Sensory Deprivation and Hallucinations

What conditions of minimal or controlled sensory stimulation favor the generation of hallucinations?

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In 1954, investigators working in the psychology laboratories of D. O. Hebb at McGill University began studies on how man responds to conditions of drastically reduced sensory input. Since then many other investigations have been made as a result of that work. Some workers have called the experimental situation isolation, some have called it reduction in variability of sensory stimulation, others term it perceptual isolation, and others (including ourselves) call it sensory deprivation.

Of the many important and interesting results of the original work at McGill none was more dramatic than the discovery that the isolation conditions elicited vivid and elaborate visual hallucinations. Twenty-five of the 29 subjects experienced some form of hallucinating activity; the time of initial occurrence of these experiences ranged from 20 minutes to 70 hours after the beginning of confinement.

Confinement in the McGill work was in a small, lighted cubicle, where each subject wore a pair of translucent goggles through which brightness, but not form, discriminations could be made. The masking noise of an air conditioner was also continually present during confinement. The subjects were asked to remain in confinement as long as they could, and this was usually 2 or 3 days. During the confinement the subjects could communicate at will with the experimenter through a two-way speaker system. Food was brought in upon request. The experimenter led the subject to an adjacent room to satisfy toilet needs. In all, these interruptions took up 2 or 3 hours per day.

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The Princeton series of experiments on sensory deprivation began about a year after the appearance of the first published report of the McGill investigations. The confinement conditions used at McGill were not duplicated, since we hoped to provide an extension of, and not a repetition of, those studies. In our work the subjects were isolated in a dark, lightproof, soundproof cubicle. The confinement cell was only slightly larger than the extra-long single bed it contained. A "panic button" was located inside the cubicle by which the subject could demand an early release if confinement became unbearable, and subjects were paid $20 per day of confinement. Within limits, they did not know how long confinement was to last. We requested that they make themselves available for a block of 5 or 6 days; of this time we would use what was needed.

These were the general conditions of the sensory deprivation studies; variations of them or other special conditions, according to the particular study, are indicated below.

First Study

The first group of subjects, only four in number, were confined under the mildest conditions of sensory deprivation we have ever used. They had their meals brought in to them on schedule, and they ate by the illumination of a 15-watt red bulb. Each subject was confined for 48 hours; during this time the subjects were blindfolded and led to the toilet upon request. Their confinement was twice interrupted in order to conduct learning tests.

Not one of these subjects reported any visual hallucinations. We reason that the opportunity for good vision with form discrimination at meal times may have prevented hallucinations.

Second Study

In the second study the opportunity for sensory stimulation during confinement was reduced but not eliminated. Food was not brought into the cell but was stored there in advance of confinement. A food chest, stocked with sandwiches, soups, fruit, and water was available to the subject, and he ate *ad libitum* in total darkness. Toilet requirements were still a problem. Upon request, the subject was blindfolded and led down a long corridor to a toilet. There were usually about two such trips per day of confinement. We later learned that the blindfold was not entirely satisfactory and that minor light leaks occurred; at the time we considered this to be of little importance.

Of the 11 subjects confined under these conditions, nine completed 72 hours. Six of these nine subjects reported hallucinations. One subject experienced four different hallucinations, while the other five subjects reported experiencing two hallucinations apiece.

The reported hallucinations varied in content and complexity, and it was along these dimensions that we attempted to classify them. Type 1 hallucinations were defined as the simplest—those composed of flashing, flickering, and dim glowing lights which lacked shape or form and which appeared in the peripheral field of vision. Type 2 hallucinations were defined as having simple but definite shape, usually geometric in nature, and as occurring in the central visual field. Type 3 hallucinations were highly structured, integrated scenes containing many complex elements, movements, and so on, and more nearly resembled an ordinary visual experience.

Of the 14 hallucinations reported in this study, nine were of type 1 and five were of type 2; there were none of type 3. This finding is still somewhat in contrast to the results of most of the other investigations of sensory deprivation, where the reported hallucinations are of type 3 and of far greater frequency.

