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## Psychopathology of sleep deprivation : does it cause psychosis?

Eugene C. Hermanson  
*University of Nebraska Medical Center*

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THE PSYCHOPATHOLOGY OF SLEEP DEPRIVATION

--DOES IT CAUSE PSYCHOSIS?

Eugene C. Hermanson

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College of Medicine, University of Nebraska

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## THE PSYCHOPATHOLOGY OF SLEEP DEPRIVATION

### --DOES IT CAUSE PSYCHOSIS?

Introduction      The earliest comment in the literature on the effects of sleep deprivation was probably made by Andrew Dickson White, former president of Cornell University and professor of history. In speaking of people accused of witchcraft in the Middle Ages, he gives as accurate a description of the effects of sleep deprivation as anyone might give today: "One sort of treatment used for those accused of witchcraft was the 'tortura insomniae.' Of all things in brain disease, clam and regular sleep is most beneficial, yet under this practice, these half-crazed creatures were prevented night after night and day after day from sleeping, or even resting. In this way, a temporary delusion became chronic insanity. Mild cases became violent, and torture and death ensued." (1)

It may appear at first that devising a test for causing sleeplessness and determining whether or not psychopathology occurs in sleep deprivation would be most obvious--one merely would keep the subject awake as long as desired.

However, as Kleitman discovered, it is well nigh impossible to obtain sleeplessness alone. His original intention was to have subjects spend those hours normally occupied by sleep in bed, but awake. He found this could not be done past about 36 hours, without resorting to physical activity on the part of the subject. (2)

For this reason, any test procedure for sleeplessness of necessity includes excessively long, nearly continuous amounts of activity. Therefore, it was deemed pertinent to include physical examination and biochemical test data when available.

Only one author reports before 1900, and no further work emerged until 1922; early work emphasized physical changes. The early classic in the literature was written by Nathaniel Kleitman.

Early investigators were loath to label changes as "psychotic," but after the resurgence of interest surrounding "germ warfare confessions" in the Korean conflict, most authors will now tag subjects with the label of "temporary psychosis." It is further agreed that probably everyone will become psychotic if deprived of sleep long enough -- notwithstanding the young man who

claimed 270 hours of wakefulness in a recent Life Magazine article.

The onset and development of symptoms are fairly typical, as we shall see.

History The earliest recorded work on this topic was done by Patrick and Gilbert in 1896. They kept three students awake for 90 hours and found decreases in sensory acuity, reaction time, motor speed, and memorizing ability; in one subject, "hallucinations" occurred. (3)

It would appear that no work was done in the next 26 years.

In 1922, Robinson and Herrmann had three subjects stay awake for 65 hours and could find absolutely no changes in pre- and post-deprivation performance. Areas tested included steadiness, accuracy of aiming, muscle strength, ability to name letters, and mental arithmetic. (4)

That same year Robinson and Richardson-Robinson could likewise detect no difference in the performance ability

on the Army Alpha Test taken by an entire class of students who had been kept awake for 24 hours and were compared with a control group which had had the usual amount of sleep. The lack of observable effect in the sleepless group was ascribed by the authors to the extra amount of effort put forth, which was sufficient to compensate for any deficiency which might have been present. (5)

In 1923, Rakestraw and Whittier kept eight "normal men" awake for 48 hours. They could find no consistent alteration in any of the many biochemical tests they performed on the subjects, with the possible exception of an increase in the blood lactic acid. (6)

Herz, in 1923, using himself as a subject, underwent 80 hours of wakefulness. It was impossible to detect any deviations from normal in function, except possibly an increase in the number of the polymorphonuclear neutrophile leucocytes. (7)

However, in 1924, Laslett found little change in the performance of various tests at 50 hours, but much poorer performance at 72 hours. (8, 9)

Two years later, Laird attempted to determine the effect of the loss of a night's sleep on the performance of five subjects. He stated, "Both quantity and quality, especially the latter, are adversely affected by the loss of a night's sleep." (10)

Kroetz carefully studied the urine and blood of two subjects, each kept awake on two occasions for periods varying from 52 to 80 hours, and could find only indications of increased blood and urine alkalinity. (11)

In 1930, Weiskotten stayed awake for 62 hours. This was preceded and followed by a week of control observation. Testing for memory, speed, and accuracy, he found that attentiveness and rapidity suffered more than accuracy, and that it was not until the middle of the second night of wakefulness that deterioration of performance set in. He concluded that "Loss of sleep does not seem to affect either the mental or physical powers to any appreciable degree unless continued to great length." (12)

Weiskotten and Ferguson later kept three subjects awake for 62 hours, with the same results. Emphasizing the fatigue factor in sleeplessness, they ascribed the poor performance to a decrease in attentiveness and concentration ability. (13)



