

Some excerpts from Gerard, R. W., "Neurophysiology: Brain and Behavior." In S. Arieti (Ed.), American Handbook of Psychiatry, Vol. 2, New York: Basic Books, 1959. Pp. 1620-1638.

"The theme that brain begets behavior is really noncontroversial. Controversies can and will exist at the etiological level until, for each separate condition, precise percentages can be assigned to the influence of heredity, somatic disease, past interpersonal relations, and current life stresses; but, however they are brought about, the attributes of present behavior depend upon the present attributes of the behavers. These attributes, in turn, depend upon functional and structural properties of the enduring material components of the behaving individual.... A second point on which there can be no disagreement has to do with the different levels of organization of living entities, from cell to society" (1620).

Awareness and Emotion: "...Of especial interest for the psychiatrists are the explorations of the deeper structures of the cerebrum and the diencephalon in relation to emotional drives and experiences. These phylogenetically older structures collectively, and the limbic system and the hypothalamus, in particular, seem to be involved in pleasurable and painful experience, in the emotions and behaviors ordinarily associated with fight, flight, food, and sex. Lesions in appropriate portions of the basal structures can exaggerate or eliminate one or another of these emotional complexes, and stimulation of the same regions, using permanent indwelling electrodes to administer shocks or pipettes to administer chemicals, leads to the equivalent phenomena. Thus, aggressive hostile behavior and rage seem to be opposed to the grooming affectionate behavior of sex. Destruction of the amygdala can produce the most extreme satyriasm or nymphomania; excessive activity of it can lead to uncontrollable rage. One suspects that the voracious shrew, which attacks and kills animal many times its size, is well equipped in this department. Spike activity has been recorded from these regions in presumptive schizophrenics and from psychotic equivalent epileptics during episodes of hallucination or of violence. A cat will become as vicious and aggressive as the shrew when its hypothalamus is activated by an appropriate decerebration, and a rat is similarly activated by a small lesion in the anterior hypothalamus. Such a rat, even after its acute rage reactions have subsided, still will not engage in normal sex activities even though brought into vigorous biological estrus by appropriate hormonal injections. Electrodes placed in these structures, in rat, cat, monkey, or chimpanzee (plus a few in man), can elicit objective findings in (and subjective reports of) sexual excitement, violent anger, overwhelming terror, or severe pain. When animals are allowed to administer shocks to themselves by pressing levers, they quickly make it evident whether the subjective experience produced is pleasant or otherwise. With an electrode in a 'pain' area, the animal will give itself one shock perhaps cry out, and carefully avoid the lever thereafter. With the electrode in a 'pleasure' area the animal may continue to

shock itself, without stopping for food or rest, until utterly exhausted in a day or two; and ~~xxxx~~ it will continue to press the lever, even though it is punished by a shock to the paw each time it does so. Clearly, the neural locus of basic physiological drives and emotions is being penetrated. One might almost say that the neurophysiologist is now successfully exploring the id. In any event, as one ascends the neuraxis anatomically, or the phylogenetic axis chronologically, a series of stages in the evolution of awareness and consciousness becomes evident. Whatever may have been the nature of the most primitive awareness in, say, a sea anemone, the simple sentient awareness of wakefulness in the vertebrate seems to be associated with the upper, slightly swollen end of the early segmented neuraxis. The cord and medulla perform their automatic reflex actions with no evidence of associated subjective experience. It is the primitive head end of the nervous system, the midbrain and its diffuse reticular formation, that handled the emergency situations and generated a primitive ~~xxxx~~ awareness. Next, when the basal structures of thalamus and cerebrum were added, affect enriched experience, as first displeasure and then pleasure became possible. Only with the flowering of the cerebral cortex did reason and intelligent behavior emerge as important and, perhaps, was 'duty' to the group added to ~~the~~ 'play' of the individual." ~~xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx~~ ~~xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx~~ (1625-1626).

