TO SLEEP, PERCHANCE TO DREAM --

From Soothsaying and Mythology to Scientific Investigation

Robert B. Sivley, Ph.D.

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PROLOGUE

Since this paper is a summary of psychological research on the sleep phenomenon, my first thought, in keeping with my usual format for Athenaeum Society papers, was to begin with the story of Rip Van Winkle, who slept for 20 years. I thought I would then go on to an analysis of the fairy tale about Sleeping Beauty, who was made to fall asleep by a witch, and who could only be awakened by the kiss of her Prince Charming.

THOUGH THESE ARE DELIGHTFUL tales they are quite fanciful, however, and yield no real knowledge or insights about the process of sleep. Unlike with my researches into the cowboy movies and the story of Tarzan, I could find no scientific truths embedded in these childish fantasies. It was necessary, therefore, for me to approach this paper in a very different way.

EVERYONE SLEEPS. Between the oblivion out of which we are born and that into which we expire, there is a tide of darkness that ebbs and flows each day of our lives and to which we irresistibly submit. About one-third of our lives is spent in sleep, that most profoundly mysterious realm in which the spirit seems to live apart from the waking world.

Though a very familiar state to all of us, sleep remains a mystery, and equally mysterious is its companion, the state of dreaming. This latter topic has been the fertile ground for fortune tellers and soothsayers throughout the centuries, and much of what people think they know about dreams actually comes from the folklore that has accumulated around a phenomenon that was so long inaccessible to scientific investigation.

SLEEP IS A RESTORATIVE state. Like the waking state, however, it is not simple. Sleep does not come about simply when the bodily processes resulting from waking activities require it, for whatever the condition of the body a person usually can choose either to sleep or to remain awake. Sleep is not all together unconscious, for upon waking, dreams can be recalled. It is not entirely quiescent, because some people walk in their sleep. It is not entirely insensitive, because a mother can be awakened by the cry of her baby. It is not all together planless, because some people can set themselves to wake up at a given time and do so.

The mysterious nature of sleep, and the dreams that it harbors, must always have occupied the thoughts of men. In Greek mythology Hypnos was the god of sleep, and his son Morpheus was the god of dreams and the master of the fantasyland that lay close to the realm of the dead. There was a widespread belief in the ancient world that sleep was a time of communication with the gods, a time when the spirit left the body to wander alone, and that its experiences were the dreams of the night.

THE BIBLE SUPPORTS THE IDEA that dreams are communications with God. In the 33rd chapter of Proverbs, for example, we read:

> In dreams, in visions of the night, when deepest sleep falls upon man, while they sleep on their beds, God makes them listen, and his correction strikes them with terror.

The Bible is full of dreams, one of the best known of which is that of the Pharaoh interpreted by Joseph. (Joseph had previously gotten into trouble[1] by relating his own dreams to his brothers, who interpreted them as indicating that Joseph wished to have them be subject to his authority. So incensed against him were they that they sold him to an Ishmaelite caravan, which in turn sold him to an Egyptian. Among the Egyptians he gained some reputation as an interpreter of dreams and so was called upon by the Pharaoh for an interpretation.)

JOSEPH INTERPRETED THE PHARAOH'S DREAM of seven fat calves eating seven lean calves as a prophecy that seven prosperous years would be followed by seven years of famine. A psychoanalyst might say that the dream material reflected an unconscious awareness on the part of the Pharaoh that the years of plenty might very well be followed by years of famine and want. Joseph, at any rate, advised the Pharaoh to prepare for the period of famine. Since the prediction came true, and the people of Egypt were greatly helped by the preparations made by the Pharaoh, Joseph was rewarded by being made a chief advisor to the King.

The irrational view that dreams are veiled predictions of future events was, and still is, widely held. Psychologist Eric Fromm has tried to explain this by reference to Freud's theory that dreams are disguised fulfillment of

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[1] To conserve time, sections in brackets were not read when the paper was presented.

unconscious wishes. As such, they might be expected to portray episodes that will be unwittingly sought out in real life. Thus, he would say that the dreamer unwittingly makes his own prophecy come true.

(ANOTHER CLOSELY RELATED IDEA held by many psychologists, is that the dream may also express some idea of which the dreamer already has tentative awareness. Thus, the dream becomes merely the vehicle through which the individual first expresses an idea which is later confirmed in waking life.)