In 1931, Miles and Laslett showed how close subjects are to the sleeping state, even when still ostensibly awake, by photographing the eye movements of five colleagues who stayed awake for 66 hours. (14)

The next year, Freeman investigated the effect of curtailed sleep on himself and his wife for 28 consecutive days. He systematically varied the amount of sleep to include periods each of 4, 6, 8, and 10 hours. Measuring memory span, he found no consistent variation in performance. However, both subjects became "so cantankerous they had to forgo social functions." (15)

Cooperman and others in 1934 studied six subjects who had experienced a period of prolonged sleep deprivation, and found that although cutaneous sensitivity to touch remained unchanged, pain showed progressively lower thresholds. In the latter part of the experiment, they likened the subjects' general behaviour and reactivity to those of persons under the influence of large doses of alcohol (such as 1 cc per Kg of body weight). (16)

However, such doses of alcohol are known to increase the threshold of pain with likewise no change in sensitivity to touch as described by Mullin and Luckhardt. (17)

In 1935, Katz and Landis were approached by a young man 24 years of age who offered to be a subject for their experiments in sleep deprivation. He was certain that sleep was only a habit which could be broken without any ill effects. For the experiment, he was given a time clock to punch every ten minutes, as proof of being awake. He remained "awake" for 231 hours. The total amount of ten- to thirty-minute sleep periods was only 5.25 hours. Although no physical changes were observed, his typing speed decreased. On the fourth day he had frank hallucinations. As time went on, he became more confused and irrational, didn't know where he was, and accused observers of attempting to ruin the experiment. He developed delusions of persecution and eventually became so unmanageable that the experiment had to be discontinued.

It would appear that the subject became somewhat psychotic. It is hard, however, to evaluate these results,

because it is not known how many periods of sleep shorter than ten minutes he took, but it did show that a person can remain "practically awake" for nearly ten days without any deleterious physical effects. Up until then, that was the longest anyone had been recorded staying awake. (18)

In 1939, Blake and Kleitman recorded an EEG pattern on Kleitman himself after he had been awake for over 100 hours. While the subject was lying down, Delta waves predominated, even when he was talking, and disappeared only when he made an extreme effort to concentrate. It would appear that the subject was having microsleeps, although he was never actually aware of having been asleep, and answered every question that he heard (though it sometimes took a strong auditory stimulus to get him to respond.) To check the maximum duration of wakefulness, the subject was asked to count as long as he could. This took a great amount of concentration on his part, and immediate changes in the EEG from a Delta rhythm to a discharge of Beta waves took place. Even with this effort, he would lose consciousness at a count between three and ten, and in a few seconds, the Delta waves were again predominant. (19)

Nathaniel Kleitman The classic in the field of sleep was written by Kleitman, who probably did the greatest amount of early work. He used 35 subjects (all men but two, and mostly students) in 60 separate periods of sleeplessness between 1922 and 1939.

His original intention was to try to maintain the routine of living in everything but sleep. Subjects would undress and go to bed at the usual time, but were asked to remain awake throughout the night. This could sometimes be done during the first night but was entirely impossible the second, without resorting to some sort of muscular activity, even just talking. Thus he ended up studying loss of sleep as well as the effect of almost uninterrupted muscular activity.

Although there were subjective differences in the sleepless subjects, many features were common. Each subject could usually get through the first night without feeling very tired or sleepy. He could do sedentary work without close supervision. There was usually an attack of drowsiness between 3:00 and 6:00 a.m. accompanied by itching of the eyes, and the subject often saw double. The next morning, the subject felt as usual except for a

slight malaise which always appeared on sitting down or resting, and he was likely to forget he had had a sleepless night if he occupied himself.

Throughout the second night, the subject's condition was entirely different. His eyes itched and felt dry, and this sensation could only be abolished by closing the eyes, which made it very difficult to remain awake even while walking. Reading or study usually resulted in sleep. During the second day, the subject could do routine laboratory work as usual, as long as he did not sit down, but attending lectures, and particularly taking notes, usually ended in failure. After a few words had been written correctly, the hand would begin to slip and unintelligible scribbling resulted. A new effort would lead to only short lasting improvement of writing. At times, the pencil even fell out of the subject's hand. All efforts of this type could only be sustained for a short time. The subject often could not count his own pulse beyond 15 or 20, but began dozing.

As the third night resembled the second, and the fourth resembled the third, the author adopted a standard procedure of a waking period of 62 to 65 hours, as at the end of that time, the

individual was thought to be as sleepy as he was likely to get. Objectively, the appearance of the sleepless person seemed quite normal, particularly during the daytime while he was engaged in some form of muscular activity. However, sitting down would render him extremely sleepy, and after closing his eyelids merely to relieve the itching, subject would be found asleep. Subjects often pretended to leave the room so as to have more room to walk, but in a minute or so would be found seated and fast asleep. On being aroused, they would often vehemently deny having been asleep and would show extreme resentment at being distrusted. This hyperirritability could be banished by having the subject walk briskly for a few minutes, but would soon return. The most mild-mannered person became ill-tempered under continued attempts to keep him awake.