Modifiability---by experience: "...Imprinting, a dramatic example of the same patterning by experience, first observed in newly hatched ducklings, has now been demonstrated in other birds and in mammals. It may, moreover, be a multiple rather than a single event in the normally maturing nervous system; perhaps, as each subsystem ~~xxxxxxxx~~ ^{becomes} effectively functional, there is a brief period during which its dynamic organization is strongly influenced by the actual nerve messages reaching it. Reaction patterns to a parent and feeding, for example, might be established early; those to a mate and sex, and the attendant socialization responses, later on in association with adolescence. It will be important to determine the extent to which man's prejudices, either general or culture-bound, are established by a type of imprinting, rather than by learning, and the extent to which even primary mental abilities or personality traits are determined by early experience of one type or another. There is evidence that young men raised by authoritarian father are more likely to respond to stress with norepinephrine activation and anger; those with a dominant mother by epinephrine release and anxiety. Presumably, the wider cultural milieu, presenting children with a permissive environment in one society (for example, Eskimos) and a restrictive one on another (for example, Prussians), acts similarly to establish a variety of personality patterns. Even the acute emotional disturbances and hallucinosis associated with general sensory deprivation (which seems closely related to the causalgia experience associated with deprivation of all but one sense modality) may also depend on individual experience and culture. Infants, primitives, and nonsocial animals in general, never having become dependent on interaction with other individuals, would probably respond to the reduction

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of sensory input by sleep rather than by panic" (1631). His observations on the production of the norepinephrine vs. the epinephrine reaction is taken from the work by Funkenstein on Mastery of Stress which I reported on previously.

"Clearly, the nervous system is formed, from its very inception, by a combination of past and present factors. As in all other developing systems, it brings to a given moment whatever architecture and inhomogeneity it has come to possess; and the play of current experience upon this pattern from the past may modify it so that ~~xx~~ a somewhat different pattern is carried forward to meet future experience. Thus, 'constitution' plus 'environment' are perpetually creating a new 'constitution.' The earlier the material trace, the more profound is its effect; inherited influences are likely to be more far-reaching than are congenital ones, those of early infancy more than those of maturity. This does not preclude the possibility of later experiences counteracting the effects of earlier ones, but it does emphasize ~~xx~~ the heavy imbalance in favor of the former, and the consequent need of high intensity or much repetition of a late experience to undo an early one. The extensive working through of mourning is perhaps the best example of both the difficulty and the possible extent of neuronal ^{re}patterning." (1632).

Reverberation---Consciousness, Tension, and Excitation Level: "It is not impossible that even normal sensation depends on at least a few reverberations, within a fraction of a second; the phenomena of repression, sublimation, perception, etc., suggest just this. Ordinary four-letter words can be recognized in tachistoscopic exposure in about a twentieth of a second, but forbidden ones require nearly a tenth. Some unconscious ~~XXXX~~ recognition must have occurred in order to repress the conscious recognition, and this could be accounted for in terms ~~xxxxxxxxxxxxxxxxxxxx~~ of inhibitory discharges from the cortex blocking, say, a thalamocortical circuit before sufficient reverberation had occurred to arouse awareness. The whole problem of consciousness can be examined from this same viewpoint. The vast bulk of responses to stimuli are executed automatically, reflexly, and without conscious attention. This is true of complex learned behaviors, as in skilled motor sequences, as well as of the more general unlearned responses. When scratching eliminates an itch, the entire episode can occur without consciousness; routine repetitive automatic behavior has eliminated the disturbance. But if the routine response fails to achieve this end, innovative or creative behavior is called for, and awareness enters the picture. Well-known neural mechanisms seem to account for the steps through awareness, attention, emotion, and reason. If the automatic response does not eliminate the stimulus, afferent messages continue to flow into the nervous system and to pass the synapses normally open ~~x~~ to them. But, as presented earlier, they also reach other synapses, normally nontransmitting, finally break through these by virtue of simple summation owing to ~~co~~nⁱnued input, and irradiate to additional neurons farther from the normal channels. Additional summation and further irradiation will occur from these new ~~pp~~ points if the input remains, and a progressive

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recruitment occurs and the spread reaches the higher brain regions. As these new neurons are thrown into repeated activity, by incoming or reverberating impulses, the appropriate subjective experience is also activated. Awareness is thus related to unresolved stimulation, and tension and anxiety are associated with lack of closure and unfinished business. The awaited event, the unsolved problem, the unmade decision, the unassimilated novelty, even the unbalanced emotional equation ('I haven't gotten even with him for what he did')--all these are associated with continuing neural activity, with tension, and with either specific or free-floating anxiety. When closure is obtained and the solution reached, the whole neurological turmoil ends and, unless fixed by too long a period of activation, is lost as quickly as a looked-up telephone number is forgotten after use" (1633-1634).

