.N = caudate nucleus; D.M.N = dorsomedial thalamic nucleus; Hypoth. = hypothalamus; TEG. = tegmentum of brain stem; 8, 9, 10, 11, 12, 18, 24, 32, 38 = Brodmann's cyto-architectural areas of cerebral cortex. Figs. b and c modified from W. E. Le Gros Clark, Lancet, 1:353, 1948)
patient's adaptation to the realities of existence (25). Inasmuch as the thalamus is generally regarded as the center of emotion and is largely responsible for the feeling tone which accompanies ideas, interruption of the pathways between the thalamus and the frontal lobes is desirable if the emotional component of ideas is to be reduced (22). Sectioning the fiber bundles from the frontal lobes...produces alteration in emotional responses by disrupting ideational with affective experiences (77).

Presumably, then, favorable results are accomplished by cutting the pathways which run from the thalamus to the frontal lobes (the thalamo-frontal fibers).

Unfortunately, a number of stubborn facts preclude unreserved endorsement of this account. For one thing, we are left wholly in the dark concerning the psychophysiologic dynamics by which the thalamus gains ascendancy over the frontal cortex. Until at least some direct evidence favoring this pathogenetic postulate is adduced, it seems wise to withhold endorsement. Assuming for the moment, however, that the circumstances are as stated, the 'level' doctrine runs into serious difficulty; for while it is true that thalamo-frontal pathways are cut in the course of operation, it is equally true that fibers running in the opposite direction, i.e., from the frontal lobes to the thalamus (fronto-thalamic pathways), are also severed (Fig. 1, b and c). Now, in terms of the 'level' doctrine, the fronto-thalamic fibers are presumably the major agents through which the frontal cortex exerts its 'normal inhibitory effect' upon the thalamus (18). It must be apparent, however, that the interruption of these fibers would inevitably throw the burden of thalamic control onto those portions of the neocortex which still remain after operation, namely, the parietal, occipital, and temporal cortices. But if the latter were insufficient in the first place to dampen thalamic 'drive,' it is difficult to see how surgical interruption of fronto-thalamic fibers could improve the situation. Here is a circumstance in which it becomes very difficult to reconcile the 'level' theory with factual observations.

There are other difficulties, to some of which the writer (60) has previously called attention: even when psychosurgery is carefully restricted to those types of psychologic disorder in which experience shows that benefit may be realizable, operation fails to accomplish its aim in a disappointingly large proportion of cases—20 to 60 per cent, depending upon the particular psychiatric disorder dealt with (25). Equally difficult to explain is the fact that in a considerable number of patients in whom a gratifying rehabilitation has been achieved and maintained for upwards of a year following operation, disheartening relapses develop. Why, if the 'level' doctrine holds valid, should this be so? Certainly, no account which invokes regeneration of the severed pathways merits serious attention, since from all information now at hand such does not occur within the human central nervous system. As a matter of fact, no theory which assumes that the thalamus is the 'seat of emotion' can satisfactorily accommodate the stubborn facts of clinical failures and relapses.

The 'level' doctrine encounters yet another difficulty when invoked to explain
Figure 2. Diagram illustrating a 'reverberating circuit' theory of normal neural function. Two circuits are shown: (a) a kinetic circuit which, acting unopposed, produces abnormal movements (in this instance, hemiballismus) of the opposite half of the body; (b) a suppressor circuit which phasically complements and suppresses the showers of kinetic impulses, so that the latter merely contribute to normal muscle tonus. Neither circuit can be said to be 'higher' or 'lower' than the other.

