EFFECTS OF DIFFUSE ALTERED BRAIN FUNCTION ON PERCEPTION

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PROBLEM

Recent studies of the relation of perceptual alteration following brain damage have emphasized the role of focal damage. To determine the patterns of perceptual changes with diffuse alterations in brain function, the following studies were undertaken.

SUBJECTS AND METHOD

Consecutive subjects in a psychiatric hospital referred for electroshock therapy were studied. Alteration in brain function was induced by varying the frequency, number and severity of the induced convulsions. The following tests were applied before treatment, at weekly intervals during, and two weeks after treatment terminated.

A) *Measures of altered brain function:* Two quantitative indices were used to determine the degree of altered cerebral function:

1) the per cent time, amplitude and lowest frequency of the induced delta response in serial electroencephalograms;

2) changes in orientation and in language following the administration of intravenous amobarbital sodium.

B) *Perceptual Tests:*

1) Tactile: Threshold perception (100 % point) of square wave electrical stimuli was determined for different body areas. Stimuli were then applied simultaneously to two body areas, with interspersed single stimuli in random fashion, and the subject was asked to report where he felt the stimulation.

2) Visual:

a) Figure-Ground: Using embedded figures (Gottschaldt) of increasing complexity, subjects were requested to identify a simple geometric figure in a complex background.

b) Tachistoscopic recognition: paired words were presented at rapid exposures to subjects. The words were matched according to tables of frequency in common usage, and were of two groups: relating to illness or to the body, and those not relating to illness. Words were matched randomly.

Results

1) With increasing degrees of altered brain function, there were increasing errors in reporting the simultaneous tactile stimuli. There was a concomitant rise in the threshold of perception. With high degrees of cerebral dysfunction, mislocalization of responses appeared, in addition to the persistent failure to report one of the stimuli.

2) The ability to isolate embedded figures was impaired in direct relation to the severity of the alteration in brain function.

3) Threshold for the perception of words increased and subjects were unable to identify two words with increasing degrees of cerebral dysfunction.

4) Changes in perception were highly correlated with other behavioral changes, indicative of an altered interaction with the environment.

Conclusion

1) Diffuse alteration in brain function, as measured by electroencephalographic delta and orientation tests after amobarbital, results in alteration of perceptual patterns marked by an increase in threshold, impaired discrimination of stimuli, of which the ability to discriminate a figure from a complex background is a special example.

2) Alteration in perception represents one aspect of an altered behavioral interaction with the environment, rather than a specific physiological defect. This factor should be considered in perceptual studies in focal brain lesions as well.

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Effect of Diffuse Altered Brain Function on Perception

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Effect of Diffuse Altered Brain Function on Perception

Much of the study of alteration in perception following changes in cerebral function has been devoted to focal lesions as in surgical ablations, missle head traum and brain tumor. Little emphasis is usually placed on the diffuse effects of such lesions on the perceptual process.

In the course of studies in electroshock therapy, we observed that this process permitted considerable control of the degree of induced alteration of brain function. In these studies we were impressed with the wide variability in the behavioral and neurophysiologic response of our subjects to apparent equivalent numbers of convulsions. We have previously reported the interdependence of the behavioral responses and the degree of apparent neurophysiologic change.

The purpose of this report is to describe perceptual changes under the conditions of differing degrees of diffuse altered brain function, and to determine the relationship of the perceptual changes to the induced neurophysiologic change.

Three perceptual tasks were utilized:

Tactile perception of threshold square wave electrical stimuli

Visual isolation of embedded geometric figures

Visual recognition of tachistoscopically presented words.

Method:

The subjects were 53 consecutive hospitalized patients, referred for electroshock. Brain function was altered by inducing repeated grand mal convulsions under pentothal premedication. The convulsions were given at a frequency of three times per week.

For a control group, randomly selected patients received subconvulsive therapy, with equivalent number of applications of pentothal but with subconvulsive doses of electric current. All evaluations and tests were the same as in the experimental group - and the type of treatment in use for each subject was not known to any of the investigators until the experiment was ended.

Two neurophysiologic indices were used. Electroencephalograms, taken at weekly intervals on a day after an induced convulsion, and quantitatively measured for the degree of induced delta activity; and amobarbital tests for brain disease. In this test, the language responses on a standardized interview, are assessed after intravenous amobarbital. Confabulation, denial, disorientation, and syntactical language changes have been described as an index of altered cerebral function. Both these tests were applied pre-treatment and during the 2nd, 3rd and 5th weeks of treatment.