"It is impressive that here, again, the interaction of 'socioemotional' factors and of 'biological' factors reveals the arbitrariness of such categories. The level of consciousness, from unconscious through mania and hallucination, is built upon the environmental stimuli and the internal neural and humoral situation; and both the meaning of the external stimulus and the type of internal adjustment are results of past experience, whether of ~~xxxx~~ the race passed on through the genes, or of the individual, picked up in utero, during infancy, or in later stages of his life span" (1635).

Reason and the Neuron Reserve: "I cannot resist carrying this approach further, to the reasoning process itself. If repeated activation leads to more enduring changes in neurones and the establishment of patterns of activity, then those experiences which are themselves ^{more frequently repeated will be} most likely to impart a structure to the nervous system. When various types and distributions of sensations recur together, as do visual or tactile messages from a material object, such an entity is likely to be perceived as having an enduring existence. So is the basic recognition of objects attained. The primitive identification is presumably the self, which is initially the total universe. Normal development consist of dividing, subdividing, and resubdividing this total 'blooming buzzing confusion' into appropriate categories. As developed earlier, in just this way does the game of twenty questions progressively zero in on a particular item. (Indeed, the normal development of behavior in the embryo shows just such a fractionation of an initial mass responsiveness or mass reflex into finer and finer specific reflexes.) To indentify a complex item in the entire conceptual universe requires more and more questions as more categories must be passed through; and in the same way the nervous system requires more neurons to categorize the universe finely than to do so roughly. As the infant brain develops, past a single self-universe experience the first major dichotomization is to separate the 'thou' from the 'I'. 'Thou' is the correct term at this stage for other objects recognized in the external world since they are endowed ~~in~~ with, or have projected upon them, the attributes of the perceiver. They are personified, possess volition and sentience, as is seen in the play of children or in the myriad deities inhabiting trees, ponds, rocks, and other objects of primitive concern....Development continues as a further subdividing of these major categories



into rubrics built on collective experience--experience and rubrics crystallized in the words and grammar of language. An increased number of available neurons is thus, of itself, conducive to fuller conceptualization and finer analysis. Whatever fraction of the total neuron population is already occupied by the patterns of routine performance will not be available for participation in innovative behavior; so a pool of activable but inactive neurons is especially important. A maintained tension or a general anxiety, by engaging an additional number of neurons, can reduce the reserve for creative behavior; on the other hand, a mild degree of anxiousness, associated with an immediate problem and leading to irradiation into new neuron territory, is probably essential to optimal creative performance. It is, indeed, the case that, as anxiety mounts, performance is first improved, then narrowed or stenosed (in the sense that alternate paths are no longer adequately explored), and then collapses more or less completely. These stages would seem to correspond with first activation and then engagement of larger and larger fractions of the available neuron population, so that the reserve available for further mobilization to meet continuing needs first rises, then falls, and finally is exhausted. It is possible to look at the behavioral deterioration of schizophrenia along just such lines. As neurons become functionally unavailable--as thresholds rise, normal activation fails, or what not--the finer categories into which the universe is normally divided disappear, and predicate logic replaces subject logic. Normally, white objects are further divided into sugar and cream; but if this division is erased, sugar and cream, both belonging to the same undivided category, become identical because they are both white. Sugar is white, cream is white, therefore sugar is cream. With further loss of functioning neurons, the distinction between personal and impersonal goes, and all things are again personified. Finally, the primary dichotomy of I and not-I is gone, and the margins of the ego become blurred. The same line of thought leads one to equate a 'psychic energy' with uncommitted reserve of functionable neurons. As there are fewer such available neurons present--anatomically, or physiologically ~~now~~ owing to high thresholds, or dynamically because too many are already occupied--the capacity for additional and novel activity must be diminished. All studies of insight, imagination, and creative thought indicate the prolonged and intense unconscious neural activity that is involved; neurons otherwise occupied or simply inactivable are lost to this demanding process. Input overload, a too-intensive demand on the brain for immediate handling of problems; input underload, or sensory deprivation, leading to shrinkage of the functionally active neuron population; excessive anxiety, fruitlessly occupying many neurons; functional unavailability, such as may occur in depressive schizophrenia; overactivity and oversynchronization or over-channeled assemblies, as in enduring neuroses; anatomical damage--all these can lead to constricted, regressive, ineffectual behavior. In many, but not all, of these cases the neural strictures are physiological and reversible with greater or lesser ease. Whether the abnormal situation can be corrected by a simple environmental change, by brief or prolonged psychotherapy, by drugs, by shock, or by even more drastic manipulation will depend on the type of depletion or stenosis to which the neural apparatus is subject." (1635-1636).