Aristotle, 2000 years ago, took the position that since dreams come in such abundance and such variety, that some of them will inevitably resemble future events, just by chance--perhaps the first example of a statistical argument in the behavioral sciences.

THE MOST INFLUENTIAL THEORY OF DREAMS in the last half-century has been that of Sigmund Freud, the founder of pyschoanalysis, which is both a theory of personality and a technique of psychotherapy and personality research. A thorough discussion of Freud's theories about dreams would, at the least, require another paper, whereas in this essay, I wish to concentrate on the study of sleep rather than on the meaning of dreams. For purposes of this discussion, however, I would simply point out that Freud did, at the very least, develop a method for making sense of otherwise obscure, nonsensical phenomena.

(Freud perceived that unconscious impulses are responsible for dreams. The aim of the dream is gratification of some drive (or to use his terminology, the fulfillment of a wish). But such fulfillment must be in a disguised form that protects the dreamer from full awareness of his unacceptable impulses.

THE PART OF THE DREAMS that we remember is the manifest content. The real meaning of the dream is called the latent content, and the process whereby analysis of the manifest content reveals the latent meaning is called the dream work.

The true meaning of the dream is disguised by three mechanisms: condensation (whereby ideas are combined into a more abbreviated form); displacement (which permits one thing to stand for another); and symbolization (whereby ideas or events may represent something else). The most common symbols represent sexual or aggressive impulses, because these are the ones that are most taboo in civilized society.)

(LATER PSYCHOANALYSISTS HAVE DISAGREED with some of Freud's ideas, but the basic postulate that dreams do have meanings and those meanings can be understood in terms of the individual's unconscious wishes and fears has held up well.)

The modern era of sleep research began in the early 1950's, and grew out of the work of a group of psychiatrists and psychologists--notably Nathaniel Kleitman, Eugene Aserinsky, and William Dement--and their students. Kleitman established the first experimental laboratory for the study of sleep at the University of Chicago, and since the early 1950's, numerous other centers of sleep study have sprung up, probably numbering well over two dozen in the United States today. (The greater part of our current knowledge about the sleep process has been learned in the past two and one-half decades. Let us look now at how new techniques and methodology made such progress possible.)

IN STUDYING SLEEP, PSYCHOLOGISTS are concerned primarily with internal behavior--that is, processes that are presumed to take place inside each person. But before we can study such behavior we must find a way to make it external, so that it can be observed and measured. How do you go about externalizing internal behaviors?

The lack of early research on sleep was due primarily to the lack of methodology. No one knew how to identify all the differences between a light sleep and a much deeper one; no one could tell when a person was dreaming. In

fact, scientists did not even know how to pinpoint the moment of drowsiness when a person actually falls asleep.

THE METHODOLOGICAL BREAKTHROUGH for the study of sleep came with the development of the electroencephalograph, which allowed man to "observe" brain activity. In 1937, the discovery was made that brain waves change in form with the onset of sleep and show further changes during the entire sleep period. This meant that researchers could now continuously monitor the changes within sleep, as well as accurately demarcate its beginning and end.

Although sleep was opened to research by the use of the EEG, the scientific study of dreams had to wait for another methodological discovery. It was suspected that dreaming might occur in certain stages of sleep and not in others, but the brain wave patterns did not provide the answer. Instead, an incidental finding in 1953 provided the key to dream research. While working on a study of sleep, Aserinsky and Kleitman noticed that several times during the night there were rapid, jerky movements of the closed eyelids, indicating that eye movements were occurring. During these periods there were increases in both heart rate and breathing, which suggested an emotional response. Acting on the hunch that rapid eye movement activity was associated with dreaming, the experimenters woke their subjects during such periods. The subjects almost always reported that they had been dreaming, while they rarely did so when awakened during other periods of sleep. Thus, Kleitman and Aserinsky had discovered what came to be known as rapid eye movement, or REM, sleep.

THESE FINDINGS WERE CONFIRMED BY other researchers, who also showed that the REM periods of sleep were accompanied by the "awake and active" EEG pattern. Since then, major physiological changes, particularly in the autonomic nervous system, have been established as a common feature of REM periods. These changes often include large, erratic fluctuations in heart rate and blood

pressure. Such "autonomic storms" have important medical implications because it has been found that heart attacks and cardiac failure often occur during the early morning hours--the time when a person is most likely to be in REM sleep.

