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Tutorial

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Sleep: The Night-Life Tour

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To the oral myologist charged with modifying basic body functions, and assuring that the patient maintains those changes permanently, sleep can pose a formidable challenge. Sucking activity, respiration, deglutition—all of these enterprises continue through the night; the job is not complete unless retraining persists during sleep. Therefore, it might be advantageous to study the strengths and weaknesses of our adversary, to have an insight into some of the newer discoveries about sleep, "our other life."

Sleep is still a poorly understood area; most authorities shy away from even stating a definition, for we still do not know precisely what sleep is. It might be noted that we never complain about sleep, only the lack of it. The establishment of numerous sleep laboratories has led to some interesting revelations which, combined with some basic fundamentals, can improve our grasp of the subject.

One of the most fascinating questions remains without an answer: why do we sleep? Almost the only proven fact that scientists have supplied concerning the purpose of sleep is that it relieves sleepiness. There is no shortage of "strong indications," and "logical deductions" based on these, so that despite verifications of some aspects of sleep, other portions remain conjecture. Researchers have yet to pin down the mechanism by which the brain switches from wakefulness to sleep, and there is even less assurance about the means by which it then reverses and awakens us.

Nevertheless, knowledge of the area has expanded greatly in the past decade or so. If nothing else, we can dispel some of the traditional misinformation about sleep. The purpose of this paper is not to report new data, but rather to assemble some items of current theory and elucidate their implications for the oral myologist. While the primary intent is to improve the patient's treatment, some aspects may have personal importance for the therapist.

PATTERNS OF SLEEP

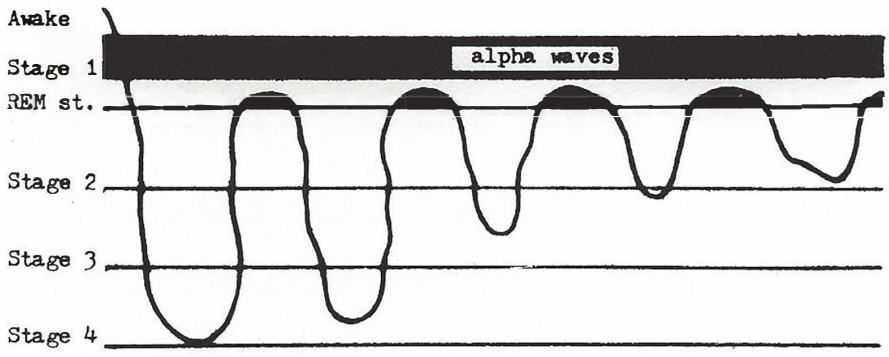
Sleep is a complex biological imperative that is intricately related to other biological rhythms and body functions. It occurs in four basic stages, identified and defined by different brain-wave tracings shown on an electroencephalogram (EEG). These stages are designated by numbers in the U.S., whereas Europeans prefer letters of the alphabet. Two other levels associated with sleep—of far greater interest to the oral myologist—are not accorded numbers; these are the alpha stage, the transition period between wake and sleep, and the REM (rapid eye movement) stage during which dreams are spun.

As one nears sleep, the "brain-print" issuing from the EEG reflects a change from the rapid, agitated waves of wakefulness to the slower, smoother pattern of the "alpha rhythm." Alpha waves have a frequency of 8 to 13 cycles per second—about as fast as you can tap a finger. They tend to disappear if the eyes are opened, but may resume if a person is extremely bored. The alpha stage is the level sought by the hypnotist; without understanding the physiology behind it, he has historically requested subjects to close their eyes during induction, but has found that eyes may be safely opened once the hypnotic state is achieved.

As the brain becomes less vigilant and the body more relaxed, wakefulness merges into true sleep and the alpha rhythm disappears. It is replaced by slower waves of 4 to 6 cycles per second, and we enter Stage 1, a light sleep of rather short duration. In only a few minutes we reach Stage 2, a medium-depth sleep producing even slower waves. "Sleep spindles," short bursts of waves, begin to appear on the tracing.

We drift progressively downward through Stage 3, a deeper level, to Stage 4, the state of profound sleep from which arousal is difficult; it is identified by large, very slow waves of high voltage.