The structure of the kinetic circuit (black lines) is as follows: Impulse 'input' is derived from exteroceptive (Ext), proprioceptive (Prop) and interoceptive (Int) sources which project from the periphery of the body onto the thalamus (Thal). The impulses pass from the thalamus to the postcentral (3, 1, 2) and precentral (4, 4') cortex and then run forward by way of subcortical 'U'-fibers to the premotor cortex (6). Area 6 also receives impulses directly from the thalamus. Impulses leave the cortex by way of parapyramidal fibers (ParaPyr), pass to certain subcortical nuclei (Sb) and are then relayed to the lower motor neurons (LMN). Here motor responses (constituting the 'output') result in further excitation of extero-, proprio- and interoceptors. The latter then play back upon the thalamus, thus completing the circuit.

The structure of the suppressor circuit (black lines, white dots) is as follows: As in the kinetic circuit, the 'input' of the suppressor circuit consists of impulses reaching the thalamus from the periphery. From the thalamus they are relayed to the cortical ‘suppressor strip’ (4s). They leave the cortex and pass via parapyramidal pathways to the caudate nucleus (Ca) and putamen (Put) whence they play upon the globus pallidus (Gl). Two pathways from the pallidum to the thalamus are now employed: one via the fasciculus lenticularis and the other via the pallido-subthalamic bundle and the corpus subthalamicum (C. Sub). The 'output' of the suppressor circuit consists of fibers coursing from the corpus subthalamicum to the reticular formation (Reticular Form) of the brain stem, whence impulses reach the lower motor neurons via extrapyramidal paths.
why psychosurgery fails to improve certain psychologic disorders in which impulsive, 'emotionally-charged' components are no less apparent than in the disorders generally considered amenable to such operations. Particular reference is made to 'constitutional psychopathic personality—emotionally-unstable type' and to hebephrenic schizophrenia. Finally, lobotomized patients are in no sense characteristically lacking in those forms of behavior commonly designated as 'emotional.' Some show far more aggressiveness after operation than is desirable (25). Nor are they seriously lacking in the capacity to exhibit 'intellectual' behavior (24). Indeed, in some instances these patients are capable of such seemingly 'normal' performances on standard I.Q. tests that their psychologic deficits can be demonstrated only by the use of special tests like those recently devised by Halstead (29, 30) and Rylander and Sjöqvist (79). Clearly, the 'level' theory needs much bolstering if it is to meet these difficulties.

(ii) Surgical Procedures Directed Against the Hyperkinetic Disorders. Observations from this source, like those from psychosurgery, reveal certain clues that may ultimately lead to a more substantial concept than the conventional 'level' doctrine of how the nervous system works in health and disease.

For some time it has been known that certain tremors and other abnormal movements seen in such disorders as paralysis agitans, hemichorea, -athetosis and -ballismus develop in consequence of lesions in the corpus striatum and/or upper midbrain, including the substantia nigra and corpus subthalamicum. Interpreted in accord with the 'level' theory, such lesions disrupt the ability of the level(s) in which they are located to exert their customary inhibitory control over 'lower' levels, the result of which is that the latter become free to express their inner (?) impulses to abnormal movement.

With the advent of operative procedures directed against the hyperkinetic disorders, it has been demonstrated by several independent workers that surgical interruption of levels 'higher' than those damaged by the disease process may be followed by gratifying abolition of the abnormal movements. In this connection, Bucy and Buchanan (9), Bucy (10) and Putnam (73, 74) have extirpated the cortex of Areas 4 and 6; Browder (8) has sectioned the anterior limb of the internal capsule; and the present writer (56, 57, 58, 63) has extirpated and/or sectioned various structures in and about the corpus striatum and 'motor' cortex. In view of these and closely related subhuman studies (55), there has begun to emerge in place of the 'level' concept a new doctrine of the structural pattern of neural functions—that of the reverberating or 'feed-back' circuit. Bucy (11) has elaborated one such theory to account for the tremors of paralysis agitans and another for choreo-athetosis. The present writer (63) has recently proposed a reverberating circuit theory of the pathogenesis of hemiballismus, an illustration of which appears in Fig. 2.

