ELECTROENCEPHALOGRAPHIC CHANGES DURING AND AFTER 14 DAYS OF PERCEPTUAL DEPRIVATION

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Electroencephalographic Changes during and after 14 Days of Perceptual Deprivation

Abstract. *A progressive decrease in frequencies in the alpha range was observed during 14-day exposure to unpatterned light and white noise. The electroencephalographic records were still abnormal 1 week later, and long-lasting motivational losses were observed.*

For several years researchers at the University of Manitoba have been studying the behavioral effects of 7-day periods of perceptual deprivation (*1*). Recently it was decided to extend the period to 2 weeks. It was considered important to obtain, first, some data on the electrical activity of the brain during isolation, particularly in the second week, as well as data for some days after termination of the period of isolation. Our report covers electroencephalographic changes in three individuals subjected to perceptual deprivation for this prolonged period.

Although there is a voluminous literature on the effects of sensory and perceptual deprivation, data on the electroencephalographic changes are almost nonexistent (*2*). In one of the McGill studies (*3*), electroencephalographic tracings for six subjects who were isolated from 3 to 6 days showed a progressive decrease in frequencies for the occipital lobe. Tracings taken 3½ hours after isolation still showed some signs of abnormality. Electroencephalographic records taken in the Manitoba studies also revealed a decrease in frequencies for the occipital lobe after 7 days of perceptual deprivation. These records showed that frequencies had not returned to normal 3 to 4 hours later (*4*). Finally, we have data on one subject isolated for 10 days. In this case the electroencephalographic activity was still abnormal 1 week after the end of isolation. It is of interest to note that this subject experienced a severe and long-lasting motivational loss (*1*). In the light of these meager but provocative findings, further research seemed warranted.

Three male subjects—two senior undergraduate students 21 and 22 years old, respectively, and a university professor 36 years old (subject C in Table 1)—were placed at different times in a dome-shaped isolation chamber for a period of 14 days. Toilet facilities, a food chamber, and an air-conditioning unit were provided within the chamber, making it unnecessary for the subject to leave for any reason during the isolation period. The only piece of furniture was an air mattress. Entrance to the chamber was through a double trapdoor in the floor, which also served as a food chamber. The behavior of the subjects was monitored at all times by means of an intercommunication and closed-circuit television system. The subject, wearing polo pajamas, lay on a mattress. He wore a pair of translucent goggles which reduced the level of ambient illumination from 90 to 20 ft-ca (under the goggles). He also wore a pair of special gloves to minimize tactual stimulation, and a set of earmuffs through which white noise, somewhat above the threshold of hearing, was constantly presented. He was not permitted to sing, hum, or engage in any other vocal activity. He was allowed to move about but not to exercise. Conversation over the intercommunication system was kept to a bare minimum; it occurred on the rare occasion when the subject did not adhere to certain restrictions, such as those against singing or humming. No psychological tests of any type were administered during the period of isolation. Each student was paid $300 for participating in the experiment. The professor was not paid. His incentive was scientific curiosity. There were no failures: the first three candidates selected successfully endured the prolonged isolation.

Electroencephalographic tracings were taken by an Offner type T, eight-channel machine. Records were taken before isolation and then during isolation at 7, 10, 12, and 14 days. At these specified times the electroencephalographer entered the chamber and attached a set of needle electrodes to the subject's skull. The entire intrusion lasted approximately 30 minutes. During this interval the white noise was shut off, but the subject continued to wear the goggles. Follow-up records were taken at 3 hours and at 1, 2, and 7 days after the end of the isolation period. In order to obtain a quantitative measure of the electroencephalographic changes, two types of analyses were