The popular notion that we fall into deeper and deeper sleep during the night until we reach the nadir, then turn and become more and more awake as morning nears, is far from accurate. In fact, during a normal uninterrupted night's sleep of 7 to 8 hours, we swing from light to deep sleep and back again about 5 times, as shown schematically in the accompanying diagram. Each trip down and back requires about 90 minutes; slight individual differ-



THE STAGES AND CYCLES OF SLEEP. Deeper and lighter sleep alternate as suggested by curved line. The trough of sleep tends to become shallower as the night wears on. The first sleep of the night is usually deepest, and the first dreaming period occurs on emerging from it. Solid black areas indicate dreaming episodes; 4 or 5 such dream cycles may occur, separated by periods of dreamless sleep lasting about 90 minutes. The alpha wave stage blends sleep with consciousness.

ences of 5 or 10 minutes may occur in either direction, but are consistent for each individual.

On the first excursion of the night, an elapsed time of approximately 40 minutes is required to descend from Stage 1 to Stage 4, the state of oblivion that most people think of as sleep. Blood pressure, pulse, and respiration decline as we drift down through Stages 2 and 3, but muscles retain some vigor and movement occurs regularly. Sleepwalking and bed-wetting occur only during these deeper stages. At Stage 4 there is less body movement, and at least briefly we "sleep like a log." Stage 4 restores, relaxes, and rests the body physically. After strenuous physical activity, the need for this level of sleep is increased. Stage 4 is only one type of sleep, however, and does nothing to satisfy other sleep needs.

Having attained deepest sleep, we do not linger very long. We gradually swing back up through the lighter phases of sleep during which there are again shifts of posture and other body movements. As we approach Stage 1, muscle tone almost disappears; except for an occasional twitch, the body is virtually paralyzed. This is the "emergent" phase where we are shunted off into the stage of REM sleep and experience our first dreams of the night. We probably climb to the point of waking several times in the night without having any recollection of doing so.

For the balance of the night sleep continues in this cyclic fashion. The first sleep of the night tends to be the deepest. Thereafter, we may descend only to Stage 3—or even Stage 2, as the night progresses—then return upward toward Stage 1.

PERCHANCE TO DREAM

Everyone dreams[9,10]. There are those who deny that they dream, and most of us are able to recall little more than the last dream of the night. Nevertheless, itemizing one's actual dreams of only a single night might yield a roster resembling a goodly portion of the day's TV listings. Approximately 20% to 25% of sleep is spent in dreaming.

As we slide down the brain-wave incline into sleep, the cerebral cortex also falls asleep. However, as we struggle up from the depths of the first heavy sleep of the night, our brain clicks on and begins to function as actively as in the most alert waking state. Frequent bursts of rapid eye movements, observable through closed eyelids, signal the start of a dream episode. It is assumed that the eyes react as we scan our dream, although the rapidity of the movement is difficult to understand. The congenitally blind do not have visual dreams, nor do they exhibit rapid eye movement[10]. The first REM period of the night usually lasts only 10 minutes or so, then we begin the next cycle and cortical activity subsides.

As the night progresses, less time is devoted to the deeper levels, whereas an increasingly longer time is spent in the REM stage. In addition to the eye movements, REM sleep can be recognized by complete relaxation of the mandible. There is autonomic activity at this stage, some muscular twitching, the pulse becomes irregular and the blood pressure variable[7]. Males of all ages have penile erections during REM sleep, and gastric secretion is increased in both sexes.

When we are aroused from sleep during the night, it is necessary to return to Stage 1 and begin the entire cycle anew. The essential status of REM sleep is revealed by some of the intriguing studies involving dream deprivation [2, 3, 4, 11]. When tireless researchers awakened experimental subjects at the conclusion of a REM period, the subject invariably reported dreaming, then dropped off into the next cycle of sleep with no apparent aftereffect. However, dramatically different results were obtained when the subject was roused at the first indication of REM sleep throughout the night. Subjects began to show anxiety, irritability, and difficulty in concentrating. Powerful efforts were exerted to make up for the lost dreams.