That inhibitory influences may be exerted in a direction quite the reverse of that conceived in the traditional 'level' doctrine has recently been disclosed by
Magoun and Rhines (47, 48). These investigators discovered in the reticular formation of the medulla a region which, upon being stimulated, inhibits activities not only at 'lower' (spinal) levels but also at 'higher' (cortical) levels. They believe that this represents a physiologic as well as an experimentally inducible phenomenon (Fig. 3).

In his numerous attempts to comprehend the 'unknowns' of his universe, man has habitually resorted to analogies with what is already familiar to him. It is no accident, for instance, that the 'telephone' concept of nervous functioning (68, 71) was evolved at a time when the modern telephone system was being developed. The more serious deficiencies of the 'telephone' theory, especially its dualistic and demoniacal implications, have only recently become apparent. Had the radio anteceded the telephone as the early means of communication by wave

![Diagram of neural levels and inhibitory influence](image)
transmission, it is probable that a wholly different concept of neural functioning would have been elaborated—one perhaps approximating our current ideas. The intimation is that future discoveries in areas seemingly remote from neurology may be expected to suggest still other analogies which will make our present notions seem archaic to another generation of investigators. But whatever such future developments may bring, it is clear that for the reverberating circuit theory, the terms 'higher' and 'lower,' so essential to the conventional 'level' doctrine, have no more anatomico-physiologic meaning than the terms 'up' and 'down' as applied to interstellar and intra-atomic space. The newer 'circuit' view has already proved accessible to mathematic, electronic, and general physical formulations (51, 52, 76, 88)—a circumstance that would be difficult or impossible to realize by strict adherence to the 'level' concept.

V

THE THALAMUS AND 'EMOTION.' The evidence from which the widely-held notion has been derived that the thalamus is the 'center of emotions' proves, upon critical examination, to be both meager and inconclusive. The relevant experimental and clinico-pathologic data recorded up to 1941 have been independently reviewed by Lashley (44), Rioch (78), and Masserman (50) and found gravely insufficient. Alpers (1) and Morgan (66) likewise rejected the notion as inconsequential to the understanding of clinical problems.

Experiments in direct stimulation of the thalamus were performed as long ago as 1887 by Bechterew (7) who described various circulatory and respiratory changes, vocalization, erection of the hair, and integrated movements of the limbs. In 1892 Goltz (28) reported that certain responses observed in the decerebrate dog resemble fear and rage, and similar observations were made on the cat in 1904 by Woodworth and Sherrington (91). An extensive and systematic inquiry into thalamic physiology was begun in 1909 by Karplus and Kreidl (38) and continued up to 1937. The latter experimenters applied faradic currents to the hypothalamus and subthalamus and were impressed by the resemblance of some of the motor reactions to the 'emotional' expressions reported by Goltz.

During the decade 1920-30, Dusser de Barrenne (20) and Cannon and collaborators (12, 13, 14, 15) observed that when the cerebral cortex of the cat is separated from the 'lower centers' and the animal is allowed to recover from anesthesia, short-lived activities resembling rage and fear occur. Philip Bard (2, 3, 4) localized the neural site of 'sham rage' in the cat in the hypothalamus and demonstrated that when the brain is severed at levels below the hypothalamus, such fragments of rage as are observable appear not to be 'welded together' in an easily recognizable pattern. Somewhat later, purring was observed in decorticate cats (6, 81). This expression of 'pleasure' was regarded as hypothalamic in origin by Gibbs and Gibbs (27). Further refinements in the
The technic of stimulating the hypothalamus in unanesthetized cats permitted the demonstration of snarling, tail-lashing, erection of fur, dilatation of pupils, biting, clawing and fighting movements (36, 75). Bard (5) then showed that the 'hypothalamic animal' is capable of being sexually aroused and of performing coitus.

Taken altogether, these studies demonstrated beyond doubt the existence in the hypothalamus of nuclei and pathways which, when activated under artificial experimental circumstances, evoke chemical, glandular and motor responses resembling those seen in 'emotional' states.