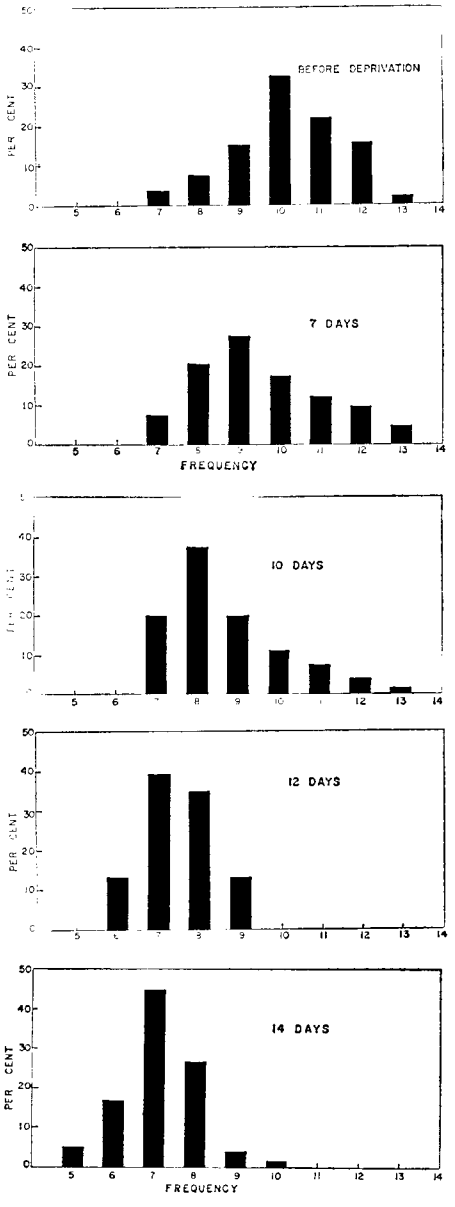

Fig. 1. Frequency spectrum for subject A before perceptual deprivation and at 7, 10, 12, and 14 days after the beginning of deprivation. The ordinate shows the percentage of time that waves of various frequencies appear in the occipital lobe tracings during a 300-second period.

made. In the first, the mean frequency for the occipital lobe was determined. This involved calculating the number of waves occurring in each of 300 1-second samples of artifact-free occipital lobe tracings. The second method involved a frequency spectrum analysis of the type suggested by Engel *et al.* (*5*). This consists of determining the percentage of time that a particular frequency (for example, 8, 9, or 10, waves per second) appears in the occipital lobe tracings during the total 300-second period.

Table 1 shows the mean occipital frequency for the subjects at various times during and after isolation. The picture is remarkably consistent for the three subjects. There is a progressive decrease in mean frequency during the course of isolation. This decrease, however, appears to have been more than twice as great during the second week as during the first. The postisolation records for the three subjects are also similar. They show a progressive increase in mean frequency during the first week after isolation. After 7 days the frequencies had still not returned to the pre-isolation levels; in all three cases they were within half a cycle of these levels. Figure 1 shows the changes in the frequency spectrum for subject A at various times during isolation. It can be seen that there is a progressive shift in the spectrum toward the lower end of the frequency scale. After isolation, as Fig. 2 indicates, this spectrum gradually shifts back to the higher frequencies. However, at the end of 7 days the frequency pattern is still unlike that for the pre-isolation period. The spectra for the other two subjects showed similar changes both during and after isolation.

Since subjects that have experienced isolation for 14 days are rare, some mention should be made of their subjective reactions. Data on these were obtained after isolation by means of a questionnaire, an interview, and diaries. Various precautions were taken to minimize the factor of suggestion. All three subjects reported intellectual deficits during isolation—inability to concentrate, difficulty in organizing their thoughts, and reduced motivation for thinking and reasoning. These deficits, contrary to what the electroencephalographic results suggest, did not appear to be accentuated during the second week. This discrepancy, however, may be due to the unreliability of the retrospective reports. Hallucinatory phenomena were almost totally lacking.

Table 1. Mean frequencies (waves per second) for the occipital lobe for three subjects at various times during and after 14 days of perceptual deprivation.

Subject	During deprivation					After deprivation			
	Day 0	Day 7	Day 10	Day 12	Day 14	Hour 3	Day 1	Day 2	Day 7
A	10.10	9.16	8.60	7.48	7.15	7.50	7.89	8.62	9.57
B	13.03	12.65	11.40	10.94	10.44	10.80	11.04	11.34	12.50
C*	11.56		10.14	8.84	8.00	9.00	10.21		11.01

*No encephalographic records were taken for this subject during day 7 of deprivation or on day 2 after deprivation.

