Timorous Suggestions for a Tentative Hypothesis of Neural Action

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The notions of brain functioning described here are based upon a system of thought elaborated elsewhere[1], a system which in essence constitutes a new format for the behavioral sciences. While admittedly quite speculative and arising from a position of relative ignorance of the details of neuroanatomy and neurophysiology, this view of neural action is based upon rather considerable experience of varied behaviors in many vertebrate species. It differs from the S-R format in the following important ways:

(1) We believe that the S-R paradigm missed the main format of behavior, and of nervous action, namely, the internal activation of the system and the sequential flow of configurations — the neural channel complexes and their reflection in muscular configurations.

(2) Because of the peculiar evolution of the vertebrates, their nervous system is fundamentally designed for internal activation, with the operation of external "stimuli" coming as an "improvement patent" on the older ways of functioning. The newer parts of the nervous system are built upon and can be said to be in the service of the older parts.

(3) The nervous system is hierarchically arranged, in accordance with its evolutionary history. The functional properties of neural action (and of behavior sequences) differ as sequences progress from the new to the old. The flow is normally in this direction, from neoteric to primal.

(4) The relative contribution of inputs from various sources — internal, proprioceptive, and external — varies at the different evolutionary levels, with the older portions responding more to purely internal inputs and the newer portions depending more on external inputs.

[1] In "A Natural Format for Psychology", a presentation at the 1962 American Psychological Association meetings.

(5) Behavior, indeed, all organismic activity, whether "S" or "R", has only to do with the effort of the organism to complete interrupted sequences of behavior — usually interrupted by the insalubrious environment of the ordinary vertebrate — and to return to a condition where the primal sequences can fire off to completion. Both "S" and "R" are subsidiary categories, and in the nervous system all data are reduced to common processes — the pulse flow, the neural cell functions, whatever changes occur at the synapse, the reconstitution of the pulse in the post synaptic neuron.

(6) The end point of any particular behavioral or neurological process, regardless of where the inputs come from, must result in an output that has, in its next step, a similar if not identical acceptor pattern — thus the basic action becomes the spatial, architectural, and probably temporal matching of channel configurations to input acceptors. The degree of match governs the next step in the elaborated chain reaction.

(7) Preoccupation with musculature may be unfounded and unprofitable. The system is basically a chemical one, and chemical steps are interposed at all points. Behavior as a movement pattern is not the fundamental. This feature has been seized upon because of the properties of the observing organism itself.

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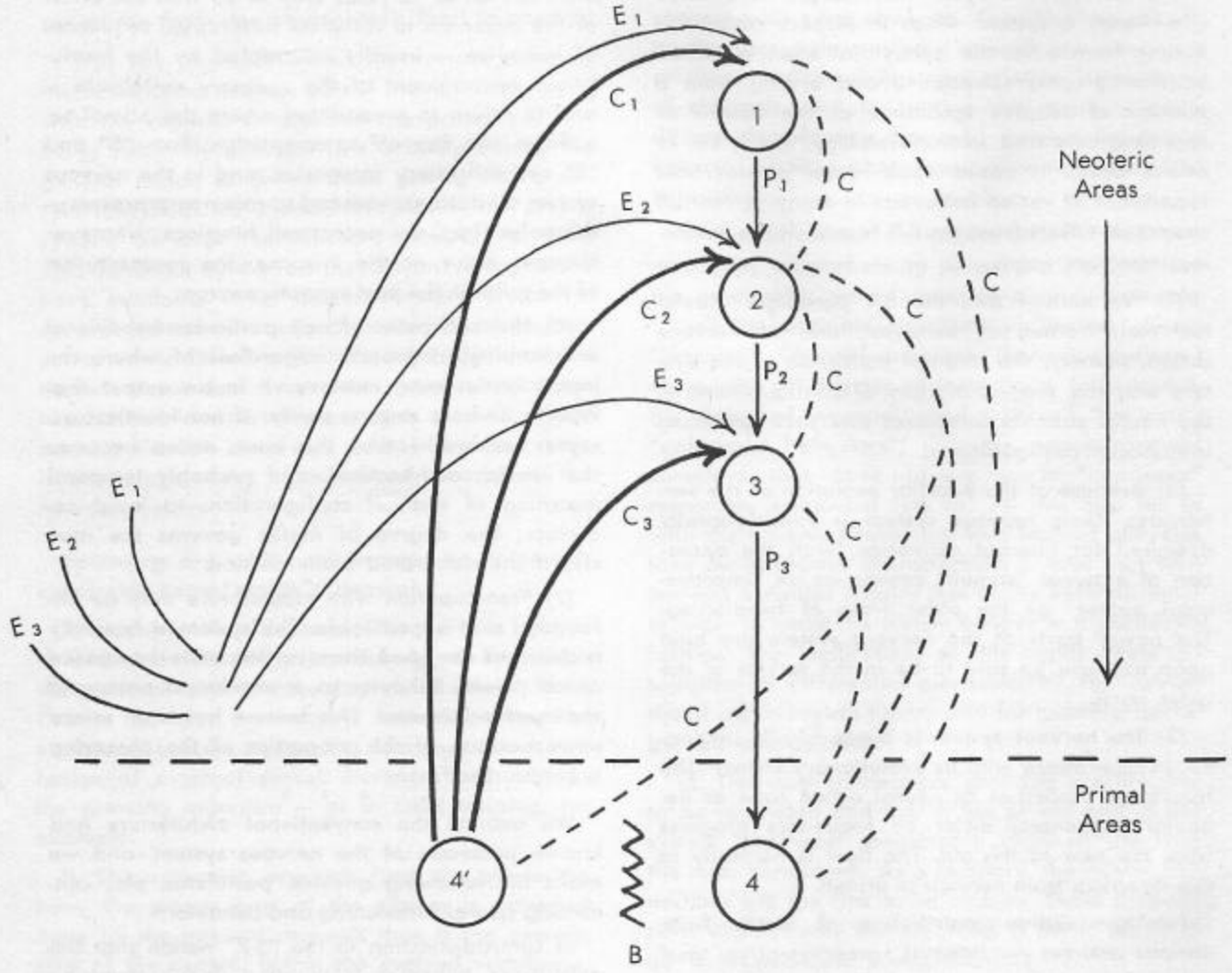
We assume the conventional architecture and known processes of the nervous system, and we make the following guesses, postulates, etc., concerning neural functioning and behavior:

