

TO SLEEP, NO DOUBT TO DREAM ...

Aserinsky, E, & Kleitman, N. (1953). Regularly occurring periods of eye mobility and concomitant phenomena during sleep. *Science*, 118, 273-274. Dement, W. (1960). The effect of dream deprivation. *Science*, 131, 1705-1707.

As you can see, this section is somewhat different from the others in that there are two articles being discussed. The first study discovered a basic phenomenon about sleeping and dreaming that made the second study possible. The primary focus is William Dement's work on dream deprivation, but to prepare you for that, Aserinsky's findings must be addressed first.

In 1952, Eugene Aserinsky, while a graduate student, was studying sleep. Part of his research involved observing sleeping infants. He noticed that as these infants slept, there were periodic occurrences of active eye movements. During the remainder of the night, there were only occasional slow, rolling eye movements. He theorized that these periods of active eye movements might be associated with dreaming. However, infants could not tell him whether they had been dreaming or not. So, in order to test this idea, he expanded his research to include adults.

Aserinsky and his coauthor, Nathaniel Kleitman, employed 20 normal adults to serve as subjects. Sensitive electronic measuring devices were connected by electrodes to the muscles around the eyes of these subjects. The leads from these electrodes stretched into the next room where the subjects' sleep could be monitored. The subjects were then allowed to fall asleep normally (subjects participated on more than one night each). During the night, subjects were awakened and *interrogated*, either during periods of eye activity or during periods when little or no eye movement was observed. The idea was to wake the subjects and ask them if they had been dreaming and if they could remember the content of the dream. The results were quite revealing.

For all of the subjects combined, there were a total of 27 awakenings during periods of sleep accompanied by rapid eye movements. Of these, 20 reported detailed visual dreams. The other seven reported "the feeling of having dreamed," but could not recall the content in detail. During periods of no eye movement, there were 23 awakenings; in 19 of these instances, the subjects did not report any dreaming, while in the other four, the participants felt vaguely as if they might have been dreaming, but were not able to describe the dreams. On some occasions, subjects were allowed to sleep through the night uninterrupted. It was found that they experienced between three and four periods of eye activity during the average of seven hours of sleep.

While it may not have seemed so remarkable at the time, Aserinsky had discovered what is very familiar to most of us now: REM (rapid eye movement) sleep, or dreaming sleep. From his discovery grew a huge body of research on sleep and dreaming that continues to expand. Over the years, as research methods and physiological recording devices have become more sophisticated, we have been able to refine Aserinsky's findings and unlock many of the mysteries of sleep.

For example, we now know that after you fall asleep, you sleep in four stages, beginning with the lightest sleep (Stage 1) and progressing into deeper and deeper stages. After you reach the deepest stage (Stage 4), you begin to move back up through the stages; your sleep becomes lighter and lighter. As you approach Stage 1 again, you enter a very different kind of sleep called REM. It is during REM that you do most of your dreaming. However, contrary to popular belief, it has been found scientifically that you do not move around very much during REM. Your body is immobilized by electrochemical messages from your brain that actually paralyze your muscles. This is a survival mechanism that prevents you from acting out your dreams and possibly injuring yourself or worse!

Following a short period in REM, you proceed back into the four stages of sleep called non-rapid-eye-movement sleep (NON-REM or NREM for short). During the night, you cycle between NREM and REM about five or six times (your first REM period comes about 90 minutes after falling asleep), with NREM becoming shorter and REM becoming longer (thereby causing you to dream more toward morning). And, by the way, everyone dreams. While there is a small percentage of individuals who never remember dreams, research has determined that we all have them.

All of this knowledge springs from the discovery of REM by Aserinsky in the early 1950s. And one of the leading researchers who followed Aserinsky in giving us this wealth of information on sleeping and dreaming is William Dement. Beginning around the time of Aserinsky's findings, Dement was interested in studying the basic function and significance of dreaming.