Of course, one of the major problems in this area is the adequate definition

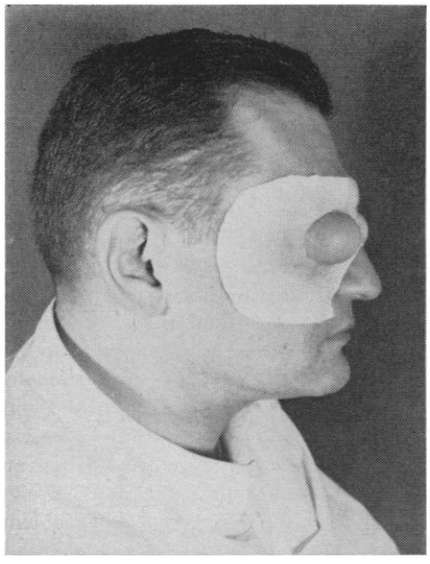

Fig. 1. Shaped ping-pong balls attached over a subject's eyes by mole skin.

of a hallucination as distinguished from vivid imagination, daydreams, hypnagogic visions, and so on. Our own attempt at a definition of hallucination led us to accept the following criteria: (i) it had to have an "out-thereness"; (ii) its content could not be controlled by the subject; (iii) its beginning or ending could not be controlled by the subject; (iv) it had to be scannable; and (v) ideally, it should "fool" the subject.

A consideration of the findings of the first two studies led us to believe that the severity of the conditions of confinement was important for the generation of hallucinations. Thus it was decided to further reduce the opportunity for sensory stimulation in the next study.

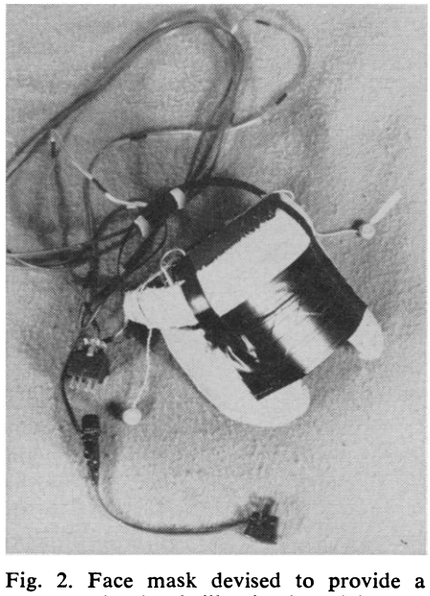

Fig. 2. Face mask devised to provide a constant level of illumination. The external insulation has been removed to show the construction of the mask. The arrow points to an ear phone.

Third Study

In order that confinement should not be interrupted, and so that there would be complete social isolation, toilet facilities were provided within the soundproof chamber. These toilet facilities consisted of relief bottles placed within the confinement cubicle and a chemical toilet placed just outside it but still within the dark, soundproof chamber. These two facilities were sealable, so that odor was not a problem, and they could be easily used in total darkness.

With the addition of the new toilet facilities it was possible to confine subjects in total darkness without any chance of light leaks and without any human contact, as well as under soundproof conditions. Needless to say, in none of our studies were subjects allowed to make sounds such as talking, singing, and so on. A monitoring system revealed whether the subjects adhered to these instructions.

Under these conditions, nine subjects were confined for 4 days each. Only one hallucination, and a doubtful one at that, was reported. This particular report came toward the end of a confinement. The subject was about to eat a sandwich when he noticed that its edge "glowed." (Since it was a lunchmeat sandwich it is probably just as well that he threw it away!)

Our findings up to this point indicated that we had made the wrong assumptions as to which factors underlie the hallucinatory activity of sensory deprivation. For, within limits, it now appears that, contrary to our initial premise, as the sensory impoverishment of the confinement increases, the likelihood of hallucinations decreases.

As shown in preceding paragraphs, our second study yielded more reports of hallucinations than either of the other two; moreover, the second study was the one in which the accidental light leaks occurred around the blindfold which was used when the subject was taken to the toilet. Not only in our own studies did the presence of illumination seem important for hallucinations; it was also important in the studies of others, such as the investigations at McGill, in which frequent hallucinations were reported. Therefore, we started another series of studies in which we utilized various kinds of visual stimulation.