Another feature was the irrationality of action which Patrick and Gilbert termed hallucinations but which Kleitman called "semi-dreaming." In doing his work, the subject would often make remarks which were not appropriate to the situation; and when questioned, he would report the impression that he and

the watcher had been discussing the subject, which was not true. The subject would then conclude that he had been dreaming, although he appeared to be awake and was engaged in some form of activity.

During the 17-year period in which he did his work, Kleitman also recorded heart rate, body temperature, basal metabolism, appetite, blood and urine composition, red and white blood cell counts, and was unable to find any consistent variation. (20)

1940-1949 In 1941, Edwards reported on the basis of 100 hours of sleep deprivation on himself. Dozing, irritability, impairment of concentration and attention, difficulty in maintaining equilibrium, increasing restlessness, indifference, desire to be left alone, illusions, and hallucinations were experienced. Of 17 patients he investigated, ten had difficulty remembering what they had said or done in the previous five to thirty minutes. Seven experienced definite hallucinations (three more had questionable ones). Five had illusions. (21)

In 1945, Zobel-Nacca stated that the most characteristic thing about his subjects was that they resembled "heavily drunken" people. (22)

In 1946, Tyler and his associates reported on 350 subjects kept awake under close supervision for periods up to 112 hours. He was unable to find any blood constituent changes, including the excretion of 17 ketosteroids. He noted also that with prolonged wakefulness there was an electroencephalographic decrease of Alpha activity with an increase in faster activity. He grouped the psychological changes into psychoneurotic reactions, schizophrenic-like reactions, and paranoid reactions. (23)

In 1946, Rothman and associates also reported that illusions and hallucinations commonly appeared after 36 to 50 hours of wakefulness, and stated that they coincided with an increase in high frequency, low amplitude waves on the electroencephalogram. (24)

That same year, Tyler and others also reported no significant changes in diurnal rhythm or concentrations of adreno-cortical activity. (25)

In 1947, Tyler and others confirmed the previous changes in electroencephalographic findings. (26)



1950-1959 In 1953, Henry P. McLaughlin served as consultant to the Surgeon General, U. S. Army, and investigated the reasons for "confessions" and "changes of faith" that the Communists obtained from military personnel in Korea. He concluded that fatigue, exhaustion, and sleep deprivation played a major role in results achieved through prisoner treatment as developed and used in Iron Curtain countries. He felt that sleep deprivation was an essential part of "brainwashing" and drew the following conclusions:

- 1) All persons will suffer untoward effects from sleep deprivation though his awareness of these may be lacking.
- 2) The amount of change required for clinical detection varies with the individual.
- 3) Exhaustion is likely to have contributions from both physical and emotional areas.
- 4) Though the effects are cumulative, there is usually substantial recovery with rest in a relatively short time period.
- 5) One may anticipate the onset of a schizophrenic-like reaction or hypnagogic state in the majority of persons where sleep deprivation continues for a sufficient period.

The author called for further investigation in this area, as he feels there are important military, political, security, and psychiatric implications. (27)

In 1954, Lehmann and Koranyi found that depriving six chronic schizophrenics of sleep for 100 hours caused their reversion to acute symptoms which had not been present for several years. (28)

That same year, Ax and others tested 43 normal subjects after 24 hours of wakefulness. He found that low-motivating tasks produced a marked deterioration in performance, whereas high-motivating tasks were performed without decrement. He interpreted this as indicating that moderate sleep deprivation lowered the "internal drive state" but that this may be compensated for temporarily by increased external motivation. (29)

In 1955, Tyler reported alone on studies made on volunteers from Army, Marine Corps, and civilian public services. Subjects ranged in age from 17 to 35 and were free to drop out at any time without any reflection on their military records. No effort was made to induce people to continue. There was, however, considerable motivation for volunteering. The subjects were all the object of admiration of non-participating men in the camp, and morale was excellent. All were cooperative and sympathetic with the purpose of the study.

Twenty-two per cent of the men did not complete the experiment. The period of highest incidence of quitting was between the 20th and the 48th hours. (Forty per cent of those who quit did so because they were required to, when they showed some symptom of illness, such as fever, a cold, or grossly psychotic behaviour.) Nineteen of the men who quit did so because they thought the experiment might harm them, a number of these being concerned that they might lose the ability to ever sleep properly again. Others thought they might lose their minds.

It was pointed out to some of the subjects who dropped out in the first 24 hours that it was not unusual for them to stay up all night on parties, in some cases for periods longer than the time they had gone without sleep. They usually gave vague answers, implying that the situations were different. It appears that a substantial number of those who dropped out early in the experiment developed unreasonable fears of continuing longer (delusions?).