Typically, on the first dream-deprivation night, a sleeper had to be awakened 6 or 7 times to deny him his dreams. On the second night the number of awakenings almost doubles, and by the fifth night as many as 30 were required to halt attempts to dream. One volunteer reached the point after 6 nights that he could no longer be awakened by loud noise or gentle shaking. Rather than falling back into the dreamless sleep that usually precedes dreaming, he began to dream within 30 seconds after closing his eyes, and had to be disturbed over 200 times. After 8 nights it was impossible to wake him, and he began dreaming almost the instant he closed his eyes.

Other experimental subjects in such studies have experienced extreme depression, or even mental illnesses necessitating hospitalization, months after research was finished. It should be noted in this regard that some healthy subjects were kept awake for more than a week with the result that they got very sleepy; they did not get sick or go crazy. The implication remains that we do not dream because we choose to, but because we have to. We can no more avoid dreaming than we can avoid digestion.

What specific purpose, then, do dreams serve? What critical, if unrecognized, need is thus met? There are conflicting theories. Some feel that dreaming may be a sort of therapeutic insanity, a process that permits us to be "quietly and safely insane every night of our lives[4]." Such statements may be occasioned by the psychotic-like quality of most reported dreams, and the irrational gibberish of those who talk in their sleep.

It can be assumed that, just as Stage 4 sleep restores one physically, REM sleep restores us mentally. It is important for the consolidation of recently acquired learning, and for psychological adaptation. Some feel that during REM sleep the day's events are reviewed, and important information is categorized and integrated into various brain circuits. We gain more perspective about troublesome issues. It has been shown that psychological stress creates a need for more REM sleep.

DISCUSSION

Based on the foregoing descriptions, a dozen items of importance to the oral myologist may now be examined. The list is not exhaustive, and the research in some areas remains maddeningly incomplete. It is a start.

Learning

We should note first of all the unique and very precious advantage available to us during the fleeting

alpha wave stage. This is the only line of communication between conscious and subconscious function that is known to us at present, short of formal hypnosis. These fortunate moments that blend wakefulness into the first sleep of the night represent our single opportunity to exert voluntary influence over involuntary performance. The mechanics of such use have been described elsewhere[1].

We cannot will our subconscious mind to alter its behavior during the waking state. And once we drop into true sleep, even Stage 1 sleep closes the door to the acquisition of external knowledge. There is general agreement among sleep researchers that it is simply not possible to learn original material while asleep. The claims of "sleep-learning" hucksters who offer fame, fortune, and foreign languages neatly packaged in cassettes are evidently shame and delusion.

It is true that some studies have revealed the possibility of reinforcing *previously learned* behavior through nocturnal stimulation[5]. However, this can be an erratic procedure. We saw above that the cerebral cortex ceases its labors as we descend to even moderate sleep. Stimulation at this level or below would be futile. Only during REM sleep is the cortex at work, and even that activity may be deceptive. We do not know *how* the brain is then working, what processes it is busy with, only that it is doing something. It seems certain that it is not the cogent, reasoning toil of the waking brain. It would appear impractical and highly inefficient to expect revisions of behavior under these conditions. The hope that we can sleep and dream our way to mastery of anything that is learnable seems destined to remain the stuff that dreams are made of.

Memory

It may be beneficial to note the role of memory in this context. Memory is the basis of learning. We recognize that our mind may be as porous as a sieve while in a conscious state, dropping facts and details rather disconcertingly at times. Still, on a subconscious level, every one of us has almost total recall. Those with a "good memory" are simply those who are more adept at retrieving items from the vast storehouse of their subconscious.

Dreaming obviously does not occur on a conscious level. We may doubt that statement occasionally, when we look into the face of a patient and find him lost in daydreaming. The latter is quite a different phenomenon. Real dreams are right in there with our subconscious during sleep; one might think that, with such direct access, our subconscious would retain dreams, would catalog and file each one as it occurs. In fact, the rapidity with which dreams are forgotten — indeed, never remembered at all—is truly astonishing. All but a tiny part of our dreams might as well never have transpired. Even the most vivid dream begins to fade as we grope to describe it the next morning. Few of us could narrate any dream that we had only last month unless we wrote it down immediately, embellished it by filling in the gaps of the original, and then reinforced with conscious review.