THEORETICAL PROPOSITIONS

What struck Dement as most significant was the discovery that dreaming occurs every night in everyone. As Dement states in his article, "Since there appear to be no exceptions to the nightly occurrence of a substantial

amount of dreaming in every sleeping person, it might be asked whether or not this amount of dreaming is in some way a necessary and vital part of our existence" (p. 1705). This led him to ask some obvious questions: "Would it be possible for human beings to continue to function normally if their dream life were completely or partially suppressed? Should dreaming be considered necessary in a psychological sense or a physiological sense or both?" (p. 1705).

Dement decided to try to answer these questions by studying subjects who had somehow been deprived of the chance to dream. At first he tried using depressant drugs to prevent dreaming, but the drugs themselves produced too great an effect on the subjects' sleep patterns to allow for valid results. So, he decided on "the somewhat drastic method" of waking subjects up every time they entered REM sleep during the night.

METHOD

This article reported on the first eight subjects in an ongoing sleep and dreaming research project. The subjects were all males ranging in age from 23 to 32. A participant would arrive at the sleep laboratory around his usual bedtime. Small electrodes were attached to the scalp and near the eyes to record brain-wave patterns and eye movements. As in the Aserinsky study, the wires to these electrodes ran into the next room so that the subject could sleep in a quiet, darkened room.

The procedure for the study was as follows: For the first several nights, the subject was allowed to sleep normally for the entire night. This was done to establish a baseline for each subject's usual amount of dreaming and overall sleep pattern.

Once this information was obtained, the next step was to deprive the subject of REM or dream sleep. Over the next several nights (the number of consecutive deprivation nights ranged from three to seven for the various subjects), the experimenter would awaken the subject every time the information from the electrodes indicated that he had begun to dream. The subject was required to sit up in bed and demonstrate that he was fully awake for several minutes before being allowed to go back to sleep.

An important point mentioned by Dement was that the subjects were asked not to sleep at any other times during the dream study. This was because if subjects slept or napped, they might dream, and this could contaminate the findings of the study.

Following the nights of dream deprivation, subjects entered the *recovery phase* of the experiment. During these nights (which varied from one to six), the subjects were allowed to sleep undisturbed throughout the night. Their periods of dreaming continued to be monitored electronically and the amount of dreaming was recorded as usual.

Next, each subject was given several nights off (something they were very glad about, no doubt!). Then six of them returned to the lab for another series of interrupted nights. These awakenings "exactly duplicated the dream deprivation nights in number of nights and number of awakenings per night. The only difference was that the subject was awakened in the intervals between eye-movement (dream) periods. "Whenever a dream period began, the subject was allowed to sleep on without interruption and was awakened only after the dream had ended spontaneously" (p. 1706). Finally, subjects again had the same number of recovery nights as they did following the dream deprivation phase. These were called *control recovery*, and were included to eliminate the possibility that any effects of dream deprivation were not due simply to being awakened many times during the night, whether dreaming or not.

RESULTS

Table 1 summarizes the main findings reported. During the baseline nights, when subjects were allowed to sleep undisturbed, the average amount of sleep per night was 6 hours and 50 minutes. The average amount of time the subjects spent dreaming was 80 minutes, or 19.5% (see Table 1, column 1). Dement discovered in these results from the first several nights that the amount of time spent dreaming was remarkably similar from subject to subject. In fact, the amount of variation among the dreamers was only plus or minus 7 minutes!

The main point of this study was to examine the effects of being deprived of dreaming, or REM, sleep. The first finding to address this was the number of awakenings required to prevent REM sleep during the dream deprivation nights. As you can see in Table 1 (column 3a), on the first night, the experimenter had to awaken the subjects between 7 and 22 times in order to block REM. However, as the study progressed, subjects had to be awakened more and more often in order to

prevent them from dreaming. On the last deprivation night, the number of forced awakenings ranged from 13 to 30 (column 3b). On average, there were twice as many attempts to dream at the end of the deprivation nights.