But here the trail breaks off. Masserman (50) raised a highly pertinent issue when he asked whether such stimuli give rise to the actual experience of fear, rage, erotic feeling, etc. He pointed out that the observable motor reactions, while similar in some respects to those observed in rage, fear, etc., differ in many important ways from the affective responses seen in the intact animal. For example, the motor activity of 'sham' emotional states is not directed at specific objects in the environment; it is not adapted to the animal's surroundings (e.g., readily available avenues of escape are altogether neglected); and it ceases abruptly upon discontinuance of the stimulus, leaving none of the subsiding 'emotional' reverberations seen in the intact animal. Masserman contended that the activity of the 'thalamic animal' no more denotes actual 'emotion' than does the contraction of a skeletal muscle as induced by stimulation of its motor nerve.

It is now possible to implant tiny electrodes into the hypothalamus of the intact animal. If, while such an animal is exhibiting a normal 'emotional' response—whether 'pleasurable' or 'unpleasant'—the electrodes are activated, the pre-existing behavior continues effectually unchanged unless mechanically interfered with by the motor components of the induced response. Again, when large bilateral lesions are produced in the cat's hypothalamus by electrocoagulation, the animal exhibits within one to three weeks of operation essentially normal 'emotional' responses to food, mice, dogs, erotic stimulation, etc. (5, 49). Finally, when such an experimental animal is stimulated electrically at neural 'levels' alongside of or below the hypothalamus, typical 'hypothalamic' responses may be evoked (though they are not as well organized and are in general more easily exhausted than in the animal with a non-damaged hypothalamus). It is significant that while the hypothalamus may and probably does function to facilitate or integrate the various expressions of 'emotion,' such expressions are demonstrable even when the hypothalamus has been extensively destroyed. Apathy is not an enduring sequel of hypothalamic destruction.

That direct stimulation of the hypothalamus induces emotion-simulating reactions but probably is not accompanied by the experiential components of fear and rage was suggested by Masserman's (50) failure to 'centrally condition' these pseudo-affective responses to an indifferent stimulus. This author concludes that there is little or no basis for the thesis that the hypothalamus 'governs' or
even mediates the 'emotional experiences' themselves. He considers it permissible to regard it as a re-inforcing and co-ordinating mechanism of *emotional expression*. Wheatley (87), approaching the subject from a somewhat different experimental viewpoint, announced that 'normal emotion is undoubtedly impossible' in the decorticate and high decerebrate animal.

In the clinical neurologic area, the authority of Head and Holmes (32) and of Déjerine and Roussy (19) appears to have provided the chief support for the doctrine that the thalamus is the 'emotional center' of the brain. Head's view was that the thalamus endows incoming somatic sensations with pleasurable or unpleasant qualities and that release of this 'emotional center' from cortical control following hemispheral brain lesions intensifies the emotional charge attaching to incoming sensations.

**In consequence** of these and similar postulations, the thalamus has been variously credited with playing the following roles: (i) serving as the 'highest center' for the integration of moto-glandular patterns expressive of 'emotion'; (ii) initiating or facilitating nervous impulses which play upon and modify cortical processes so as to impart to them an 'emotional charge'; and (iii) providing a 'drive' which re-inforces and maintains behavior while the 'emotion' persists.

As to the first-mentioned role, attention has already been called to the fact that only *part* integrations of the complex somatic and visceral activities seen in 'emotion' are achieved in the 'thalamic' animal as compared with those seen in the intact animal. But *part* integrations are also accomplished in other portions of the nervous system. Hence, the thalamus cannot be considered unique in this respect. Bodily activities representing fragments of those often observed in 'emotional states' can be demonstrated by excitation of pathways in the cerebral hemispheres, a circumstance which seems to Kennard (41) to make it possible for the cortex independent of the thalamus to govern directly the manifestations of 'emotional reaction.' Furthermore, *part* integrations of so-called emotional patterns are also accomplished at midbrain (7, 39), medullary (91) and even spinal levels (4, 5, 21, 83). Since, as Rioch (78) asserts, there is no valid evidence that the affective and sensory components of 'emotion' are actually present in the 'thalamic animal,' the concept of the thalamus as an 'emotional center' lacks the experimental support that many have supposed it enjoys.

