EEG adaptation during prolonged periods of water deprivation¹

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Abstract

Twenty albino rats were deprived of water for 96 hr. and their EEGs were sampled at 24-hr. intervals. Analysis of both frequency and amplitude of EEG deflections revealed an initial period of desynchronization followed by a period of resynchronization. A trend analysis revealed a significant quadratic component for both measures when plotted as a function of hours of deprivation.

Problem

It has been repeatedly demonstrated that the bioelectrical activity of the cerebral cortex is altered by food or water deprivation (Anokhin, 1961; Steiner, 1962; Hockman, 1964; Sudakov & Fadeev, 1965). Anokhin recorded the EEGs of cats after 24-hr. food deprivation as well as immediately after stomach loading the deprived animals with milk. Steiner used a similar procedure, but with 24-hr. water deprivation as the independent variable. In both cases deprivation produced a desynchronized EEG while satiation caused a resynchronization (return of low frequency, high amplitude activity).

Cortical desynchronization has been conceived of as a part of the orienting reflex (Sokolov, 1960). According to this view alpha blocking is a characteristic response of the organism to novel stimulation. The over-all function of the orienting reflex is to increase the animal's ability to perceive the novel stimulus while cortical desynchronization has the specific effect of lowering the organism's sensory thresholds. A direct consequence of the response dependence upon novelty is adaptation. When the stimulating condition fails to change it ceases to have "signal" value. Since no new information is conveyed, the organism adapts or electrocortically habituates to the stimulus.

Under conditions of water deprivation, thermoregulation and waste elimination initially cause increasing dehydration. After a period of time, however, certain adaptations oppose the growing deficit. One such adaptation is the secretion of the antidiuretic hormone by the anterior pituitary (Verney, 1947). The effect of this secretion is to minimize body water loss, with the result that the changes in the osmotic stimuli due to continued deprivation are diminished. This fact viewed in light of Sokolov's theory would lead to the prediction that prolonged water deprivation should cause an initial desynchronization followed by a period of resynchronization. It was the purpose of this study to test the above hypothesis.

Method

Twenty male Holtzman rats of approximately 100 days of age were used. Under ether anesthesia two electrodes were implanted in the skull of each rat, anterior to the frontoparietal suture. A stainless steel electrode was sewn into the anterior trapezius muscle and served as a ground. The animals were given free access to food and water for 14 days after the operation.

All potentials were recorded differentially with a Grass 5P5 EEG preamplifier, driver amplifier and inkwriter. The preamplifier sensitivity was set at $50 \mu\text{V/cm}$ and the paper speed at 50 mm/sec. Fourteen days postoperatively the animals were individually placed in a wooden recording box with the EEG input leads attached to the implanted skull terminals. The rats were left in the box for 10 min. to facilitate adaptation to the recording situation; however, no recording was made on this day. The following day the animals were again placed in the box for 10 min. and recordings were obtained during the latter 5 min. The first 5 min. served to "quiet" the animals. Recording consisted of 1 min. of consecutive artifact-free EEG writeout. After this first session the animals were placed on a 96-hr. water deprivation schedule with food available ad libitum. Recordings were made at 24-hr. intervals for the duration of the deprivation

Fig. 1. Mean EEG frequency and mean amplitude of deflection as a function of hours of water deprivation.

TABLE I

Newman-Keuls test of all logical comparisons on the EEG mean frequency data for five durations of water deprivation, (N=20).

Length of deprivation periods compared (hr.)	p
0-24	<.01
24-48	<.01
48-72	>.05
72-96	>.05
48-96	<.05
0-96	<.01

period. The amplitude and frequency of the EEGs were quantified manually.

Results

In Fig. 1 frequency of EEG potentials is presented as a function of hours of deprivation. A repeated measurements analysis revealed the fact that significant day-to-day differences existed ($F=17.96$, $df=4/76$, $p<.005$). A more specific test to determine the origin of the significant differences was carried out by a Newman-Keuls test of all logical comparisons (Winer, 1962). A summary of the pertinent comparisons is presented in Table I.

Figure 1 also shows amplitude as a function of hours of deprivation. Tests similar to those used for the analysis of the frequency data revealed a significant over-all F ratio ($F=3.33$, $df=4/76$, $p<.025$) and significant day-to-day changes as summarized in Table II.

The functions for the two dependent variables suggested quadratic relationships between frequency and amplitude and hours of deprivation. To determine if this was the case, a trend analysis (Edwards, 1962) was performed on the two sets of data. In each case the linear component was found to be nonsignificant (Frequency; $F=0.16$, $df=3/76$, $p>.25$, Amplitude; $F=2.50$, $df=3/76$, $p>.05$) while the quadratic component was highly significant (Frequency; $F=6.22$, $df=3/76$, $p<.01$, Amplitude; $F=13.33$, $df=3/76$, $p<.01$). The significant decrease in mean frequency as depriva-

TABLE II

Newman-Keuls test of all logical comparisons on the EEG mean amplitude data for five durations of water deprivation, (N=20).

Length of deprivation periods compared (hr.)	p
0-24	>.05
24-48	>.05
0-48	<.05
48-72	>.05
72-96	<.07
0-96	>.25

tion increased from 24 to 48 hr., and the tendency toward a significant increase in mean amplitude as deprivation increased from 72 to 96 hr., are taken as evidence of habituation and, therefore, as confirmations of the hypothesis that prolonged deprivation would lead to a resynchronization of the EEG. The fact that the functions were quadratic, that is, having a return phase, lend further support to this view.

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Note

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