SLEEP: NORMAL AND PATHOLOGICAL*

BY

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The Nature of Sleep

"Sleep," says Dr. Johnson, "is a state in which a great part of every life is passed. . . . Yet of this change, so frequent, so great, so general, and so necessary, no searcher has yet found either the efficient or final cause; or can tell by what power the mind and body are thus chained down in irresistible stupefaction." Considering the problems which sleep presents to the physiologist, the physician, and the psychiatrist, it is surprising how true this still is, and how varied are the views held concerning its nature. Nevertheless, much has been learned during recent years, and though large gaps in our knowledge remain we know enough to be able to trace some at least of "the efficient causes" of sleep, and of its strange disturbances, which are surely among the most bizarre of nervous disorders.

Some species of animal sleep for several short spells during the twenty-four hours, others for one long spell. Szymanski (1918a, 1918b, 1919) made the interesting observation that the polyphasic sleepers are animals which depend on tactile or olfactory senses for obtaining food, as do the earthworm and rabbit. Animals which depend on visual stimuli, such as the dog, are monophasic sleepers. The human infant is polyphasic at first: it becomes monophasic as its diet changes from a tactile and olfactory to a visual stimulus.

During sleep not only is consciousness lost but certain bodily changes occur. The pulse rate, blood pressure, and respiratory rate fall; the eyes usually deviate upwards, the pupils are contracted but continue to react to light, though slowly; the tendon reflexes are abolished and the plantar reflexes may become extensor. Since we know that the conscious perception of all except the cruder forms of sensation is a function of the cerebral cortex it is a reasonable inference that during sleep the activity of the cerebral cortex is depressed. This view has been confirmed by the study of the behaviour of cortical electrical rhythms during sleep by means of electro-encephalography (Walter, 1938). Five stages have been recognized in the process of falling asleep. Briefly, as sleep deepens there is a transition from the normal alpha waves, which are recorded from the occipital lobe in subjects with the eyes closed, through a phase of bursts of more rapid waves to the development of slow random waves known as delta waves, of a type present in various conditions in which the cerebral cortex is in a state of profound inactivity.

How is this cortical inactivity brought about? Pavlov (1928) put forward the view that sleep was identical with internal inhibition. His reason for this was that in certain animal experiments on conditioned reflexes the animal would fall asleep during a stage of the process which

Pavlov considered to be a phase of internal inhibition. He therefore concluded that sleep was due to the spread of inhibition over the cortex. This hypothesis, however, may be criticized on the ground that even if sleep coincides with internal inhibition it is not necessarily identical with it. For example, if there is a waking centre—a question I shall discuss shortly—the extension of inhibition to the waking centre might produce sleep without sleep necessarily being identical with an extension of inhibition over the whole cortex. Kleitman (1929) proposes a different view—namely, that sleep is an easily reversible inactivity of the highest functional centres of the cortex which is due to a functional break resulting from a decrease in afferent impulses from the sensorium, especially from the proprioceptors stimulated by muscle tonus. Electro-encephalography perhaps affords some support for this view, for Bremer (1937) states that in an animal decerebrated by transection of the brain-stem the electro-encephalogram of the cerebral cortex is identical with that found during normal sleep.

There is both experimental and clinical evidence for the existence of a centre concerned with the regulation of sleep and waking, and situated in the posterior part of the hypothalamus.

It has repeatedly been shown that lesions in this region, especially between the corpora mammillaria and the nucleus of the third nerve, and involving the efferent path from the hypothalamus, cause pathological somnolence in animals (Ranson, 1939.) Lesions produced in man by disease, being usually more diffuse, are of less localizing value, but the sleep disturbances characteristic of epidemic encephalitis lethargica can be correlated with the predilection of the virus of this disease for the grey matter around the anterior end of the aqueduct of Sylvius, and intracranial tumours are most likely to produce somnolence when they are situated in the interpeduncular space. Since destruction of this region causes somnolence it would perhaps be more aptly described as a waking centre rather than a sleep centre. Fulton (1938), on anatomical grounds, stresses the probable importance of the corpora mammillaria because of their heavy projection to the thalamic nuclei and hence their close link with a most important relay station on the path of afferent impulses towards the cerebral cortex. No part of the normal nervous system, however, acts in isolation, and normal sleep is the outcome of an interplay between the cerebral cortex and the hypothalamic sleep-waking centre.