TABLE 1 Summary of Dream-Deprivation Results

	1.	2.	3a.	3b.	4.	5.
	PERCENT DREAM- TIME	NUMBER OF DREAM DEPRIVATION	NUMBER OF AWAKENINGS		PERCENT DREAM- TIME	PERCENT DREAM- TIME
SUBJECT	BASELINE	NIGHTS	NIGHT	NIGHT	RECOVERY	CONTROL
1.	19.5	5	8	14	34.0	15.6
2.	18.8	7	7	24	34.2	22.7
3.	19.5	5	11	30	17.8	20.2
4.	18.6	5	7	23	26.3	18.8
5.	19.3	5	10	20	29.5	26.3
6.	20.8	4	13	20	29.0	
7.	17.9	4	22	30	19.8	16.8
					(28.1)*	
8.	20.8	3	9	13	-	**
Average	19.5	4.38	11	22	26.6	20.1

*Second recovery night.

**Subject dropped out of study before recovery nights.

(Adapted from p. 1707.)

The next and perhaps most revealing result was the increase in dreaming time after the subjects were prevented from dreaming for several nights. The numbers in Table 1 (column 4) reflect the first recovery night. The average total dream time on this night was 112 minutes, or 26.6% (compared with 80 minutes and 19.5% during baseline nights in column 1). Dement pointed out that there were two subjects who did not show a significant increase in REM (subjects 3 and 7). If they are excluded from the calculations, the average total dream time is 127 minutes, or 29%. This is a 50% increase over the average for the baseline nights.

While only the first recovery night is reported in Table 1, it was noted that most of the subjects continued to show elevated dream time (compared with baseline amounts) for five consecutive nights.

"Wait a minute!" you're thinking. Maybe this increase in dreaming has nothing to do with REM deprivation at all. Maybe it's just because these subjects were awakened so often. Well, you'll remember that Dement planned for your astute observation. Six of the subjects returned after several days of rest and repeated the procedure exactly except they were awakened between REM periods (the same number of times). This produced no significant increases in dreaming. The average time spent dreaming after the control awakenings was 88 minutes, or 20.1 % of the total sleep time (column 5). When compared to 80 minutes, or 19.5%, in column 1, no significant difference was found.

DISCUSSION

Dement tentatively concluded from these findings that we need to dream. When we are not allowed to dream, there seems to be some kind of pressure to dream that increases over successive dream-deprivation nights. This was evident in his findings from the increasing number of attempts to dream following deprivation (column 3a vs. column 3b) and in the significant increase in dream time (column

4 vs. column 1). He also notes that this increase continues over several nights so that it appears to make up in quantity the approximate amount of lost dreaming. Although Dement did not use the phrase at the time, this important finding has come to be known as the *REM rebound* effect.

Several interesting additional discoveries were made in this brief, yet remarkable article. If you return to the table for a moment, you'll see that two subjects, as mentioned before, did not show a significant REM-rebound (subjects 3 and 7). It is always important in research incorporating a relatively small number of subjects to attempt to explain these exceptions. Dement found that the small increase in subject 7 was not difficult to explain: "His failure to show a rise on the first recovery night was in all likelihood due to the fact that he had imbibed several cocktails at a party before coming to the laboratory, so the expected increase in dream time was offset by the depressing effect of the alcohol" (p. 1706).

Subject 3, however, was more difficult to reconcile. Although he showed the largest increase in the number of awakenings during deprivation (from 7 to 30), he did not have any REM rebound on any of his five recovery nights. Dement acknowledged that this subject was the one exception in his findings and theorized that perhaps he had an unusually stable sleep pattern that was resistant to change.

Finally, the eight subjects were monitored for any behavioral changes that they might experience due to the loss of REM sleep. All the subjects developed minor symptoms of anxiety, irritability, or difficulty concentrating during the REM interruption period. Five of the subjects reported a clear increase in appetite during the deprivation, and three of these gained three to five pounds. None of these behavioral symptoms appeared during the period of control awakenings.