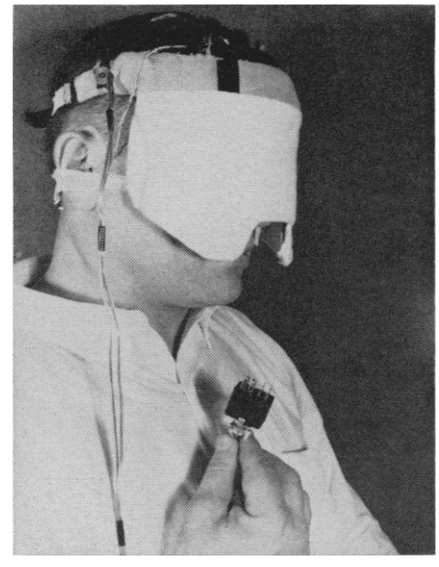

Fig. 3. Test subject wearing the face mask.

Fourth Study

We still felt that patterned illumination during sensory deprivation would inhibit the occurrence of hallucinations; otherwise, man in the everyday world might be plagued by them.

Instead of depending on accidental light leaks, with all their complications, we copied some of the McGill conditions. For example, we wanted a diffuse, homogeneous illumination which would not permit form discrimination. This we achieved by placing shaped ping-pong balls over the subjects' eyes, as indicated in Fig. 1. Illumination could be perceived through the celluloid hemispheres, but pattern vision was not possible. If the source of illumination had been fixed—say, in the ceiling of the cubicle—the intensity of the illumination would have varied as the subject's head moved. To eliminate this variability, the source of illumination was attached to a mask worn by the subject so that it moved with him and thus provided a constant level of illumination. Figures 2 and 3 show the arrangement of an illuminated panel attached to a welder's face mask which was fitted to the subject's head. The illuminated panel was made of Sylvania Panelescent material which provided a

Fig. 4. A posed picture showing a subject's position in the cubicle and the arrangement of food and water (the subject would not wear a wrist watch in an actual study). The microphone hanging from the ceiling is for monitoring.

uniform, dull, pale blue-green glow that filled the entire visual field. The only way the intensity of the stimulus could be varied was by the subject's closing his eyes.

The arrangements for eating were also changed at this point; the cubicle was stocked with jars of junior-grade baby food, bars of tropical chocolate, and water. A jar of food could be opened as it was needed, and thus the possibility of spoilage and the need for refrigeration were eliminated. It was even possible for the subjects to control the selection of their food, despite the darkness, because the jars were coded. Each jar had a plastic spoon taped to it. If the jar contained a main course, the handle of the spoon was down; if it contained a dessert or a fruit, the handle was up, as indicated in Fig. 4. These foods were bland, nutritious, and completely adequate for confinement conditions. It should be pointed out, however, that almost all the subjects lost weight. In some cases the loss was as much as 5 pounds in 2 days of confinement. The mean loss in weight was just under 3 pounds; this, oddly enough, did not correlate with the amount of food consumed.

Ten subjects were confined under these conditions for 48 hours each. All were as thoroughly informed about hallucinations as was possible. They were briefed on the criteria of hallucinations as well as on the relevant characteristics which they should attempt to report. In addition, we emphasized that there was no stigma attached to having hallucinations under conditions of sensory deprivation.

Of these ten subjects, two experienced hallucinations—in all cases, of type 3. One subject saw a "skyline" and "a cogwheel turning slowly," while the other subject saw "a floral wallpaper design," "a river with floating white balls," "an archway," and "a chapel." Each of these hallucinations was very brief, lasting less than a few seconds.

The remaining eight subjects experienced no hallucinations.

Fifth Study

Results of the fourth study were neither clearly negative nor clearly positive with respect to the occurrence of hallucinations. This was the first time that type 3 hallucinations had been reported in our studies, but, on the other hand, only two of the subjects experienced hallucinations at all. Our results up to this point clearly indicated that the conditions under which hallucinatory activity is maximum had not yet been found.

Another stimulus factor which was present in many other confinement studies in which frequent hallucinations were reported was monotonous sound. On the assumption that this added stimulation might in some way contribute to visual hallucinations, we next introduced sound along with the light stimulus.

As with the light, we attempted to present a sound stimulus which was constant. Thus, the sound was piped in to the subject through ear plugs of the hearing-aid type, which can be seen in Fig. 2. If the sound had been broadcast into the room from a fixed point, the subject would have been able to vary its intensity by moving his head. Our arrangement rendered the intensity of the sound stimulus constant, regardless of head position and movement. The sound stimulus used was thermal noise presented at 40 decibels above the subject's threshold for this kind of sound.