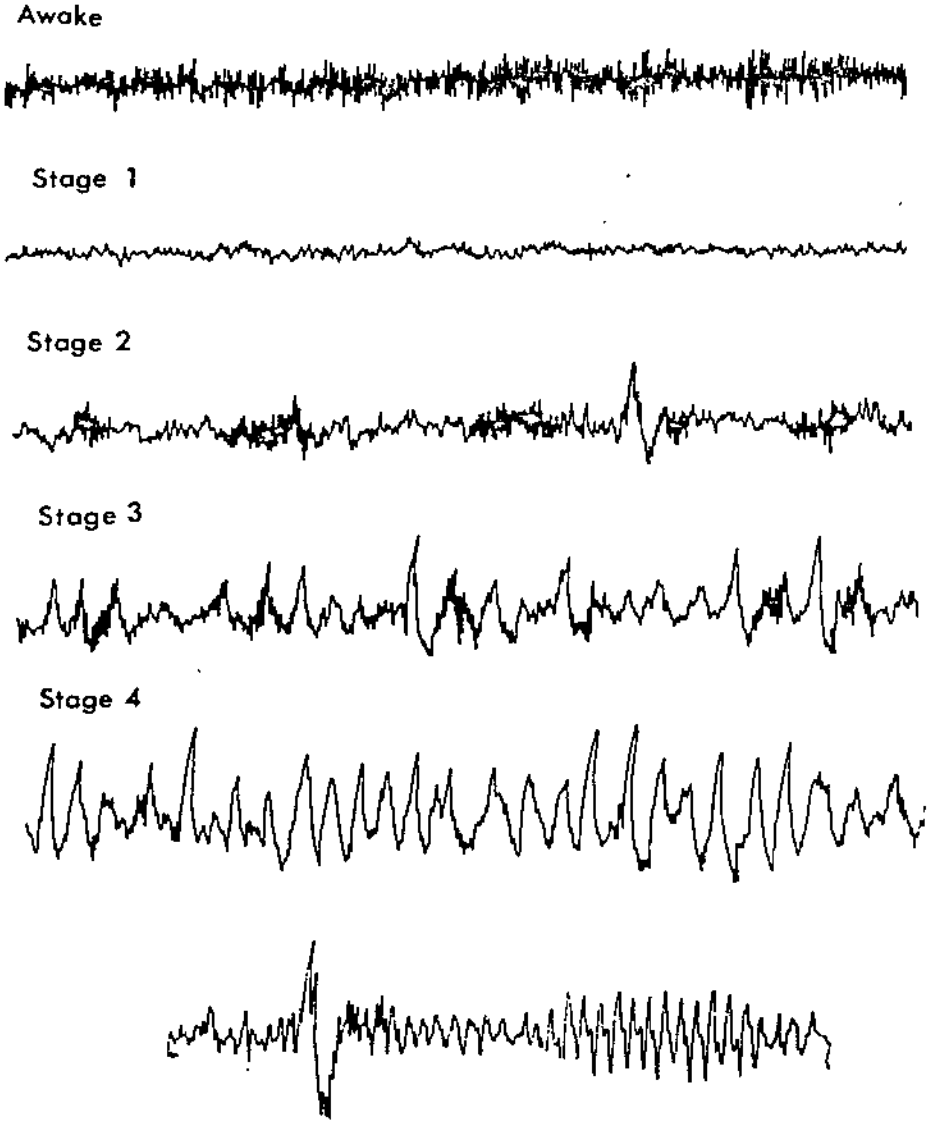
Figure 1 shows the different EEG patterns associated with the relaxed waking state and the various sleep stages. The top line shows the familiar wave pattern of approximately 10 cycles per second, called alpha rhythm, which characterizes a relaxed waking state. Stage 1 is a period of light sleep, which occurs early in the sleep period and during which the individual is easily awakened. In Stage 2 the person is more soundly asleep, and his EEG pattern shows the presence of sharply pointed waves known as sleep spindles. Stages 3 and 4 are characterized by high amplitude, slow waves which are called delta waves. These waves are most predominant in Stage 4--a state of deep sleep from which a person is not easily awakened.

THE BOTTOM LINE SHOWS a tracing similar to that which is seen during the waking state, but in which rapid eye movements occur, and during which most dreaming takes place. This is the REM sleep stage.