That there may be a wide disparity between 'emotional experience' and 'emotional expression' is richly attested to by clinical cases of pseudo-bulbar palsy in which the patient on slight provocation exhibits spells of crying or laughing. In this condition, some patients flatly deny that they feel sad when crying or happy when laughing (89). The introspective reports of some indicate that they remain relatively apathetic during an outburst whereas other sufferers report feeling chagrined, impatient, or otherwise distinctly displeased while they are
in the act of laughing. From such data it is clear that the dramatic outward expressions of 'emotion' do not necessarily correspond to the 'affect' experienced by the subject.

The second alleged role of the thalamus—that of initiating or facilitating nervous impulses which so modify cortical processes as to impart an 'affective quality'—was originally inferred by Head from the demonstration of hypersensitivity, sometimes amounting to intolerable discomfort, in portions of the body opposite the side of a 'thalamic' lesion. Head supposed that in his cases the thalamus was effectually isolated from the cortex. As a matter of fact, critical inspection of his anatomic data fails to verify his claims as to isolation of the thalamus from the cortex. But aside from this objection, similar subjective complaints of hypersensitivity are encountered in many other clinical cases in which the responsible lesions are located nowhere near the thalamus—e.g., in cases of inflammation of the peripheral nerves, spinal nerve roots and spinal ganglia; and in injuries, degenerations, and tumors of the cauda equina, spinal cord, and medulla. Commenting on these facts, Lashley (44) asserts that 'nothing more than an abnormality of somesthetic sensation is indicated by the observations; certainly not a general increase in affectivity.'

The third role imputed to the thalamus, that of providing an 'emotional drive' or tension-impelling activity, appears the least tenable of all. It has already been remarked that in 'sham' emotions there is virtually no after-discharge, i.e., that the emotional response ceases promptly upon withdrawal of the provoking stimulus. This circumstance could hardly mean that the thalamus 'serves as a reservoir of emotional tension' or contributes to the motivational aspects of emotional behavior (44).

One final source from which the inference has been drawn that the thalamus is the 'center of emotion' merits notice. The early theoretic formulations on the physiology of emotions—particularly those of Bechterew, William James, Lange, Cannon, and Crile—imputed to the viscera a prominent role in emotional expression and affective experience. This early orientation continues: 'Emotions . . . are defined usually as inherited pattern reactions involving extensive visceral behavior . . . and as differentiated in quality according to the dominance of the sympathetic or parasympathetic segments of the autonomic nervous system' (72).

At the outset of the current century the prevailing notion was that the complex of nerves and ganglia concerned in the innervation of the viscera functions essentially independently of the brain. At that time the only portion of the brain confidently known to be connected with this 'autonomic' complex was the medulla oblongata. When, therefore, the circumstance was demonstrated that the paleothalamus mediates and correlates a number of visceral functions (cardiovascular, respiratory, gastro-intestinal, genito-urinary, thermo-regulatory and endocrinal) it seemed to many investigators entirely 'logical' to assume that the thalamus is indeed the 'center of emotions,' especially since the role played by
the cerebral cortex in visceral functions was as yet virtually unknown.

Subsequently disclosed facts reveal the gratuitous character of this assumption. A considerable amount of data is now at hand to indicate that the cerebral cortex, especially that of the frontal lobes, mediates 'visceral' functions no less than 'somatic' (4, 16, 17, 26, 41, 67). Figure 4 is a schematic composite of regions of the primate brain which, when subjected to stimulation or extirpation, consistently lead to modifications of visceral functions.