Hypersomnia

Disease of the brain more often causes prolonged sleep than abnormal wakefulness. Sleep which is abnormally prolonged and from which it is more than normally difficult to arouse the patient is known as hypersomnia. As already mentioned, this is usually the result of lesions situated roughly between the corpora mammillaria and

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the nucleus of the third nerve. The state of the patient suffering from hypersomnia closely resembles that found in normal sleep. Even at the first glance the healthy colour, tranquil facies, and quiet, somewhat shallow breathing distinguish hypersomnia from states of coma in which the functions of the cerebral cortex are more profoundly disordered and not merely in abeyance through the overactivity of a natural mechanism. As in normal sleep, the eyelids are closed, the pupils contracted, and the limbs relatively toneless. The tendon reflexes may be diminished or lost and the plantar reflexes may be extensor. The patient can always be aroused to some extent by vigorous stimulation, and when thus aroused may reply rationally to questions and will usually swallow food. When the pathological sleep is deep, however, the response may be very limited, but even so it is more normal than that of a patient in coma. For example, a publican in a state of profound hypersomnia from which nothing else would arouse him still responded with a smile when offered a drink. Walter, Griffiths, and Nevin (1939) state that in a case of pathological somnolence due to tumour of the hypothalamus the electro-encephalogram resembled that found in deep natural sleep and could be differentiated from the electro-encephalograms both of ether anaesthesia and of coma due to increased intracranial pressure.

Narcolepsy

"Narcolepsy" is the term applied to sleep which is abnormal by reason of its onset being sudden and irresistible, though the circumstances may be inappropriate and excessive fatigue is absent; but narcolepsy differs from hypersomnia in that the patient can be aroused from the narcoleptic attack as from normal sleep. A few writers have regarded narcolepsy as a condition allied to epilepsy rather than as a form of sleep disturbance. Nevertheless the patient who suffers from narcolepsy is apt to suffer also from other forms of sleep disturbance. There are at least five different sorts of disturbance of the sleep mechanism which are mutually related, one or more being found in the same individual. These are narcolepsy, cataplexy, sleep paralysis, somnambulism, and sleep hallucinosis.

The irresistible attacks of sleep characteristic of narcolepsy may be very numerous, occurring many times a day. In the attacks the patient rapidly becomes unconscious, but the condition resembles normal sleep in that he can be aroused immediately by appropriate stimuli. The attacks are most likely to occur in circumstances normally conducive to drowsiness, such as after a heavy meal or during a monotonous occupation, especially when driving a car, and are usually worse in the afternoon. They are occasionally precipitated by strong emotion. The sleep is usually brief, lasting only for seconds or minutes, but if the patient remains undisturbed he may sleep for hours.

Cataplexy and Sleep Paralysis

By cataplexy is understood an attack to which sufferers from narcolepsy are liable, but which differs from sleep in that, though the patient suddenly loses all power of movement and of maintaining posture, consciousness is preserved. Sometimes tremor of the head or muscular twitching occurs at the onset, but these may be absent. The patient sinks limply to the ground with the eyes closed. The muscles are hypotonic, the pupils may fail to react to light, the tendon reflexes may be diminished or lost during the attacks, and the plantar reflexes may be extensor. Though completely unable to move or to utter a sound the patient is fully aware of all that is happening.

Cataplectic attacks usually last less than a minute, and recovery is rapid. They are commonly precipitated by strong emotion, pleasurable or otherwise, especially by laughter, and the patient may be unable to move until he has controlled his feelings.

Sleep paralysis resembles cataplexy except that instead of being precipitated during the day by emotion, it usually occurs during the period of falling asleep or of awakening. The patient, though fully conscious, is unable to move hand or foot, and often feels intense anxiety. A touch will rapidly disperse the paralysis.