A study of EEG patterns during a typical 8-hour period of sleep (Figure 2) shows that subjects progress from the waking state into stages 1 through 4 during the first hour of sleep, and then vacillate between the various stages, reaching a period of REM sleep after about 1 1/2 hours of sleep. Though about 25 percent of their total sleep time is spent in REM sleep, most of it occurs after the first three or four hours, and is concentrated during the latter part of the 8-hour period. Most people are surprised to learn that they actually dream about one-fourth of all the time they sleep, since they usually remember only very small portions of these dreams.

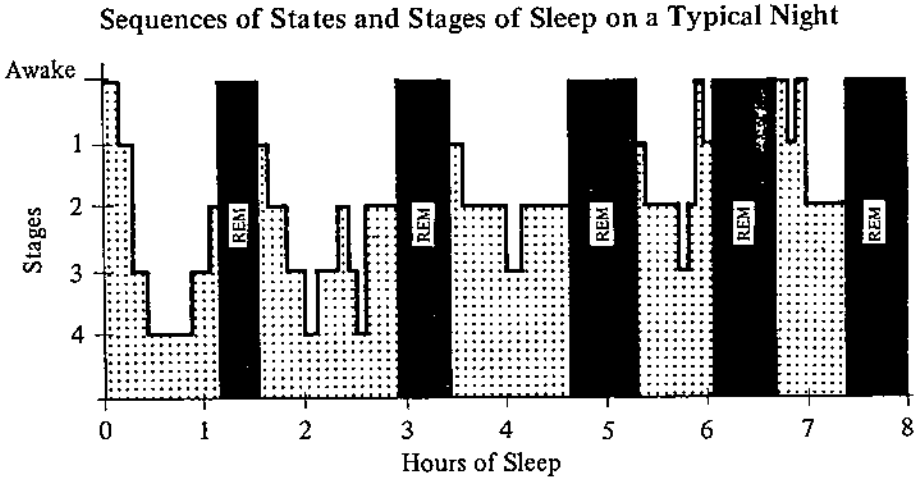
THE REM STATE IS UNUSUAL in many ways. During REM periods there are accelerations and irregularities in heart and respiration, elevations of blood pressure, and other physiological changes associated with arousal; how then does

Fig. 1. EEG PATTERNS ASSOCIATED WITH SLEEP[1]



[1] DEMENT, p. 112.

Fig. 2.



[1] DEMENT, p. 114.

most of the body appear to remain in the placid, relatively immobile state we associate with sleep? The answer seems to be that the brain somehow paralyzes most of the major body muscles during REM periods; that is, most of the bodily reflexes that can readily be elicited during ordinary sleep are suppressed. Apparently, part of the great increase in brain activity during REM periods is channeled into suppressing most muscular function. A few muscles are spared--those of the eye, the middle ear, and the respiratory system. It is also true that one can occasionally observe brief, miniscule changes of the muscles in the extremities, all of which seem to be associated with the content of the dream the sleeper is experiencing.

(The noted French scientist, Michael Jumae, succeeded in removing the small part of the brain responsible for the muscular inhibition in cats. REM periods continued to occur in these cats, but after the operation, the sleeping cats jumped up and ran about the room spitting and hissing. Their eyes remained functionally closed, however, and they appeared to be oblivious to the world around them. Apparently during the REM periods we attempt to act out whatever the dream is about, but one small part of the brain acts as an inhibitory center to prevent us from impulsively acting out the dream.)

SLEEP TALKING AND SLEEP WALKING are not, however, the result of the body's failure to inhibit muscular activity during dreaming. In point of fact, most sleep walking and sleep talking occur during non-REM periods of sleep. Subjects usually cannot recall what they did while sleep walking, and the dreams they remember in the morning bear no resemblance to what they did while walking about. (Unfortunately, little else is known at this stage about either phenomenon, and though both are referred to as disorders of sleep, neither is related to any definite form of emotional disorder.)

It is difficult to say why we dream or what the functions of dreams are, though we do know that if we are awakened each time the REM state appears, thus depriving us of dreams, we tend to make up these lost periods whenever given the chance. This rebound phenomenon is found both in humans and in other mammals. A cat deprived of REM sleep for any length of time becomes hyper-motivated in many ways when awake. Sexual behavior is greatly increased, as are aggressive tendencies and food seeking behavior. Apparently the body has a strong need to undergo REM periods at regular intervals, but the function of these periods is still unclear.