From such data, we may confidently assert that whatever may be the ultimate fate of those theories of 'emotion' which invoke visceral participation, the thalamus certainly enjoys no corner on the market of visceral representation and pattern organization. If the viscera should ultimately be proven to contribute in important ways to 'emotion,' investigators will be obliged to reckon with the neocortex as a potential mediator of 'emotional patterns.' Rioch (78) has put the matter thus: '. . . cortical representation of autonomic function will find explanation in terms of a corticalization of the efferent mechanisms of emotional expression.'

VI

THE CEREBRAL CORTEX AND THE 'INTELLECT.' Considering that most neurologists, psychologists, and psychiatrists grow up in families, attend school, and play in groups which differ in no important respects from those common to our culture, it should occasion no surprise that they carry over into their professional jargon axioms, postulates, and beliefs deeply rooted in Indo-European language habits. Under such circumstances, the exercise of the traditional dichotomy between 'emotion' and 'intellect' seems both 'natural' and self-evident. 'Reaction,' says Wolf (90), 'may be emotional or intellectual.' [Italics mine.]

When the point is pressed, most psychologists acknowledge that the meanings of the terms 'intellectual' and 'emotional' as applied to organismic activity are nebulous. Nevertheless, discussions continue to be conducted not only as if qualitative differences between 'intellect' and 'emotion' generally exist but also as if each listener is so clearly aware of the uses to which the speaker puts the terms that no definition is needed. Differentiation, however, appears to be far more easily accomplished in the form of verbal symbols than by unbiased exam-

FIGURE 4. CORTICAL FIELDS IN WHICH VISCERAL FUNCTIONS ARE REPRESENTED. A = lateral, and B = mesial aspect of left cerebral hemisphere. The diagram is a composite of findings derived from various human and subhuman investigations and therefore represents no particular species. The cyto-architectural areas corresponding most closely to the demonstrated functional fields are numbered in accord with Brodmann's cortical map. Cardiovascular functions are represented in Areas 4, 6, 10, 11 and 12; respiratory, in 6, 10, 11, 12 and 44; gastro-intestinal, in 4, 6, 9, 10, 11, 12 and 13; kidney and urinary bladder, in 4 and 6 (mesial surface); thermo-regulatory, in 6; pilomotor, in 4 and 6; sweating, in 6, 9, 10 and the island of Reil; salivatory, in 44; pupillary, in 8 and 19; and lachrymal, in 8. Recently acquired evidence suggests that the anterior portion of the island of Reil (Ra) is a 'motor' projection field and the posterior portion (Rp) a 'sensory' projection field for the hollow viscera in general.
Figure 4.
ination of the behavioral processes to which they are said to refer.4

It has been proposed, for instance, that adaptivity can be made a sufficient basis of differentiation. This, however, does not promise to be a very useful criterion, for, on the one hand, behavior commonly designated as 'emotional' may on occasion prove highly adaptive (e.g., 'fear' transfixing the subject to such a degree that he remains inconspicuous to his enemy); and, on the other hand, behavior commonly designated as 'intellectual' may prove disappointingly non-adaptive (e.g., as when a long experiment ends in a blind alley).Again, it has been proposed that 'intellectual' behavior may be distinguished from 'emotional' in that the former is characterized by discrimination, abstraction, and generalization whereas the latter is not. Here again, however, the criterion appears to be largely gratuitous. To be sure, degree differences may be discoverable; but in view of the circumstance that a responding organism invariably reacts to a part rather than to the whole of any situation in which it is placed (59), it would be difficult to imagine an actual instance of 'emotional' behavior in which processes of discrimination, abstraction, and generalization are not identifiable.