Eleven subjects were confined for 48 hours under these conditions of constant sound and light. None of them reported any visual hallucinations.

The tally of all our data up to this point is that, of 45 subjects, only nine experienced visual hallucinations. Clearly, then, we seemed to have made the wrong hypothesis regarding the conditions of sensory deprivation necessary for maximum occurrence of hallucinations.

Before turning to the next study, however, we want to report two interesting observations concerning the visual stimulus utilized in the fourth and fifth studies. All subjects reported that the light stimulus soon lost its blue-greenish color and became a dark gray, but oddly enough, the color was immediately restored with each blink of the eye. Once restored, however, it quickly seemed to fade again to a gray. Thus, the visual stimulus was not as constant as we had hoped it would be, and perhaps it is impossible to obtain complete constancy.

The second item of interest was the total absence of afterimages for all subjects. At the end of the confinement the illumination was extinguished and the subject was plunged into complete darkness. Normally, under these conditions, with a stimulus of this intensity and duration, afterimagery would have been very pronounced. However, such was not the case, although the subjects were specifically instructed to look for afterimages and did so for a considerable period of time.

Sixth Study

As shown earlier, the greatest frequency of hallucinations in our investigations occurred during the second study. In that study accidental light leaks were present, due to faulty blindfolds which were utilized twice each day of confinement. At first we thought the important feature was that nonpatterned vision occurred, but our findings now seemed to place importance upon the noncontinuous nature of the stimulus. Thus we decided to present a brief light stimulus which was amorphous, multicolored, and of low intensity. Obviously the rationale for some of these conditions was little better than hunch.

The visual stimulus was presented on a 30- by 30-inch panel on the wall at the foot of the subject's bed. The visual display was composed of smears and pieces of pastel-colored chalk, which became luminescent when illuminated by black light. When the panel was activated it appeared to have an amorphous tridimensionality which somewhat resembled a dark and distant starry sky. The starters for the black light were removed from the light fixture and placed outside the experimental chamber because they made a buzzing sound during operation.

Fig. 5. The headgear that holds the subject's microphone.

The subject no longer wore the mask of the previous study but was equipped with the headgear shown in Fig. 5. A microphone was placed in front of his mouth so that he might report hallucinations at the time of their occurrence.

Ten subjects were confined for 48 hours, during which time the panel was illuminated for at least two 1-second periods every 8 hours. Such a schedule could not be followed rigidly because the subject was often asleep when scheduled to receive the stimulus; nevertheless, the schedule was followed as closely as possible. (It was possible to determine when the subject was asleep by listening to his breathing sounds.)

Of the ten subjects in the sixth study, only one reported visual hallucinations. This particular subject not only had every possible variety of hallucination, but he also had an unbelievably large number of them. He made a total of 96 reports, reporting 18 hallucinations of type 3, 11 of type 2, and 12 of type 1, and reporting on 45 other occasions that "the level of illumination in the room has changed" when he was actually in total darkness. The great frequency of his reports seemed to be more an indication of a need to maintain contact with the outside world than a measure of hallucinatory activity.

In connection with the sixth study, several incidental findings are of interest. For one thing, almost all subjects in the sixth study had the strong impression that the visual panel was illuminated by a light from behind their heads. Actually, the source of illumination was immediately below the panel. These subjects did not *assume* that the illumination came from behind them but, as they reported, they seemed to "see" it as coming from behind them. We are at a loss to understand these reports.

The subjects did not know in advance that visual stimuli would be presented to them during confinement. At the first presentation a few subjects expressed doubt about the reality of their visual experience. With the continued presentation, they quickly became aware of the true nature of the stimulus. A subject usually verified his opinion by waving his hands before his face while the stimulus was on.

Auditory Hallucinations

Up to this point no mention has been made of the occurrence of auditory hallucinations, and for good reason. If the identification of visual hallucinations offers some complications, the situation is even worse for auditory hallucinations. The problem is that one can never be sure that the sounds heard are not real sounds rather than hallucinatory ones. It is never possible to be absolutely sure that no sound has reached the ears. Even in entirely soundproof quarters, where there is no possibility of hearing any external sound, one can still be auditorially stimulated by one's own breathing noises, pulse sounds, middle-ear muscles, and so on. In our sensory deprivation cubicle, which afforded 80-decibel sound attenuation, it was still possible to detect certain faint building and construction noises. Thus, when a subject reported "hearing" something there was always some possibility that the sound was real and not hallucinatory.