One subject reported two instances of a "black dot racing across [his] field of vision." Another reported the occasional presence of "flickering pinpoints of light lasting from 10 to 15 seconds." All these occurred toward the end of the experimental period. Frequent references were made to repetitive auditory events noted throughout the entire 14-day period—birds chirping or singing, waves splashing, water dripping, and so on. These experiences, however, are believed to have been auditory illusions rather than hallucinations, since the subjects were not convinced of their reality and regarded them merely as distortions of the continually present white noise.

Upon emerging from isolation, none of the subjects reported any "profound and prolonged disturbances of visual perception" of the type mentioned in one of the McGill 6-day studies (*6*) (for example, warping and curving of lines, walls moving in and out, and gross changes in the size and shape of objects—effects which in some instances were present 24 hours later, as reported in the McGill study). Various objects were seen as much brighter and more vivid in color than usual, but they did not seem changed in size, shape, or movement. Although this absence of hallucinations and perceptual distortions is at variance with the McGill findings, the results are in agreement with those of the more recent 7-day deprivation experiments. In our earlier studies (*1*) and in studies of Ruff and Levy (*7*), hallucinations and postisolation perceptual distortions were rare. Furthermore, Cameron *et al.* (*8*) recently reported similar negative results in an individual subjected to perceptual deprivation for 16 days.

Certain dramatic and prolonged behavioral changes were observed, but they were of a motivational rather than a perceptual nature. After isolation, two of the subjects reported (in their diaries) severe motivational losses, which they described as "an inability to get started doing anything," a "loathing to do any work requiring even the slightest degree of physical or mental exertion," and "a don't-give-a-darn attitude toward everything." In one of the two subjects these symptoms lasted for 8 days; in the other, for 6 days. The third subject reported similar motivational losses but felt that he had completely recovered by the third day. It is interesting to note that the postisolation electroencephalographic record for this subject (C) was characterized by a greater initial degree of recovery than the records for the other two (see Table 1).

This study is based on a small

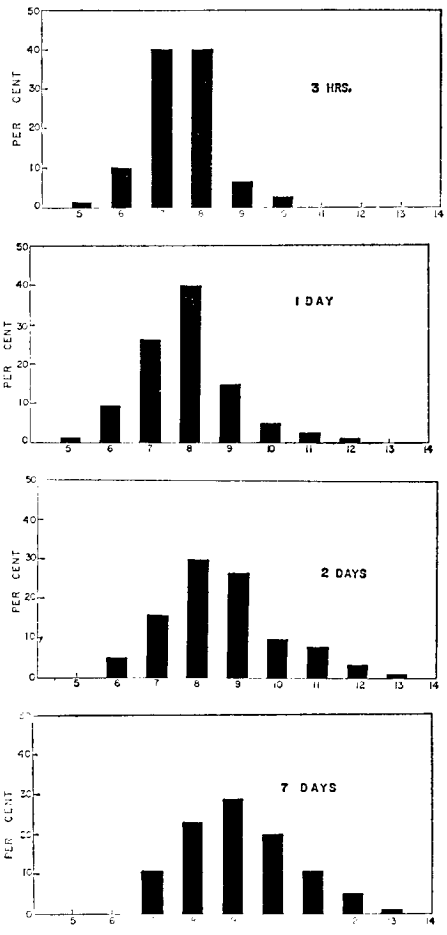

Fig. 2. Frequency spectrum for subject A at 3 hours and at 1, 2, and 7 days after the completion of 2 weeks of perceptual deprivation.

sample, it is true, but the results are remarkably consistent. They indicate that prolonged periods of perceptual deprivation can produce a considerable degree of disorganization of brain activity, with effects still discernible a week later. In the light of these results one can only wonder about the possible physiological and psychological state of prisoners of war and others who, in the past, have been isolated for months or even years (*9*).

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References and Notes

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