With a very few exceptions, there seemed to be no physical basis for the symptoms the patients described. The most

frequent complaints were headaches, "tight feeling" in head, "head hurts but it is not like a headache." It should, however, be noted that headaches were not uncommon complaints in those who finished the experiment. Next in frequency were gastrointestinal complaints, loss of appetite (not confirmed by observers at mealtimes) stomach ache, diarrhea, and constipation. Least frequent were dizziness and feeling faint. Illusions, delusions, and hallucinations usually started after 40 hours. Seventy per cent complained of auditory or visual aberrations. In the great majority, these occurred periodically, and as in most cases the patients were aware that they were hearing or seeing things that did not exist, they could not be classified as true hallucinations.

The most common illusions and hallucinations concerned females. The next most common involved animals or animal sounds. Four men experienced aberrations that were true hallucinations and for this reason were dropped from the experiment. One insisted his mother and girlfriend were watching him and demanded they be sent home. Another claimed women were being used as examiners and demanded they be discharged. One

man constantly heard dogs barking; another began conversing with some unseen person.

Disturbance in thinking was common to all subjects after the second night. There was some loss of memory, but this was primarily for recent events during the experiment. However, comparison of Rorschach taken prior to the experiment and again after 100 hours of wakefulness showed no changes. There were three cases, however, in which subjects being examined during a test situation exhibited persistence in repeating an answer which had been given to a previous question. On the other hand, disturbances in thought processes were more apparent outside the test situation during spontaneous conversation. Very common were rambling, garrulous speech with little coherent structure or logical connection among the many ideas often covered in a few minutes' conversation. Frequently there was difficulty in answering simple questions, and answers were inappropriate. These disturbances in thinking occurred more frequently at night and lasted for short periods until the subject became aware of his wandering thoughts. The phenomenon was related to recurrent periods of extreme difficulty in keeping awake. Inappropriate, silly laughter occurred often, usually

during some task situation; and on questioning, the subject either did not know that he had laughed, or he replied that he was thinking of a funny situation which on inspection did not seem funny enough to provoke the reaction.

It was difficult to observe changes in emotional response because of the general euphoria among the subjects. An outsider, viewing the men for the first time during the fourth day, might not have been able to detect behaviour differences from fresh, rested men. This was particularly true as the subjects were always ready to show off for strangers.

Frequently, men also walked into obstacles, fell, or walked up or down steps that did not exist, apparently with their eyes open. However, during the test situation, no changes were found in visual acuity, depth perception, distance judgment or other tests of vision. This seems to indicate that hallucinations or at least illusions were common.

In several of the subjects, reactions occurred resembling acute schizophrenia of the paranoid type, such as delusions of grandeur, persecution, hallucinations, and unprovoked aggressiveness. One subject, at 46 hours, walked off and then started

an unprovoked fight with an officer, and after rest was ashamed of his behaviour. All these subjects were considered well adjusted and had no previous history of unusual behaviour.

The author concludes that after approximately 40 hours of sleep deprivation, there occurs in all subjects psychotic-like reactions. In the majority of the subjects, the symptoms are mild, in some they are severe, resembling a psychotic state. In all subjects, symptoms disappear after sleep and rest. (30)

In 1955, Bredland found significant impairment of activities requiring the most concentration and attention after periods of sleep deprivation up to 36 hours. (31)

In contrast to this, in 1956, P. O. O'Reilly, using the Roschach, concluded that sleep-deprived subjects have been able to perform normally on specific tests designed to measure work capacity, psychomotor performance, intellectual acumen, and personality structure. (32)

That same year, Hinkle and Wolff, writing on "communist interrogation and indoctrination methods" concluded that in "police states" sleep deprivation can induce personality disorganization; and so inquisitors have long recognized that

enforced wakefulness, emotional turmoil, and physical isolation may lead to psychotic behaviour. These observations, they felt, "have been generally overlooked by the psychiatrists."  
(33)

Rioch that same year confirmed the finding of previous investigators that no significant change in adreno-cortical activity could be demonstrated, although others have suggested that teliologically this should not be so, if only on the basis of the stressful situation involved. (34)

In 1957, Clark and Bliss noted that subjects who previously tolerated .5 micrograms of LSD-25 with no ill effects developed hallucinations on the same dosage after sleep deprivation. They specifically emphasize the fact that previously the same dose had not been hallucinogenic, and state that .5 micrograms combined with sleep deprivation resulted in severer reactions than 1 microgram of the drug in a rested state. They concluded that sleep deprivation enhanced the disruptive effects of LSD-25 upon ego function. (35)

In 1957, West and others stated that in the case of certain prisoners of war returning following the Korean conflict, extensive psychological effects of chronic sleep loss



could be inferred. In some cases, reality testing eventually became severely impaired, and false confessions of germ warfare were obtained from flyers who were actually psychotic at the time the confessions were signed, after weeks or even months of insufficient sleep. Usually, rapid recovery followed adequate sleep, with reintegration of ego function, including repression. Frequently, however, the victim could not account for his behaviour, so complex rationalizations were evolved. (36)

As late as 1956, Hauty and Payne reported that "subjective attitude (appearance, mood, and behaviour) is the only factor severely affected by sleep reduction." (37) However, Morris and others have shown differently, and we will report on his study in some detail.