Hypnosis has revealed that there is not even subconscious recall for all but a minute fraction of dreams. If there is no subconscious memory, no learning occurred. It is hard to understand our desperate need for the evanescent dream, in the dim light of present knowledge.

Individuality of Sleep

Some of us definitely dream to a different drummer. While the average person sleeps 7.9 hours per night[10], an individual person may sleep 6 or 9 hours. There is even greater variability in personal bedtimes. The early bird is wide awake and alert at 5 a.m., does his best work in the morning, but runs down early in the evening and is ready for bed at 9 p.m. or earlier. The night owl finds it difficult to awaken before midmorning, does not get fully cranked up until early afternoon, often does his best late at night, and retires during the wee hours.

Neither type is "better," nor does either necessarily get too little or too much sleep. They simply use a different distribution of sleep through the 24 hours. The differences are due to each individual's biological rhythms and should be respected. All biological rhythms exist for a reason. People get along better when they adapt to the demands of their own rhythms and avoid attempting to change them.

This can have definite importance for the patient who is trying to modify subconscious behavior. During the period of attempted change, the usual bedtime should be observed without exception, even if the hour seems unacceptable to the clinician. Special care should be taken not to request an earlier than usual schedule; by the time sleep finally arrives, motivation may have already left.

There is also the consideration that body rhythms are synchronized; disruption of one biological rhythm may cause problems with another. We should, of course, do everything in our power to maintain optimum conditions during the latter stages of therapy. Asynchrony can result from going to bed earlier than usual and arising earlier. The experienced clinicial will already be aware of the disastrous results when patients stay up long *after* customary bedtime.

Waking Rhythms

There is considerable evidence that the 90-minute cycles that recur all during sleep may continue throughout the 24 hours. Even when awake, we are differently conscious and alert from moment to moment. Our mood changes. Various biological measures are known to differ from one time to another. In the waking state, muscular activity, cerebral axcitement, or strong motivation can mask a tendency to let down periodically. Still, the ritual of the midmorning and midafternoon coffee break, the moments when ambition is great and the mind crystal clear, these may reflect fluctuations of a basic rest-activity cycle. Experimental subjects have been observed to eat more at periods that correspond to their nighttime REM sleep stage[9]. Our custom of eating 3 meals a day, combined with the coffee break snacks and one at bedtime, would roughly approximate 90-minute intervals.

The clinician cannot schedule therapy sessions to correspond only to the "up" moments of either therapist or patient. Given some knowledge of the surges and slides in performance, however, we might be able to better understand why some sessions are more difficult

than others, and to withhold blame from either party. An important fact to realize is that the clinician must be prepared to provide even stronger motivation for the patient who is in a dull and listless trough right at the time of his appointment.

Secretions

As might be expected, body secretions continue in sleep, although there are changes in volume. Ordinarily, urine secretion is less during sleep—an obvious blessing—but the kidneys continue to function. Perspiration appears to increase, although it is difficult to separate the effects of sleep from environmental factors such as room temperature and the insulating quality of blankets.

Digestion seems to be little affected by sleep. The secretion of gastric juice follows a biological rhythm that rises and dips throughout the 24 hours. Gastric secretion is increased during REM sleep, and peaks between 1 and 3 a.m.[7]. This would correspond to the second REM stage, since a common hour for going to sleep is 10 to 12 p.m.

There have been otherwise knowledgeable writers on the subject of sleep who state that the salivary glands stop secreting fully during sleep[10]. Would that it were so! To show the fallacy of such thinking requires only the morning arousal of one mouthbreather. The parched and sore conditions of the mucous membranes of the throat, which require constant bathing with saliva, and the sopping cheek lifting from the pool formed by saliva that has trickled out instead of being swallowed, these are convincing evidence. Certainly the secretions of both nose and mouth diminish, but they do not cease. The most critical aspect of the oral myologist's work lies in providing an effective means by which to normalize deglutition during sleep. Without this, nothing.