Somnambulism may be regarded as the reciprocal of cataplexy in that the patient, though partly asleep, is able to stand and walk in an automatic fashion. It is occasionally associated with narcolepsy.

Sleep Hallucinosis

Sufferers from narcolepsy sometimes experience vivid hallucinations. These, which are more often visual than auditory, may occur as the patient is falling asleep, when they are termed "hypnagogic hallucinations." Sometimes, however, they occur during the night when the patient is apparently awake. These hallucinations are often elaborate and terrifying, and, though they seem real at the time, their true character is readily recognized during waking life.

Thus a patient of mine, a married woman aged 34, who suffered from narcolepsy, would awaken every night in a state of terror in which external stimuli, such as the reflection of the street lamp on the wall or the wail of a cat, would appear to have a sinister meaning. She was also subject to terrifying nightmares. Another patient, an unmarried woman of 24 who also suffered from narcolepsy, had hallucinatory attacks which she described as nightmares and which preceded the narcolepsy by six months. As soon as she laid her head on the pillow she found that she could not move, but she would hear people whispering all round her head and "horrible laughter like that of the witches at pantomimes." She could feel ghosts coming into the bedroom and leaning over her, though she could not see them. Even more dramatic were the effects of these hallucinations on a man of 22, a commercial traveller, who had suffered from bad dreams since childhood. On three occasions his nocturnal hallucinations led to violent conduct on his part. All three of these attacks occurred when he was staying in a hotel in the course of his travels. He went to bed and to sleep at the usual time, but awakened about 2 a.m. to find himself standing by the bed. He experienced extreme anxiety, as if there was someone in the room creeping towards him and that it was imperative for him to get out. In this state he would shout, and, if no one came, give way to panic. Twice he broke a window, and on the third occasion he kicked a hole three feet wide between his own room and the next. As soon as someone came he became normal and retired to bed again. This man had always been subject to hypnagogic hallucinations when falling asleep in the twilight. In this state any object in the room would take on an alarming form as of something moving towards him. Similarly a noise would cause a sharp pang of fear and an acceleration of his heart rate.

Nature of Narcolepsy and Allied Disorders

We have now to explain narcolepsy and allied disorders in terms of a disturbance of sleep. Here I would emphasize that no hard-and-fast lines separate even the most bizarre of these disorders from the normal, least of all, perhaps, narcolepsy. The abnormal feature of narcolepsy is the sudden and irresistible onset of sleep, but it should be noted that the circumstances in which it occurs are often those which predispose to normal sleep, such as a monotonous occupation and a heavy meal. Narcolepsy is thus an exaggeration of a normal tendency. The narco-

leptic may perhaps be regarded as a person who has reverted to the polyphasic sleep of infancy. This may well be due, at least in part, to a deficiency of the control which the cerebral cortex normally exercises over the sleep centre, and in this connexion it may be significant that Kleitman and Camille (1932) found that though dogs are normally monophasic sleepers, decorticated dogs exhibited polyphasic sleep. It is also significant that drugs which cause increased cortical activity, such as benzedrine, cause wakefulness in normal people and diminish or abolish narcoleptic attacks in sufferers from narcolepsy.

Cataplexy has been ingeniously interpreted by Adie (1926) as a dissociation between the mental and the physical components of sleep. In a cataplectic attack the motor and postural centres fall asleep while the levels concerned with consciousness remain awake. It is certainly striking that in an attack of cataplexy all the motor and reflex changes typical of sleep appear. Even cataplexy, strange though it is, is not completely removed from normal life, as the term "helpless with laughter" indicates. The disorder of function in sleep paralysis is similar to that found in cataplexy, but of more gradual onset. Sleep does not, as normally, spread rapidly and diffusely through the nervous system, but the motor and postural centres fall asleep before the mind, or, in awakening, the mind awakens before the body. In either case the patient is conscious but powerless. In somnambulism the reverse occurs—the motor and postural centres are active while the mind is still asleep. In the words of Osler's beloved Sir Thomas Browne, "Those abstracted and ecstatic souls do walk about in their own corpses, as spirits with the bodies they assume, wherein they seem to hear, see and feel, though indeed the organs are destitute of sense and their natures of those faculties that should inform them."