In 1956 and 1957, Morris and others, using conscientious objectors as subjects, ran two studies, the first including 24 subjects, the second, 50. In each case half the subjects were used as controls. The general procedure reflected the authors' aim to provide a non-coercive atmosphere with a minimum of exhausting heavy physical work. The subjects lived in a ward, rooms were equipped with a variety of games and amusement

devices, and food and coffee were always available. A 24-hour watch was maintained with emphasis on "gentle and sympathetic persuasion." (If a subject became drowsy, he was taken for a walk, given a shower, etc.)

In both experiments, there were several eleven-day cycles. A four-day baseline was obtained, followed by 72 to 96 hours sleep loss, followed by three to four days' recovery. Subjects were tested throughout each day with psychological and physiological tests. In both studies, three interviews were obtained, one during the baseline period, two during the sleep deprivation period. Interviews were taped and later evaluated

on the basis of

- 1) visual misperception
- 2) temporal disorientation
- 3) cognitive disorganization
- 4) tactual misperception
- 5) disorientation for space, objects, and persons.

The most frequent subjective changes reported were in perception. These were sometimes so extreme as to be hallucinations. These perceptual aberrations seemed to follow a course similar to that of performance, appearing sporadically during periods of extreme drowsiness, and increasing in frequency, duration, and intensity, with increasing sleep loss.

After 30 hours, all subjects reported itching and burning around their eyes and many complained of blurred vision, diplopia, and effort involved in seeing. Double images were more noticeable when subjects were required to look at small objects for any period of time. Visual illusions never became more pronounced in some subjects.

However, by 40 to 60 hours of sleep loss, several subjects reported short periods of gross visual distortion showing impairment in depth perception, size, shape, position, and texture. Some experienced micropsia or macropsia. For others, stationary objects suddenly appeared to move.

By 65 to 90 hours, some subjects showed a large degree of disorientation concerning the reality of these misperceptions. One subject, on noticing cobwebs covering his hands and face (which he could both see and feel), tried repeatedly to wash them off and even later stoutly maintained that they had been there. This was classified as a hallucination, though the authors raised the question whether these "hallucinations" were severe forms of illusions. It was also found that a correlation existed between experiencing dreams during sleep lapses and experiencing hallucinations later in the experiment. Temporal

orientation progressively deteriorated with progression of sleep loss. Cognitive disorganization was said to be related to the subject's inability to maintain a continuous sequence of mental operation, the discontinuity being related to brief dreams or intrusive thoughts. Subjects increasingly avoided intellectual effort with progressive sleep loss.

The most remarkable tactual misperception revolved around the "hat" illusion which was apparently a band of pressure around the head. About 20% of the subjects reported this illusion and most were often observed trying to remove the hat.

A few reported feelings suggesting depersonalization. One subject said, "I just don't feel like the person I should be, I feel like a different person, altogether different. I thought perhaps I might be somebody else, so I asked my buddies, and they said I was just myself."

Only three of the areas evaluated (visual misperception, temporal disorientation, and cognitive disorganization) showed a statistically significant increase during sleep loss, just short of the 5% level of significance. The authors therefore suggested that these three kinds of misperception were linked by some

common factor. The authors concluded that hallucinations develop out of illusions and dreams, and that we ordinarily avoid hallucinations by logical analysis, but that the subjects were suffering from increasing numbers of deepening "lapses," during which attention, perceptual frames of reference, temporal continuity, and perhaps cognitive processes were impaired. They suggest that during sleep loss perceptual thresholds are raised, causing the subject to fail to respond to external stimuli, with increasingly frequent lapses, the process of logical analysis is broken up, and in extreme cases, subjects lose contact with reality. (38)

In 1957, Gieseck observed a large group of subjects deprived of sleep for 96 hours. He found very little personality changes up to 72 hours. Thereafter, various hypnogogic phenomena occurred. Hallucinations were noted. He concluded that as the period of sleep deprivation increased, the major change in psychological function seen in all was the deterioration in the maintenance of vigilance. Previously well learned tasks and new, attention-holding tasks were well performed, whereas those between these extremes showed definite deterioration. (39)

In 1957, Brauchi and West observed two men who remained awake over 168 hours. The setting was a radio broadcast marathon, and the subjects were competing for a \$500 prize. Guards were present at all times to observe whether either contestant fell asleep, and the contestants were examined twice a day by a doctor. After the fourth day, each received five mg. of dextroamphetamine twice a day and both drank large amounts of coffee.