CERTAIN DRUGS, INCLUDING AMPHETAMINES (which people use to stay awake), barbiturates (which they use to help them sleep), and alcohol have all been shown to suppress REM sleep. During delirium tremens, which follows acute withdrawal from alcohol in alcoholics, REM sleep approaches 100 percent of total sleep time, and the hallucinations appear to be the breaking through of REM sleep during waking time.

In spite of the new research methodology, little is yet known about the basic need for sleep. Though there have been reports of people who have gone for years without sleep, no case has ever been documented, and present knowledge would suggest that such is not possible.

STUDIES OF ANIMALS DEPRIVED of sleep have resulted in their deaths, though autopsies have failed to show the cause of death in such subjects. Studies of humans have shown marked psychological effects, including the development of

hallucinations, but no serious aftereffects when the sleep deprivation was ended.

The two longest periods of sleep deprivation on record, so far as I have been able to find, showed very different results. Both were highly publicized. One is the case of a 32-year-old disc jockey named Peter Tripp, who in January of 1959 staged a 200-hour wakeathon in a Times Square booth for the benefit of the March of Dimes. During his sleepless marathon he was given periodic medical examinations and psychological tests. After two days he began to have visual hallucinations such as seeing cobwebs in his shoes; by 100 hours his memory was becoming quite poor and he was having a great deal of difficulty with simple performance tests. His hallucinations became more and more frightening. (At one point he saw a doctor's tweed suit as a suit of furry worms, and when he went to a nearby hotel for a change of clothing he saw the bureau drawer in flames.

A SIMPLE ALGEBRAIC FORMULA that he had earlier solved with ease now required such an effort that Tripp broke down, frightened at his inability to solve the problem.) By 170 hours the agony had become almost unbearable to watch. Although he behaved as if he were awake, his brain wave patterns resembled those of sleep. At the end of the 200 sleepless hours, nightmare, hallucination and reality had merged, and he felt he was the victim of a sadistic conspiracy among the doctors. (Luce, 1965)

Very different was the case of 18-year-old Randy Gardner, who in 1965 stayed awake for 264 hours in order to find a place in the Guiness Book of World Records. His ordeal was carefully monitored by scientists who reported no severe mental disturbances during his ordeal, except a few minor hallucinatory experiences. Immediately after completing his project he slept for 14 hours and 40 minutes, stayed awake for the next 24 hours, then slept a normal 8 hours the next night. Perhaps the crucial factors in enduring prolonged sleeplessness are physical condition, emotional stability, and motivation, and it is likely that

the more pathological reactions are due to predisposition of the subjects.

AN INTERESTING ASPECT OF the research on sleep deprivation is that practically all the symptoms of sleep loss, including the more extreme ones, disappear with a single night's sleep. Such quick recovery raises some questions about the amount of sleep necessary to maintain normal functioning.

The physiological changes that result from loss of sleep are not well understood, and sleep researchers have identified such a variety of sleep patterns that it is almost impossible to state any general rule as to how many hours of sleep any person needs.

YOU MAY BE FAMILIAR WITH the fact that Thomas Edison rarely went to bed, preferring to get his approximately 4 hours sleep out of each 24 in brief naps in his laboratory.

(Dement has documented the record of a Stanford University professor, 80 years old, who routinely slept four hours per night, waking spontaneously each morning at about 2:00 a.m., and never taking naps during the day. He was a very energetic, alert person.)

THE RECORD FOR VERIFIED BREVITY of sleep is held jointly by two gentlemen from Australia, both of whom slept just under three hours per night. One was 54 years old, the other 30.

Although there is probably an optimum amount of sleep for each individual, this amount varies from person to person and changes from time to time. During pregnancy, for example, there is an increase of approximately two hours in mean daily sleep time. Newborn infants sleep an average of 16 hours per day, though one issue of the federal government's publication, Infant Care, stated that they "ought" to sleep 21 hours per day. Many parents would agree, but only a small percentage of babies sleep that much, and a healthy infant may sleep as little as 5 1/2 hours a day with no ill effects.

SIXTEEN-YEAR-OLDS TEND TO average 10 to 11 hours of sleep per day, but by college age they have settled into a pattern that averages 8 hours. Sleep patterns also vary in relation to environmental changes. (One sleep diary kept by a research subject showed an average of 10 hours per night during the summer months, and 7 hours and 10 minutes per night during the school year.)