SIGNIFICANCE OF THE FINDINGS AND SUBSEQUENT RESEARCH

More than 30 years after this preliminary research by Dement, we know a great deal about sleeping and dreaming. Some of this knowledge was discussed briefly earlier in this chapter. We know that most of what Dement reported in his 1960 article has stood the test of time. We all dream, and if we are somehow prevented from dreaming one night, we dream more the next night. There does indeed appear to be something basic in our need to dream. In fact, the REM-rebound effect can be seen in many animals.

One of Dement's accidental findings, one that he reported only as a minor anecdote, now has greater significance. One way that people may be deprived of REM sleep is through the use of alcohol or other drugs such as amphetamines and barbiturates. While these drugs increase your tendency to fall asleep, they suppress REM sleep and cause you to remain in the deeper stages of NREM for greater portions of the night. It is for this reason that many people are unable to break the habit of taking sleeping pills or alcohol in order to sleep. As soon as they stop, the REM-rebound effect is so strong and disturbing that they become afraid to sleep and return to the drug to avoid dreaming. An even more extreme example of this problem occurs with alcoholics who may have been depriving themselves of REM sleep for years. When they stop drinking, the onset of REM rebound may be so powerful that it can occur while they are *awake*! This may be an explanation for the phenomenon known as *delirium tremens* (DTs), which usually involve terrible and frightening hallucinations during withdrawal (Greenberg & Perlman, 1967).

Dement spent decades following up on his early preliminary findings regarding the behavioral effects of dream deprivation. In his later work, he deprived subjects of REM for much longer periods of time and found no evidence of harmful changes. He concluded that "[a] decade of research has failed to prove that substantial ill effects result even from prolonged selective REM deprivation" (Dement, 1974).

Finally, research with its origins in Dement's early work reported here suggests that there is a greater synthesis of proteins in the brain during REM sleep than during NREM sleep. Some believe that these chemical changes may represent the process of integrating new information into the memory structures of the brain and may even be the organic basis for new developments in personality (Rossi, 1973).

RECENT APPLICATIONS

Most experts in the field of sleep and dreaming credit Aserinsky with the discovery of REM sleep. Most studies relating to sleeping, dreaming, or sleep disorders attribute that basic fact to him. Consequently, his early work with Kleitman is frequently cited in many recent scientific articles.

Dement's extension of Aserinsky's work continues to be cited frequently in a wide range of research articles relating to sleep patterns. One such recent study found that REM sleep plays a role in people's ability to improve their performance on a newly learned task while they sleep (Stickgold et al., 2000). Another article relying on Dement's 1960 research examined REM during daytime sleep, following a night without any sleep at all (Werth et al., 2002). These researchers found, compared to nighttime sleep, daytime sleep produces significantly different REM patterns. For example, the number of awakenings needed to prevent REM only doubled at first and then stopped increasing completely. Also, subjects displayed only a small REM rebound effect (11.6% compared to 26.6% in Dement's study). These findings imply that our typically patterns of REM are associated with our natural, biological predisposition toward nighttime sleep. In other words, we humans are *diurnal*, not *nocturnal* creatures.

Dement, now at Stanford University where he began its program in sleep medicine, published his most recent book, *The Promise of Sleep: A Pioneer in Sleep Medicine Explores the Vital Connection Between Health, Happiness and a Good Night's Sleep*, in 2000. In this book, written for the nonscientist, Dement draws upon his four decades of research on sleep, and applies his vast accumulation of knowledge to helping all of us understand the vital importance of quality sleep and how to achieve it (see <http://www.stanford.edu/~dement/> to learn more about Dement's work at Stanford University's Center of Excellence for the Diagnosis and Treatment of Sleep Disorders). In his book, Dement describes us as a "sleep-sick society," and set forth his goals as a sleep researcher:

For most of my career ... I have worked unceasingly to change the way society deals with sleep. Why? Because the current way, or nonway, is so very bad ... It greatly saddens me to think about the millions, possibly billions, of people, whose lives could be improved if they understood a few simple principles. Changing the way society and its institutions deal with sleep will do more good than almost anything else I can conceive, or certainly that was ever remotely in my grasp to accomplish. (Dement, 2000, pp. 4-5)

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