One of the contestants specifically was studied by the authors. After the fourth day, he began to suffer memory lapses and thought that various parts of his equipment were in different cities. These occurred at frequently increasing intervals until the contest was stopped. His broadcasting performance, however, was not impaired at first by memory lapses.

At one point, he opened the door of a refrigerator to "assist a lady into her car." He developed a feeling of persecution and thought he was being punished by being made to stay awake. During the last two days, both contestants were increasingly disorganized and often delusional, and the broadcast became confused, disorganized, and rambling. Auditory

and visual hallucinations became increasingly frequent, and at one time a period of folie a deux took place in which the hallucinations of one contestant were accepted by the other.

Because of the progressive psychotic behaviour, the contest was finally stopped and both contestants were taken to a local hospital. The subject studied ran out of the hospital door and was found four hours later, wandering about the town -- an episode for which he still has no memory. After a week's hospitalization, he signed out and spent the next week driving around the countryside.

After this, he returned to work, but continued to have memory lapses similar to those during the contest. He was noted to have marked personality changes, and his thinking eventually became bizarre. He developed the delusion that he was responsible for the Suez Canal crisis and his personal and financial affairs showed poor judgment.

Eventually, he became so disorganized that he was admitted to a Veterans Hospital. At that time, he was found to be oriented in all spheres, however, but he was showing memory

lapses for the previous two or three days. He showed marked anxiety and apprehension that his feelings of depersonalization and derealization might recur. In the hospital he received psychotherapy twice a week, as well as occupational, recreational, and group therapy. After four months, he was discharged, has returned to work, and has been in good health since.

This was the first instance found where personality changes of a more permanent nature resulted. The authors concluded that acute prolonged sleep deprivation inevitably produces a delirious reaction in which contact with the environment becomes progressively impaired and possible latent psychopathological trends become exaggerated. This may contribute to the emergence of significant psychopathology in persons whose personality integration might have been sustained if normal amounts of sleep were provided. (40)

In 1958, Murray and others confirmed Kleitman's previous findings of increased generalized irritability and the necessity for mobilizing much greater attention in order to perform ordinary tasks. He reported also, however, that body temperature was inversely related to feelings of somnolence. (41)



In 1959, Rioch confirmed Williams' findings that the gross personality changes occurred after a 72-hour period of sleep deprivation and noted in his study fleeing hallucinations. He also confirmed that the major change in function was the maintenance of vigilance. (42)

In 1959, Bliss and others suggested that in certain patients sleep deprivation might precipitate some schizophrenic illnesses. Two cases were cited. The first was a woman who remained sleepless at the side of her dying son. After this, she was unable to sleep for a total of 90 hours and became grossly psychotic. However, she was treated with electroshock therapy and recovered.

The second subject found himself deeply involved in local politics, and after three weeks of about two hours' sleep per night, culminating in four days of complete sleeplessness, became totally psychotic. He was diagnosed as schizophrenic, treated with chlorpromazine, and recovered.

In the authors' study, seven medical students stayed awake for 72 hours, motivated by a progressive pay scale, and various psychological tests were administered. It was found that

subjects could handle brief psychological tests adequately; however, they developed a variety of psychologic disturbances during the intervening period, including depersonalization, confusion, hallucinations. It was the authors' opinion that none of the subjects became actually psychotic; but the authors inferred that if these changes were to occur in someone who was profoundly anxious and deprived of group support, a frank psychosis might result.

In another study, the same authors showed that the effect of LSD-25 was considerably enhanced by sleep loss and suggested that sleep loss might make the cortex more susceptible to the hallucinogenic properties of the drug. (43)

In 1959, Brodie suggested that sympathetic activation was characteristic of the early phase of sleep deprivation, and that enforced wakefulness does not allow the organism to shift to the parasympathetic energy restorative mechanism, thus resulting in a severe depletion of high energy phosphate formation and the resulting diminished central sympathetic responsiveness. (44)

The same year, Williams and others investigated performance on psychological tests in great detail and interpreted

psychopathology and performance deficits to be within the framework of the 'lapse' hypothesis. They define a 'lapse' as "a period of no response accompanied by extreme drowsiness and a decline in the EEG Alpha amplitude." During a lapse period, external sensory input is said to be cut off and responses occur only to internal stimuli. (45)

The same year, West and others observed a radio entertainer (not the one referred to previously) who remained awake for more than eight days and eight nights. They described a prodromal period during the first four to five days without sleep, characterized by progressive drowsiness and lapses of awareness (which they called 'microsleeps') which last only two to three seconds and may be overlooked by observers. During 'microsleeps' the EEG shows a burst of large, slow, three- to five-per-second waves which the authors felt suggested a tiny fit or seizure of sleep.