Dreams and Hallucinations

During recent years dreams have received little attention except from psycho-analysts, who have been concerned to prove that "infected minds to their deaf pillows will discharge their secrets," although lately Dunne has attributed a metaphysical significance to dreams by regarding them as an extension of consciousness into a fourth dimension. Yet there is much to be learned from a study of the psycho-physiological aspect of dreams, as is illustrated by Havelock Ellis's book *The World of Dreams*. An investigation of dreams in the light of our new knowledge of the pathology of sleep, and in relation to organic lesions of the nervous system, such as intracranial tumours, would be especially fruitful. I can now only suggest the kind of questions that are awaiting an answer. Electroencephalography has shown that dreaming is associated with a burst of alpha rhythms in the second stage of sleep. At what level or levels of the nervous system does dreaming occur? What is the significance of the prominence in a dream of visual and to a less extent auditory imagery and the poverty of other sensory representations? The sense of smell is lost in dreams, as Sir Thomas Browne noted. "Nor will the sweetest delight of gardens afford much comfort in sleep; wherein the dulness of that sense shakes hands with delectable odours; and though in the bed of Cleopatra can hardly with any delight raise up the ghost of a rose." The same is true of the sense of pain, which is rarely experienced in dreams except those that are evoked by an actual bodily pain. Serious bodily catastrophes in dreams may be painless. In all these respects dreaming corresponds both with imagination and with memory. We can imagine and recall sights and

sounds, but only with difficulty scents or pains. We imagine, remember, and dream mainly in terms of our exteroceptive, spatializing senses; and our dreams are projected into an external world.

There is another question which is fundamentally physiological but is of great importance for psycho-analysis. Why do I identify myself with some elements in my dreams and not with others? Thoughts and feelings, for example, are "me," but other people in my dreams are not "me": they appear to be outside me, and behave in a way that I cannot control or predict. This externalization is so complete that, as psychoanalysts are well aware, most people find it very difficult to realize that the characters in their dreams are parts of their own minds. Dr. Johnson once illustrated this by a dream of his own in which he felt mortified at being overcome by an opponent in a contest of wits. His comment was, "Had not my judgement failed me, I should have seen, that the wit of the supposed antagonist, by whose superiority I felt myself depressed, was as much furnished by me as that which I had been offering in my own character."

The explanation of this must be that in the dreams there is a splitting of consciousness in which the individual becomes divided into multiple personalities, but, just as in waking life there is only one "me" and all other persons and things are external, so in dreams only one personality is linked with the physiological basis of the self. The rest are externalized.

The sufferer from narcolepsy who experiences nocturnal hallucinations is of especial interest as being in a state intermediate between normal dreaming and a hallucinatory psychosis. In contrast to the normal dreamer the narcoleptic subject appears to be awake, and indeed is partially awake. In him the dissociation of sleep occurs at the highest nervous level while postural and motor centres and the sensorium are awake. Objects and events, therefore, are perceived, and incorporated in a waking dream in which, simultaneously, images of subjective origin are projected into the environment as hallucinations. It is significant that similar hallucinations have been described by Lhermitte (1932) as a result of lesions of the posterior hypothalamus. This "peduncular hallucinosis," as Lhermitte calls it, seems to be the direct outcome of a disorder of the sleep-waking centre.

At the level of the disorder of cerebral function there is no difference between a narcoleptic hallucinosis and a hallucinatory psychosis such as a toxic delirium or even schizophrenia. The narcoleptic state, however, is immediately reversible, and the victim can be awakened from his hallucinations. Perhaps convulsion therapy is only a crude method of awakening the schizophrenic. However that may be, it is clear that hallucinations are "such stuff as dreams are made of." The converse is equally true. We are all temporarily insane during sleep, and our waking moments are but lucid intervals.

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