COGNITIVE EFFECTS OF A DECREASED VARIABILITY IN THE SENSORY ENVIRONMENT

W. Heron, W. H. Bexton, and D.O. Hebb

McGill University

This study began with the practical problem of the lapses of attention that may occur when a man must give close and prolonged attention to an environment in which nothing is happening, or in which the changes are very regular. Watching a radar screen, hour after hour, is a prime example. As Mackworth has shown in such circumstances, when at least something does happen the watcher may totally fail to respond. Such lapses of attention can have extremely serious consequences, in civilian occupations as well as military: in marine pilotage by radar, for example, or piloting aircraft on long flights. It is not unlikely, also that they may explain some railroad and automobile accidents that otherwise would remain inexplicable.

Besides its practical significance, this problem has theoretical implications of great interest. There is much evidence from recent neurophysiology to indicate that the normal functioning of the waking brain depends on its being continually exposed to sensory bombardment, which produces a continued "arousal reaction"; and work now being done by Sharpless indicates, further, that when stimulation does not occur it rapidly loses its power to maintain alertness. One function of a stimulus is to evoke a specific bit of behaviour; but it also has a nonspecific function, maintaining "arousal" in the brainstem reticular formation. In other words, the maintenance of normal, intelligent, adaptive behaviour requires a continually varied sensory input. The brain is not like a calculating machine operated by an electric motor, which is able to respond at once to its specific cues after lying idle indefinitely. Instead, it is like one that must be kept warmed up and working.

Thus the physiological evidence suggested that it would be worthwhile to examine cognitive functioning in the presence of a prolonged perceptual

isolation, as far as this is practical without injuring the subject. Bremer does it with cats by cutting the brain stem. College students are apt to object to brain operation, so we have had to be satisfied with a less extreme isolation from the environment.

Since our abstract was prepared we have carried the experiment farther in collaboration with Mr. T.H. Scott. This has modified the details of some of our results, but the main picture is unchanged. The subject in perceptual isolation for prolonged periods is subjectively disturbed, shows defects on some forms of problem-solving, and has usually more or less elaborate hallucinatory activity. Disturbance of function remains marked for several hours after emerging from isolation, and is subjectively reported for as long as 12 to 24 hours after emergence.

The method of isolation was as follows. The subjects were male college students. They were paid to stay in a quiet cubicle on a comfortable bed, 24 hours a day with time out only for eating and toileting. They wore goggles which prevented pattern vision, and cardboard cuffs, extending beyond the fingertips, which permitted free joint movement but little tactual perception. A small speaker system provided communication with the experimenter.

Our chief difficulty of course was the subject's boredom. The pay, $20 per day, was more than double what the students could hope to get at other occupations, but we still had difficulty getting them to continue for more than a day or two. The reason is obvious enough on a commonsense basis, for we all know that boredom is a genuine phenomenon. But psychologically its existence has not been recognized, and one of the most important results of the experiment may be to demonstrate that boredom is an important factor in human behaviour.

Our present concern, however, is with the cognitive disturbances during the period of isolation and immediately afterward. First: tests during isolation. The subject was given the following tests: multiplying 2- and 3-digit numbers, arithmetical problems, completion-of-number-series, making a word from jumbled letters, and making as many words as possible of 4 letters or more from the letters in a given word./ In our preliminary experiments the experimental subject was inferior to controls in both time and error scores on the arithmetical problems and the anagrams; subsequently, the differences we have found are significant only with errors in the

Control subjects were given the same series at tasks at the same intervals

second anagram task. In the other tests in the cubicle, the experimental subjects are still inferior to the controls, but not significantly, with our present small group of subjects.

Other tests were given just before entering the cubicle and immediately after leaving it. On the Kohs Block Test, and the Wechsler digit-symbol, the experimental subjects were inferior at the one percent level on leaving the cubicle. They were also inferior at the five percent level in time of copying a prose paragraph.((Slide) gives samples of the handwriting before and after the experiment. One is from a group showing the greatest effect, one is about at the average: some subjects showed little or no effect (except that the time for the group as a whole were slowed, as already noted)). This handwriting, and subjective reports, indicate that for two or more hours there is a marked disturbance of sensori-motor control. There were also reports of a mild nausea.

Finally there are the hallucinations reported by the subjects while in the experimental apparatus. Among our first subjects there were several who made reference, not very clear at first, to something that one subject called "having a dream while awake". Then one of us (Bexton) while serving as experimental subject observed the phenomenon itself and realized its peculiarity and extent.

Actually, the visual phenomena are quite similar to what has been described for mescal intoxication, and by Grey Walter recently as produced by exposure to flickering light. Also, there have been rare cases of hallucination in aged persons without any psychotic tendency, which like ours did not involve any special chemical or visual stimulation. In our first subjects we did not ask specifically about these phenomena, and we do not know how high the frequency was.

In the last fourteen the subject was asked to report any "visual imagery" they observed. It appears that the activity has a rather regular course of development from simple to complex. The first symptom is that the visual field, when the eyes are closed, changes from dark to a light color; next there are reports of dots of light, lines, or simple geometrical patterns. All 14 subjects reported such imagery, which in general was a new experience to them. The next step, reported by 11 subjects, is seeing something like

wallpaper patterns. Then comes isolated objects without background, reported by 7 out of 14, and finally integrated scenes usually containing dreamlike distortions, reported by 3 of the 14.

In general, the subjects were surprised by these phenomena, and then were amused or interested, waiting for what they would see next. Later, some subjects found them irritating, and complained that their vividness interfered with sleep. There was some, but not much, control over content; by "trying" the subject might see certain objects suggested by the experimenter, but not always as he intended: thus one subject, trying to visualize a tiger, saw an ashtray shaped like a tiger's head. The imagery usually disappeared when the subject was doing a complex task such as multiplying three-place numbers in his head, but not if he did physical exercises or talked to the experimenter.

We have not asked the subjects specifically about other kinds of imagery, in order not to put ideas in the subject's head. However, there were two reports of auditory imagery; one subject could hear talking by the people in his visual hallucinations, and another heard the playing of a music-box. There were also four subjects who reported kinesthetic and somesthetic phenomena. One reported seeing a miniature rocket ship discharging pellets that kept on striking his arm, and one reported reaching out to touch a doorknob he saw before him and felt an electric shock. Two subjects reported a phenomenon for which they found it difficult to provide words, but it was as if there were "two of me"-- two bodies side by side in the cubicle, and in one case these two bodies overlapped, partly occupying the same space. (Slide shows the subject's subsequent attempt to show what he meant in a drawing).

In addition there were reports of feelings of "otherness" and bodily "strangeness" in which it was hard to know exactly what the subject meant. One said "my mind seemed to be a ball of cotton-wool floating above my body", and one reported that his head felt detached from his body. These are familiar phenomena in certain cases of migraine, as described recently by Lippman, and earlier by Lewis Carroll in Alice in Wonderland. As Lippman points out, Lewis Carroll was a sufferer from migraine.