The symptoms are said to always be worse during the period of time the subject would normally be asleep. Gross hand tremors appear at about 72 hours. Illusions and bodily sensations of various types grow as the prodrome develops. They also describe the "hat" effect.

In brief, emergencies are well handled, and well learned semi-automatic performance holds up very well; but as previously mentioned, tasks falling between these two extremes are poorly performed. Attention span shortens, intrusive thoughts become more and more prominent, and fleeting hallucinations of two types begin to occur.

The first type is described as being high-frequency, rhythmical movements of stationary objects, and later, patterned forms, grillworks, networks, cobwebs, geometric designs. The second type is described as brief, dreamlike experiences, in which total situations are perceived and reacted to. There is a decreased interest in the outside world and a tendency to withdraw.

Prodromal symptoms are at first worse at night, but as sleep deprivation continues, become more noticeable during the daytime. The psychotic syndrome is said to become obvious about the fifth night when gross disturbances in reality testing persist for an increasing time. Prodromal changes become more marked. Hallucinations become prolonged and vivid, with less insight existing as to their nature, and often

meaning is given them that demonstrates a growing paranoid flavor.

The authors have dubbed the facies of a subject undergoing prolonged sleep deprivation "the Mindzenti look" after the pictures taken of that well known Cardinal at his trial where he publicly confessed to being a spy. As sleep deprivation goes on, periods of overt confusion and clouding of consciousness are seen. Disorganization becomes more frequent and prolonged, first for time, then place, then person, and finally self. Increasingly apparent is delusional thinking, usually paranoid.

At night, the subject resembles a case of toxic delirium, with gross psychotic episodes occurring at 90- to 120-minute intervals, with the same periodicity of dreams (which, the authors postulate, these episodes replace).

By day, it is described as resembling a case of paranoid schizophrenia of the reactive type with increasing intensity of suspiciousness, emotional lability, delusions of grandeur, and persecution.

During recovery, the subject is likely to sleep 12 to 15 hours. Dreaming occurs very quickly and surprisingly often. The authors postulate that the subject may be catching up on his dreams as well as on his sleep, and that dreams serve a necessary protective function, i. e., prevention of psychoses. After the first sleep, psychotic behaviour is not usually apparent; however, performance may be impaired for a week or ten days. (46)

1960 to the Present      In 1960, Luby and others studied a radio announcer planning to exceed the previous record of 212 hours of wakefulness. They found that during the first three days there were no significant behavioural changes. After 72 hours, irritability became prominent. After 100 hours, his mood and motor activity changed suddenly and he became expansive, hyperactive, grandiose, but attributed his new-found enthusiasm to the refusal to eat a bowl of soup prepared for him by a woman whom he accused of trying to overprotect him.

He then became hostile toward all women, expressing feelings of independence. That evening, while on the air, he challenged all the disc jockeys in the country to compete

with him in a gigantic "wake-a-thon" to be staged in the window of a large department store. Gradually he became less expansive and hyperactive, and by the 160th hour he appeared utterly weary. He also had disturbances of bodily sensation.

From then on until the end, there were frequent visual hallucinations, including a blue flame that surrounded someone who brought him a cup of coffee. Another time, this flame jumped out of the wall at him, causing him to leave the room in terror. He exhibited increasingly severe paranoid behaviour; and during the last three days, his behaviour alternated between nearly complete withdrawal and labored attempts to be polite and courteous. The authors describe his hypnogogic states as being comparable to waking dreams. He had also blackout periods during which he would continue automatic behaviour, such as playing records, yet "suddenly awaken," with no memory of what he had previously done.

When the 220th hour was reached, he could barely speak and could walk only when supported. He collapsed in the lobby of a hospital and slept for 14 hours. After being

in the hospital for two days, he seemed to be functioning at his previous adequate level. (47)

In 1960, Koranyi and Lehmann kept six chronic schizophrenics awake for 100 hours. They found that the group functioned well until the third day, after which progressive deterioration occurred, and five of the six subjects manifested their previous acute psychotic picture, which had not been evident during the period they had been in remission. At the end of the experiment, three of the patients were allowed to sleep as desired, the other three were kept in a four-day period of chlorpromazine-induced somnolence. It was found that this latter group returned to a much higher level of function than the former group, one patient even being discharged as suitable for employment. (48)

In 1960, Cappon and Banks subjected 20 subjects (selected from a group of physically and mentally abnormal people) to prolonged sleep deprivation. The subjects supported each other for the first 34 hours. After this, they informed on each other, were dull, morose, and



irritable. At 48 hours they showed paranoid tendencies.

After 50 hours, group morale was completely broken down, and everyone was out for himself. After 60 hours, many showed concern for their own mental health.