Learning as an 'intellectual' process regularly involves discrimination, abstraction, and generalization; and while the capacity to learn is certainly much facilitated by the presence of an intact neocortex, it is equally certain that it is not peculiar to the latter. If one grants that conditioning of the pavlovian variety represents one way of learning (35), then it must be accepted that the cortex is not indispensable to the process. It has been shown by Mettler et al. (54) that the decorticate dog with thalamus intact can be conditioned. It has been further claimed by Shurrager and Culler (84) that the 'spinal' animal can be conditioned. Again, comparative psychologists are well aware that invertebrates, (e.g., worms) completely lacking in both cortex and thalamus can be readily conditioned. The phenomenon of extinction of conditioned pattern has also been demonstrated in all these cases. Hence, to whatever extent capacities for learning, conditioning, extinction, etc., may be viewed as substrates of 'intelligent' behavior, they appear to constitute general properties of nervous tissue and as such are not unique features of cortical activity.

It becomes apparent upon critical analysis that in employing the term 'emotion' some writers appear to be influenced in the main by the situation (stimulus) in the presence of which the response appears; others, by the

4 This was recently exemplified at the meeting of the Association for Research in Nervous and Mental Disease, December 2 and 3, 1949, consisting of a symposium on 'Life Stress and Disease.' Although the terms 'emotion,' 'emotional reactivity,' 'emotional state,' and 'feeling state' appeared in 24 of the 66 titles and were abundantly employed throughout the meeting, no speaker attempted to define them for his own or general purposes.

5 In his experiments on the human infant, Watson (86) considered that qualitative distinctions exist between the emotions of 'fear' and 'rage.' He asserted that the 'fear' response was produced by (a) sudden loud noises and (b) removal of support; the 'rage'
observable bodily responses; others, by the subject's 'affective' experience alone; still others, by the socio-cultural and evaluative aspects of the phenomenon. The ambiguous uses to which the terms 'emotion' and 'affect' are put are apparent in the report of the American Council on Education (72). 'Affect,' says Luria (46), 'is not a completely specific state with constant characteristics and definite symptoms.' Comparable and often overlapping considerations are discernible in connection with the term 'intellectual processes.'

When in the slow course of phylogenetic advance the thalamus makes its appearance, it embraces both 'somatic' and 'visceral' patterns of function. In this fashion it complements (rather than replaces) the organization of 'somatic' and 'visceral' patterns residing within the sympathetic ganglia of invertebrates and the spinal cord, medulla, and midbrain of vertebrates. Similarly when, somewhat later in the course of phylogenetic advance, the neocortex appears, it does not merely 'cover' (as the term 'neopallium' unfortunately denotes) the pre-existing structures, but, like the thalamus which preceded it, complements their functions and provides still more complex mechanisms for the organization of 'somatic' and 'visceral' activities.

Viewed in this manner, the conventional notions of the cortex as an integrator par excellence of 'somatic' and 'intellectual' processes and the thalamus as an integrator of 'visceral' and 'emotional' processes appear to have been sustained far more by human ignorance than by the physiologic phenomena under inquiry. It should have been apparent long ago that 'intellectual' and 'emotional' processes are not polarizable propositions of the 'either-or' variety; rather, that as ways of behaving, they are distributable on a continuum and that in the interest of total organismic economy both may be served by the thalamus and the cortex as well as by neural tissues in general.

The consequence of endorsing the conventional dichotomy between 'intellect' and 'emotion' is that certain of the disease processes to which the human is heir are likewise viewed as dichotomizable. Some disorders (paranoia, certain types of schizophrenia, etc.) are looked upon as 'essentially intellectual' and others (manic-depressive psychosis, involutional melancholia, agitated depression, etc.) as 'essentially emotional.' But to support consistently any such dichotomy in actual clinical practice requires the exercise of a considerable amount of selective ignorance and serves no useful purpose save, perhaps, that of didactic teaching.

Within the past two and a half years, the writer and his colleagues, Drs. John Knott, Robert Hayne, and Donald Sweeney, have obtained a number of electrographic records bearing upon thalamic, striatal, and cortical interrelation-
ships in patients suffering from disorders loosely spoken of, on the one hand, as 'intellectual' and, on the other, as 'emotional.' The findings have been compared with similar recordings obtained from 'control' patients in whom no clinical evidence of an 'intellectual' or 'emotional' disorder was apparent. The series now numbers 32 subjects. Some results of these investigations have already been published (31, 42, 61, 62). The data bearing upon the 'intellectual' and 'emotional' issues are as yet insufficient to warrant comment beyond the general statement that thus far no consistent electrographic differentiations have been demonstrable between the two. They therefore raise some doubt as to whether or not the conventional distinction between 'intellectual' and 'emotional' disorders is supportable.