In contradistinction to the "S-R" notion that the organism's behavior is initiated and coerced by an external environmental stimulus, we base our conceptual framework on the notion that the appetitive behavior of the organism is initiated internally, in the central primal regions of the brain. (See diagram.)


E1
C1
1
P1
C
Neoteric
Areas
E2
2
C2
C
C
P2
C
E3
3
C3
C
P3
E1
E2
E3
C
Primal
Areas
4'
4
B

4' and 4 are centers representing primal functions which cannot take place because they are interrupted or blocked at B. They might represent centers for digestive processes, for example, interrupted because there is no food in the digestive tract. In a primitive organism, 4' to 4 can fire without delay because the environment is such that these processes can take place immediately and effectively.

A **center** is not an all or nothing concept. The degree to which neural action can be considered to have the properties of a center is the degree to which a certain sequence of neural configurations will take its course from an unpatterned input. In other words, a complete center would be a neural structure that would run its course regardless of the pattern of input.

1, 2, and 3 are centers for neural (and muscular) action of more recent evolutionary origin, and the order of newness proceeds according to the arrow, 1 being newer, etc.

E_1, E_2, and E_3 are environmental inputs (note that they come into the relatively more primal areas and loop back out toward the neoteric tissue) appropriate to each center.

When 4' is activated internally because the complex environment does not provide the conditions necessary for the completion of its biological processes to culminate in 4, pulse channels are generated, here called C channels[2] (heavier shaded channels marked C_1, C_2, C_3) which in essence comb or scan the brain for input acceptors which will allow the centers to fire on to 4.

If the C circuit or channel converges with or is converged upon by a suitable input E from the external world (and also by P, the proprioceptive feed forward from the previous center), the system will proceed from center to center, two or more inputs to a synapse probably being necessary for the firing of the postsynaptic neuron.

The C circuits presumably comb the primal areas first — for example, if the C channel from the 4' center encountered E_3 (the presence of food in the mouth) 3 could then fire — the organism would swallow. If E_3 is absent, combing must continue (the temporal order is not necessarily fixed or necessary — it **could** happen this way, but many C circuits are of course active at once). If E_2 is encountered, (presence of food in a dish, say), 2 may be fired (the animal will pick it up). This gives us P_2 plus E_3 which allows 3 to fire — the animal will swallow. But if all this fails, perhaps E_1 will be encountered — the sound of food falling into a cup at the end of the box. Center 1 will then fire — the animal will locomote, pick up the food, swallow, and the digestive process can resume. Note throughout that the presence of one active channel tends to facilitate another.