During the study, the following tests were administered repeatedly:

Cornell Medical Index  
Maudsley Medical Questionnaire  
Taylor Manifest Anxiety Scale.

The authors concluded that 1) the more neurotic, nervous, and anxious (as measured by the above tests), the lower the subject's ability to withstand prolonged sleep deprivation; 2) the longer a person remains in sleep deprivation, the higher the probability that he will experience changes in perception of time, space, and self, with time perception being the first affected. (49)

In 1961, Ax and Luby confirmed previous findings that prolonged sleep deprivation produced marked decline in central sympathetic responsivity. (50)

In 1962, Luby and others kept 12 volunteers awake for 123 hours and described a gradual progression of

visual changes from diplopia to illusions and finally to hallucinations. Visual phenomena were described as "fog or mist." Geometric designs of great complexity were seen by an artist and confirmed by another volunteer in what the authors suggest represented folie a deux. Every participant experienced the "hat" delusion.

Most subjects were said to become paranoid, although only one man developed well systematized delusions. These occurred at 100 hours and rapidly assumed disturbing proportions, including the belief that one of the attendants was going to stab him with a penknife. A strong belief in the reality of these delusions persisted after 14 hours of sleep, and residues of paranoid thinking were present after one week of normal sleep. One student subjected to sleep deprivation showed severe memory loss, and one month after the experiment reported slowed thinking processes and severe detriment in his academic performance. (51)

In 1962, Berger and Oswald paid six healthy young subjects, age 21 to 24, to stay awake four nights. They found that all subjects experienced visual perception changes,

often of a cobweb nature. Two saw crumbs on the table-cloth running about like insects. Three had hallucinations of women peering at them.

One subject saw an unpleasant old woman who would vanish, often the body before the face, when he drew near her; but after she disappeared, he would turn around and see her again. One subject developed the delusion that he was to be locked up in a mental institution and only regained contact with reality when taken inside the "mental hospital," which was actually a television station, and was shown the equipment. (52)

Summary Prolonged sleep deprivation is inevitably characterized by a psychotic reaction which develops as follows.

I. A Prodrome develops in the first four to five days with progressive drowsiness and brief "microsleeps" or "lapses." These are always worse during the subject's normal sleeping time. Decrease in spontaneous voluntary fine movements results in steadiness to 48 to 72 hours, after which a gross tremor begins to appear. The eyes, now lacking in fine movements,

move in a jerky fashion, and diplopia and illusions (especially of movement and more marked in the periphery) appear. Body sensations grow, with the pressure "hat" sensation being one of the commonest. Decrement of task performance occurs for those tasks falling between overlearned, semi-automatic and emergency situations.

Attention span shortens, intrusive thoughts are more and more prominent, and fleeting hallucinations of two types occur:

- 1) Those thought to be of endoptic origin:  
high frequency, rhythmical movements of stationary objects; then, grills, filigrees, cobwebs, etc.
- 2) Brief hypnogogic phenomena: brief, dream-like experiences with total situations perceived and reacted to.

Finally noted were growing fatigue, weariness, disinterest, and withdrawal.

II. The Psychosis appears gradually and becomes obvious when severe defects in reality testing occur, often around the fifth night. Prodromal symptoms become more pronounced, hallucination more prolonged and vivid with less

insight. Meaning is given them that confirms the subject's ideas of reference, resulting in an increased paranoid flavor.

Periods of overt confusion and clouding of consciousness occur, and disorientation becomes increasingly frequent and prolonged for first time, then place, then person, and finally self. Finally, gross delusional thinking, usually paranoid, supervenes. The total picture is of progressive disintegration of ego structure.

III. The Recovery starts with falling asleep wherein the subject may sleep 12 to 15 hours, and dreams nearly constantly.

Gross psychotic behaviour is unlikely after the first sleep, but impairment of performance of various tasks may last seven to ten days.

Conclusion It would appear from a study of the literature reviewed that prolonged sleep deprivation results in the following:

- 1) Only equivocal physiologic and biochemical changes.
- 2) Excessive physical exhaustion (due to activity required to remain awake) which significantly contributes to the over-all fatigue quotient.
- 3) Appearance of psychotic-like reactions or even frank psychosis in all subjects, the severity being generally related to the duration of sleeplessness, as well as the subject's previous personality integration.
- 4) Cumulative effects of sleeplessness, which however, respond well to a relatively short sleep interval with substantial recovery ensuing.
- 5) Prolonged residual disturbances in subjects with latent psychopathology or personality defects.
- 6) Exacerbation of acute schizophrenic symptoms in chronic patients, long in partial remission.
- 7) Enhanced effects of hallucinogenic agents on the cortex.

We therefore conclude that sleep deprivation of a prolonged nature does cause psychosis of a temporary duration in the well integrated personality, and of a less transient nature to the subject with latent psychopathology.

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