Nevertheless, there were still some reports of auditory phenomena which were of interest. There were no occurrences of elaborate auditory hallucinations such as "voices" or "music," but many subjects reported hearing "soft rain" or "soft rain on a tin roof."

These reports could not have been produced by real rain sounds because of the soundproofing of the cubicle, and besides, often no rain had fallen.

Many subjects reported hearing "muffled engine noises," such as truck engines. It may be that they expected to hear highway noises, since there is a highway near the laboratory. In the same vein, several subjects reported hearing "the school bells"; this again may have been more an expectation than an actuality.

As explained earlier, in the fifth study sound was constantly present during confinement. That sound had no effect upon these reports of auditory phenomena. It did not produce unique auditory hallucinations, and it did not terminate reports of the kind described above. We feel that the auditory phenomena were probably auditory illusions rather than hallucinations.

Conclusions

At this point in our studies of sensory deprivation we can only conclude that we have yet to ascertain the maximum conditions for the generation of hallucinations. In all of the attempts we have made so far we have failed to obtain the frequency of reported visual hallucinations found in the investigations of others.

We subjected 55 subjects to various degrees of sensory deprivation and found that only ten of them experienced visual hallucinations. These predominantly negative findings nevertheless lead to some positive statements about sensory deprivation and hallucinations. For example, it appears that absolutely maximum conditions of sensory deprivation do not elicit hallucinations. It also appears that neither continuous homogeneous nor momentary amorphous visual stimuli during sensory deprivation lead to hallucinations. However, because some hallucinations were reported in our studies, we may not assume that hallucinogenic factors were completely lacking. Our continuing program of research on sensory deprivation includes attempts to isolate these critical factors.

Science in the News

Space Communications: The Future Is Not Far Away, But the Major Policy Questions Are Unresolved

The Federal Communications Commission this week brought together a group of representatives of the communications industry and government agencies to begin exploring arrangements for development of an international satellite communications system. The direct issue, as put by John Finney in the New York *Times,* is "who shall sow and who shall reap the first big financial dividends of the space age . . . who shall own and operate a communications satellite system that would open up vast new channels of communications between all the nations of the world."

The FCC does not have the authority to give the definitive answers to these questions. They raise the question of the extent of government participation in the system that may be desirable or necessary, and at least the possibility of outright government ownership. The FCC must work under the assumption that the system will be privately owned. Any departure from this assumption would have to be made by the White House and Congress.

What the FCC tried to do this week was to make a start toward settling the conflicts among the segments of private industry and to lay the basis for industry representatives to get together and work up a proposal showing what industry feels it can accomplish.

The American Telephone and Telegraph Company has already asked for permission to go ahead with a plan for putting 20 satellites in orbit in order to have a commercial system for transatlantic communication in operation by 1964. A.T.&T. would pay for the satellites and the cost of putting them in orbit. But the Antitrust Division of the Justice Department has come out against any single company's dominating satellite communications, and the assumption behind the meeting this week was that a consortium of corporations in the international communications field should jointly manage any proposed system. But it is far from settled whether this will be the actual approach decided upon, and if it is, it is only an approach, providing only the framework for the answers, not the answers themselves, to the very complicated problems of how the system should be financed, controlled, and operated, and who should profit from it.

Time Factor

The great significance of the A.T.&T. proposal, with its operating target date of 1964, is the forceful reminder it offers of how quickly difficult decisions must be made if the United States is to take full advantage of the lead it holds over the Russians in the practical uses of space. This was again emphasized in Kennedy's inclusion, in his expanded space budget, of $50 million extra for fiscal 1962 to speed the development of communication satellites. This more than doubled the $44 million already requested, and a good part of this speeded-up spending is pointless unless we intend to make prompt use of the satellites once they are developed.

None of the development money would be spent specifically to set up an operating system, but the prototype satellites put up will be usable. The first of the Project Relay satellites, which will receive, amplify, and rebroadcast signals, is scheduled for mid-1962. It will travel in an elliptical orbit ranging from 1000 to 3000 miles above the earth, and will be in sight of stations on both shores of the Atlantic Ocean for 10 to 35 minutes out of an orbiting time of 180 minutes. Conditions will be right for transatlan-