Note that the C channels continue on back into the primal areas (broken lines) and offer means of possible "short circuiting" which can occur anywhere along the line. They also connect centers. There may be many other internal circuits not specified and many may impinge upon one center. This points to the relative insignificance of external inputs in many kinds of behavior.

The C channel complex is perhaps the most fruitful part of this whole conceptualization, and we assume the following properties of C channels:

(a) C channels emanate from the primal areas of the nervous system, comb toward the neoteric, and return.

(b) C channels valve the sensory input from the external world.

(c) Increased drive increases the activity of C circuits or channels, or put otherwise, activity of the C circuits is increased by drive.

(d) C channels themselves are conditionable, and in arousal they go by preference in channels already conditioned.

(e) C channels are variably conditionable, as are all other circuits — it follows that some C circuits are unconditionable and uncommitted.

(f) Strong channels (better conducting channels) divert or draw in upon themselves impinging weaker channels. This is known as the principle of confluence. Thus the C channel may pilot or "capture" the sensory channel, or the sensory channel may pilot or capture the C channel.

(g) C channels can account for covert behavior, spontaneous regression and spontaneous

[2] C channels are so named for "centrifugal" and "centripetal", etymologically indicating action from the center to the periphery and returning. The C may also stand for covert behavior.

recovery, incentive motivation, hallucinations, illusions, Gestalts, "good figure", memory retrieval, and so on.

(h) The interdynamics of different channels are different in portions of the nervous system which differ in phylogenetic age. The properties are correlated with their evolution, the mode of action differing in the older portions. The proportion of determination from various sources of input varies from one phylogenetic level to another.

(i) The impingement of the various channels increases in the neoteric part of the nervous system, with the channel structure in the primal portions being relatively discrete. This is borne out by the general notion of drives. Food getting has a certain fairly discrete channel complex in the primal system, as does reproduction, escape, etc. It is also borne out by the fact that advanced organisms have available under one drive more of the response patterns normally characteristic of another drive, while lower organisms who are short on neoteric tissue do not have this communication between their various drive systems — their whole nervous tissue is more at a primal level and there is less impingement of organized channels in the nervous system.

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Following are additional hunches or statements concerning neural action in general:

I. In appetitive behavior, the nervous system is activated internally, particularly at first, with the external inputs acquiring their control later. This is indicated by vacuum activities, nocturnal emissions, hunger pangs, the fact that the contribution of external stimuli increases with age in the growing organism — as in toilet training, for example.

II. The activation proceeds from the old to the new; the primal part of the system is activated more by the internal channels than is the neoteric part of the system, but in the evolved vertebrate, the primal end is prevented from firing its sequences until the controlling inputs come from the outputs of prior more neoteric sequences.

III. The system is conceived to be "treed out" from the primal toward the neoteric, with the neoteric having a greater fine structure, more variety, or degrees of freedom. Integration takes place from the neoteric to the primal, with the convergence of external and other circuits. This is indicated histologically and also borne out by such facts as the loss of pattern discrimination in ablation experiments.

IV. Conditioning is defined as the connecting of neural channel complexes by diverting other channels into them. Extinction is defined as diverting channels out of a complex. However, they may still connect with other channels. Conditioning and extinction are only partially inverse processes. The relative conditionability and relative permanence of channels, and the notion that extinction conditions diversionary channels, account for many hitherto puzzling phenomena of conditioning and extinction.

V. Neural channel complexes differ in their connectability or probability of conduction. This simple assumption would seem to abolish once and for all the hoary old dichotomy of "instinct" versus "learning". Channel complexes (behavior patterns) come with all degrees of learnability (connectability). So-called "unconditioned reflexes", "instincts", "unlearned behaviors", etc., are merely channel complexes that hook up very readily; "imprinted" responses, somewhat less so. All this also fits in with the observed facts that well learned activities take on instinctive characteristics — also that well learned activities require less of the external input in order to make the system behave in a particular fashion. The implications of this highly likely assumption of differential connectability, for conventional psychological theory and for scientific strategy, are considerable.

VI. The most connectable channels are the first to be connected and are at the primal end of the system. The most connectable channels are also the most permanent. As a corollary, the newer connections are the first to be undone. These assumptions explain why the organism is born "ready to go" in his particular ecological niche.

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While space does not permit detailed elaboration, with this new format for the design and function of the nervous system, and with this small number of seemingly creditable assumptions, a great mass of empirical observation seems to be reasonably well accounted for.