Perhaps the most peculiar sleep pattern known is that attributed to Salvadore Dali. To take naps, he would put a tin plate on the floor, then sit in a chair beside it, holding a spoon over the plate. At the precise moment of sleep onset, the spoon would slip from his fingers and clatter on the plate, and Dali would be snapped awake. He claimed that he was completely refreshed by the sleep that accumulated between the time the spoon left his hand and the time it hit the plate.

ANOTHER YET UNSOLVED PROBLEM is that of the function of sleep. Researchers have concluded that even though muscular fatigue is ameliorated during sleep, reversal of fatigue is not the specific function of sleep.

By the same token, sleep is not entirely a function of boredom. Removal of sensory stimulation will promote sleep for a while, but the amount of time spent sleeping under conditions of sensory deprivation tends to decrease after a few days.

THOUGH THE FUNCTION OF SLEEP is still far from understood, it is clear that it is an integral part of the rhythm of our daily lives. As fellow Athenaeum Society member Wendell Rorie so ably explained in a paper several years ago, our entire world is engaged in rhythms. In man, more than 100 functions and structured elements can be named which oscillate between maximal and minimal values once a day. Body temperature, for example, peaks during the middle of the day and falls to its lowest points during the early morning hours.

It has been experimentally demonstrated that these 24-hour cycles are based on endogenous, self-sustained oscillations.

AN EXPERIMENT ON ADULT SLEEP rhythms will be of particular interest to some of our members, because it was performed at Mammoth Cave, Kentucky, in the 1930's, by Kleitman and one of his associates. They set up housekeeping for a month in the uniform illumination and temperature conditions of the cave, and attempted to adapt to a 28-hour day, 19 hours under artificial illumination and 9 hours in the dark, making a six-day week. By good fortune, the two men differed sufficiently in their adaptation for the results to be highly instructive; the associate adapted to the new schedule in such a way that his daily temperature changes, when averaged for the last three weeks in the cave, showed the six peaks characteristic of the six lengthened (28 hour) days of the week; Kleitman, on the other hand, continued to have the seven peaks characteristic of his usual rhythm.

Though the experiment predated the coining of the term "jet lag," it is obviously pertinent to the kinds of problems that some travelers have when they find it hard to adapt to the new schedules that jet travel can produce within a few hours.

(MAN'S INTERNAL REGULATING MECHANISM is shown in one experiment when investigators were kept in a room with no external signs by which to judge the passing of time. They were still able to report the time of day within a few minutes, even after 86 hours for one of the subjects. Still, if time is interpreted according to watches that are set to run an hour slow or fast per day (under conditions in which external light does not give time clues), bodily processes eventually follow the new rhythm, though some processes do so after a short time while others may take a week or more.)

The discovery of REM sleep led to new research on dreams, dealing with problems very different from the psychoanalytic preoccupation with the meaning of dreams. One finding that has been verified is that dreams take about as much time to occur as they seem to take--they are not instantaneous as much folklore suggests.

STIMULI THAT INFLUENCE DREAM CONTENT have been studied in many ways. Generally speaking, it can be shown that stimuli do not instigate dreams, but if the stimulus happens to coincide with a REM period, it can influence the dream content. (Using such stimuli as flashing lights, pure tones, and water sprays, applied at the start of a REM period, researchers have found that the stimuli were incorporated into the dreams some of the time but not in the majority of instances. When the same stimuli are applied during non-REM periods, no dreams are elicited and no REM periods are instigated.) Thus, a person may dream of a phone ringing, and awake to find that the alarm clock is on. He has incorporated the auditory stimulus into the dream that probably was in progress when the bell started.

Enuresis (bedwetting) and night terrors are sleep disorders which occur almost exclusively in young children and are usually outgrown. Laboratory studies have shown that these episodes arise usually in the first deep stage 4 sleep of the night and are generally associated with body movements and intense autonomic activation. No one knows the cause of these disturbances, but they do tend to run in families.

TWO OTHER SLEEP DISORDERS that are more rare but can be quite serious are sleep apnea, in which an individual actually stops breathing when he goes to sleep and narcolepsy, which involves chronic, persistent sleepiness and a tendency to fall asleep frequently, even during periods of emotional excitement.

WHETHER OR NOT I HAVE SUCCEEDED in making this discourse on sleep fascinating, it is my hope that I have made it sufficiently interesting so as not to induce drowsiness.

RBS/jdg

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