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Research in Psychobiology

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Work under this program grant has been described in considerable detail in our recent interim report. We shall therefore merely restate our aims, together with brief accounts of work in some of those areas for which additional findings have become available since the completion of the interim report five months ago.

The program continues to center around three principal topics, viz.,

A. Studies of brain-behavior relationships

B. Studies of perception and learning

C. Studies in comparative and developmental psychology

Together, these studies should contribute to an understanding of behavior and its neural correlates, with obvious implications for assessing limits of human and animal capacities for space travel, and for the monitoring and control of higher functions under extreme conditions.

A. Brain-Behavior Relationships

In this area, major efforts are devoted to an elucidation of functional significance of anatomic patterns, particularly in the cerebral visual system (occipital lobes, optic radiations), the parietal lobes, frontal lobes, and basal ganglia (see, e.g., Teuber, 1963, 1964; Chorover and Gross, 1963). During the last few months, major new developments include further progress in the analysis of human cerebral potentials evoked by light (Vaughan and Hull, 1964, in press), and a beginning has been made in efforts at dissecting these potentials by selective surgical interruptions of visual pathways in the monkey.

The search for neural correlates of learning has progressed by virtue of further delineation of one-trial learning in animals, and the demonstration that consolidation of traces for this kind of learning is extremely rapid. Contrary to generally accepted views, retrograde amnesia for such tasks can be obtained only if the amnesia-producing treatment (spreading cortical depression, electroconvulsive shock, subcortical stimulation) follows the trial by less than ten seconds (Chorover, 1964; Chorover and Schiller, 1964). Analogous conditions may govern trace consolidation processes for learning requiring multiple trials (Mahut, 1964).

Other studies, described in greater detail in our earlier report concern electrographic recording and stimulation during discrimination learning in animals, the evaluation of cerebral uptake of radioactive nucleotides and aminoacids under different functional states, and the assessment of minimal signs of brain damage in humans at different ages. A major recent development in this connection is the elaboration of hypotheses regarding the neural basis of sensorimotor coordination.

According to these views, voluntary movements are associated with two kinds of neuronal discharges: the classical motor impulses descending from the central nervous system to the peripheral musculature, and an associated discharge (the "corollary discharge," see Teuber, 1963, 1964), which moves within the central nervous system from motor to sensory regions, preparing the latter for the changes in peripheral input that result from executing the intended movement.

B. Perception and Learning

Correspondingly, experimental analyses of perception in our laboratories continue to be guided by the view that correlations between motor output and sensory feedback are implicated in the origin and maintenance of coordination. To test the role of this motor-sensory feedback, experiments are performed which introduce some consistent change in relations between the perceiver and his environment (e.g., displacing spectacles), thus permitting the study of readaptation to such change ("rearrangement experiments," see Held and Freedman, 1963). Alternatively, unpredictable or random changes in relation between perceiver and environment can be introduced, causing failure of adaptation ("disarrangement experiments," see Held and Freedman, loc.cit.). A series of findings based on these two types of experimentation has recently been published (Held and Freedman, 1963 ; Held and Mikaelian, 1964, in press).

Still more recent developments in this area include new ways of decorrelating motor output and sensory feedback, (a), by introducing changes at the motor end of the feedback loop, or (b), by manipulating the time relations within the loop. Thus, experiments are in progress showing decay in coordination as a predictable result of changing the muscular effort required for producing directed voluntary movements. Similarly, losses in rate of adaptation to displacing spectacles can be demonstrated by introducing time delays of the order of 100 msec. into the motor-sensory loop. Experiments are also in progress exploring the role of stroboscopic illumination in readaptation to displacing spectacles. The same methods of intermittent illumination are employed in the rearing of kittens where the origin rather than maintenance of normal coordination is under investigation.

Lastly, work continues on extent and limits of transfer of sensorimotor reorganization across sensory modalities, or from one hand to another. For instance, it has already been established that changes in eye-hand coordination as measured by accuracy of directional reaching movements while wearing prismatic spectacles is specific to the hand trained, since it does not transfer (without additional training) to an untrained hand.

Other work (described in the detailed interim report) includes related studies of intersensory transfer of pattern discrimination learning (Rudel and Teuber, 1964, exploration of haptic and visual forms of the classical geometric-optic illusions (Rudel and Teuber, 1963), experiments on perceptual blanking and metacontrast (Schiller, 1964), and, quite recently, experiments on normal time-perception (Richards, 1964, in press).

Work on learning includes continued experimentation on the role of recoding in the immediate recall of verbal material by normal adults (Wickelgren, 1964a,b), and still more recently, an experimental analysis on the influence of "syntactic" structure of verbal material on perception and recall in two-channel listening (Fodor and Bever, 1964, in preparation).

C. Developmental and Comparative Psychology

Developmental studies are directed at an elucidation of the origins of early forms of sensorimotor coordination in kittens, monkeys, and human infants reared under a variety of conditions (see detailed report and Held and Hein, 1963; White, 1963, White et al., 1964, in press). During the last few months, further normative studies of the origin of eye-hand coordination have been added (Twitchell, 1964, in preparation).

Comparative studies, contrasting different phylogenetic levels, continue to be concerned with pattern discrimination learning and its intraretinal and eye-to-eye transfer in the goldfish (Ingle, 1964), the work on kittens already cited, and increasing efforts at defining the perceptual and learning capacities of the most primitive primate (Tupaia glis), in comparison with squirrels, stumptail macaques and Rhesus monkeys.

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