From the present writer's standpoint, the only objective distinction between 'intellectual' and 'emotional' activities is that expressing the relative discreteness or diffuseness of segmental bodily activity evoked in a given situation. Where the 'somatic' and 'visceral' activity of the individual is confined to a relatively few neuromuscular segments, we may speak of the behavior as relatively 'intellectual' (regardless of whether or not it proves to be adaptive); where wide participation of neuromuscular segments is evoked in the situation, we may speak of it as relatively 'emotional.' By this semantic device, we avoid pigeon-holing and signify that the distinction between them is quantitative only.

The observable behavior of the organism does not lend itself to a dissection of 'intellectual' from 'emotional' components. When engaged in a game of chess, the individual can be considered as exhibiting 'purely intellectual' behavior only if his drives to gain ascendency over his rival, his mild but nonetheless existent apprehensions over the possibility of being checked, his implicit satisfactions in working out of a 'tight spot,' etc. are ignored. Even in the performance of a 'pure intellectual' activity such as contemplating the number 337 as opposed to 338 it may be seriously doubted whether the experience can be altogether devoid of 'pleasurable' or 'unpleasant' features. Esthetic or other affective preferences for 7 or 8 can usually be shown to obtain. In a similar sense, analysis of activities commonly called 'purely emotional' reveals that discrimination, abstraction, and generalization are regularly involved, so that those activities prove to be neither separate nor separable from 'intellectual' processes.

In brief review, then, at least three fallacies of an elementalistic character inhere within the proposition that the thalamus is 'the center of emotion' and the cerebral cortex 'the seat of the intellect': (i) that of imputing to one agent what may in fact be ascribable to many; (ii) that of assuming that be-
cause one agent plays thus-and-such a role, another cannot or does not; and (iii) that of supposing that the behavior of an organism is phenomenologically divisible into two distinct classes—'intellectual' and 'emotional.'

In addition to noting these 'logical' objections we have reviewed a number of findings drawn from experimental and clinico-pathologic sources which militate against the dichotomy under inquiry. Unbiased examination of the evidence suggests that, in concert with other portions of the nervous system, both the thalamus and the cortex participate in biologic processes which are variously labelled 'emotional' and 'intellectual.'

In view of these considerations, the writer urges that the elementalistic practice of equating the terms 'thalamic' with 'emotional' and 'cortical' with 'intellectual' be abandoned at the earliest possible moment. These constructs are in no way essential to the broad formulations of general semantics. Their retention can serve no purpose other than to detract from the valid principles upon which the semantic discipline stands.

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I begin by laying down two aphorisms, which will, I believe, be approved by all mountaineers:

1. There is no mountain in the Alps which may not be climbed by a party of practised mountaineers with good guides, in fine weather and under favorable conditions of the snow, with perfect safety.

2. There is no mountain in the Alps which may not become excessively dangerous if the climbers are inexperienced, the guides incompetent, the weather bad, and the snow unfavorable.

To this I will add the corollary that the common question, Which is the most difficult mountain in the Alps? is meaningless, and proves how erroneous are the ordinary opinions on the subject. There are circumstances under which the Righi is far more dangerous than the Matterhorn under others. Any mountain may pass from the top to the bottom of the scale of danger, according to the variation of the circumstances I have mentioned, in a day, or sometimes in an hour. The fact is enough to show that the ordinary classification of danger is quite inapplicable, and would condemn some safe expeditions whilst justifying others in the highest degree dangerous.

LESLIE STEPHEN, The Playground of Europe (1875).