The technique of each of the three perceptual tasks will be described with the corresponding results. For purposes of this presentation, the observations are limited to the quantitative aspects only; and as there is a wide variability in physiologic response, we will present group data for experimental and control groups first; and then compare the observations according to the degree of induced physiologic change.

Results:

A. Perception of Simultaneous Tactile Threshold Stimuli:

In this task, isolated square wave electrical stimuli were simultaneously delivered to two body parts through attached 1 cm - disc electrodes. Initial threshold (100% point,) values were determined for each body part and throughout the testing, random single stimuli were interspersed to minimize errors due to fluctuation of threshold. Subjects were asked to localize the applied stimuli.

Slide 1 describes the mean number of errors pre-treatment, and at the height of the induced physiologic effect, which is usually after the 12th treatment. The subconvulsive (control) group shows a drop in the number of errors, the so-called practice effect. The convulsive group, however, shows a significant increase in errors. The increase is even more marked in those patients who had first been treated by a subconvulsive, and later re-treated with a convulsive course of therapy.

In Slide 2, the group differences are compared. Pre-treatment, the difference in the number of errors is insignificant, but at the height of the treatment course the differences become significant.

In Slide 3, the role of the induced physiologic change is assessed. In the first section, the subjects who have had two or three positive amobarbital tests during treatment are compared to those with either no positive response or only one. The number of errors are higher in patients with more positive amobarbital responses. Furthermore, in comparing the difference from the pre-treatment score, the values are significantly different for the group with the greater physiologic change.

In the second section, the same results are noted for the electroencephalographic delta response; and in the third section, the two neurophysiologic indices are compared.

Errors in the perception of simultaneous tactile stimuli increase with increasing degrees of altered brain function.

B. Perception of Embedded Figures:

In this task, geometric figures embedded in a complex designed field are presented and the subject is asked to trace the simple figure. The simple figure is simultaneously presented above the complex field.

Slide 4 shows the mean number of errors before and after convulsive and subconvulsive courses. The subconvulsive or control group, with minimal or no neurophysiologic change, shows a drop in the number of errors. Both convulsive groups show an increase in the number of errors.

In Slide 5, the subconvulsive and convulsive groups are compared both before and during the 5th week of treatment. Before treatment, no difference in the number of errors is noted. At the height of the electroshock effect, the convulsive group makes significantly more errors than the subconvulsive group.

This effect is even more clearly visualized in the next slide (Slide 6). Here, the groups are divided according to the degree of induced physiologic change. On the amobarbital test, the electroencephalogram, and the combined data, there is a significant difference in the number of errors made. Patients with higher degrees of neurophysiologic change make the most errors.

C. Tachistoscopic Recognition of Words:

Paired words, selected for their equivalence in frequency in English usage and randomly matched, were presented at five different speeds of exposure ranging from 10 to 250 milliseconds. The words were presented in a pre-set sequence for a total of 240 trials.

In Slide 7, the errors in each group are presented. Here too, the subconvulsive or control group shows a significant drop in the number of errors, while the convulsive group shows a much smaller practice effect.

In the next slide (8), the pre-treatment and post-treatment scores are compared. The groups are well matched before, and in both there is a reduction in the number of errors with altered brain function, But, the reduction in the subconvulsive groups is greater than the convulsive. These differences are small and are not significant.

In Slide 9, the role of neurophysiologic change is again assessed. Here, too, as in the preceding slide, there is a decrease in the practice effect with the greater the change in cerebral function. This is clearly seen in the convulsive physiologic scores, where the patients with the least physiologic change show a decrease in errors, while those with the greatest physiologic change show a small number of errors.

In this task, in contrast to the two preceding ones, the effect of altered brain function is not manifest in an increase in the number of errors, but is seen only when the expected improvement in performance fails to appear.

Conclusion:

Diffuse alteration in cerebral function has been produced in psychiatric patients by the repeated electrical induction of grand mal convulsions. In control subconvulsive and experimental convulsive groups, the relationship of perceptual errors to changes in degree of cerebral function has been observed.

In separate perceptual tasks, increasing errors in perception in proportion to the degree of induced alteration in neurophysiologic indices of cerebral function can be observed.

In addition to these perceptual task changes, however, there are concomitant alterations in behavior, language, orientation, attitude and mood, and these are highly variable depending upon individual differences in the subjects. The perceptual alterations described here represent but

one aspect of the changes in the behavioral interaction of the organism with the environment. Further studies of this factor of individual variability in response to cerebral lesions are now in progress.