Sedatives

It was hinted above that changes in nocturnal behavior patterns are achieved more readily when the patient is able to drop into the alpha wave state and thence to sleep without undue delay. It has been suggested that sedation may be advised for those patients who are unable to succumb promptly to Marlowe's "sweet harlot of the senses." It now appears that we should not be too glib with such recommendations.

It has been found that most, if not all, sedatives and tranquilizers interfere with REM sleep. Some researchers now feel that sedatives do not produce natural sleep but create a state similar to sleep[6]. Impaired task performance and feelings of grogginess may be noted the day after sedatives have been taken, effects that may be due to REM sleep deprivation.

We might be better advised to offer Granma's prescription of a glass of warm milk at bedtime. Most protein food, including milk and some vegetables, contain the amino acid, L-tryptophan. The latter is a precursor of the neurotransmitter serotonin, which is believed to induce and maintain sleep. In doses as low as one gram, L-tryptophan has been found to speed the onset and prolong the period of sleep without altering REM sleep in any way[6]. Reported studies have used doses of one gram or more; one would require 8 glasses of milk to provide one gram of L-tryptophan. Nevertheless, it might be possible that the amount contained in a glass of milk, added to the person's L-tryptophan intake at dinner, would suffice to enhance sleep[7].

Stimulants

The topic of alcohol is misplaced in this section in order to clarify its rightful place. Alcohol is frequently considered to be a stimulant; in fact, it is a central nervous system depressant. This oldest of sleeping aids, often self-prescribed even by some who have no sleeping problem, does appear to speed the onset of sleep. However, its deleterious effects far outweigh its benefits. It sharply reduces REM sleep, and the hangover that follows may be partially due to REM deprivation.

Pep pills, the amphetamines, are true stimulants with a powerful effect on higher nerve centers. They may be taken unknowingly in weight-control medication and result in some unexpected insomnia.

Much the same result can stem from ephedrine, which raises blood pressure, stimulates the heart, relaxes smooth muscle of the bronchial tree and has a membrane-shrinking action. Since it is a frequent component of nasal medications, we may be spinning our wheels with certain problem patients. We suggest a spray or pill to reduce nasal congestion, so that the patient can sleep better, when this very medication impairs sleep.

It is generally recognized that caffeine can interfere with sleep for several hours. What we sometimes fail to remember is that soft drinks and that nice cup of hot cocoa also contain appreciable amounts of caffeine and can be just as harmful.

Naps

It may be helpful to note one or two characteristics of naps. They represent a different type of sleep than the full-fledged, nighttime production. Daytime naps do not adhere to the same rhythm as nightly sleep. Some portions of the cycle are omitted or abridged, and even successive naps may be dissimilar. For instance, REM sleep predominates during morning naps, whereas we may plunge directly into Stage 4 sleep in the late afternoon[7]. The alpha wave period certainly appears to be different; it seems to have little potential for either help or hindrance in the procedures with which the oral myologist is concerned, during naps.

Enuresis

Information concerning bed-wetting is customarily entered under the heading of "Emotional status" in the case-history form of the present writer. It may well be a matter for the physician, but seems invariably to have an emotional component. As such, it would be inappropriate to delve into remediation in this context. We may note that muscle tonus in REM sleep is almost nonexistent. Some opinion holds that certain voluntary muscles, such as the sphincters of the bladder and rectum, do not relax but instead increase their tonus. Others deny the need for a tightly contracted external sphincter, claiming that the internal sphincter, which is not a voluntary muscle, is quite sufficient to serve the "end" in question. In any event, enuresis does *not* occur during REM sleep.

It is advisable to keep in mind the statement previously made, that the kidneys continue to function in sleep. Input is related to output. Restricting fluid intake before going to bed is one of the keystones of treatment for the enuretic.

Sleeptalk

Although not of critical concern to the therapist, it is interesting to take some notice of the mumbled assertions of the sleeper. As an indication of the quality of thinking performed when one is asleep, it is evidence of a most humiliating sort. Sentences or jagged fragments issue forth which make absolutely no sense in the critical light of morning. Despite our occasional impression an awakening that we formulated some profound concept during the night, experiments wherein these verbalizations were tape recorded have produced no candidates for the Nobel prize in either literature or philosophy.

It would be unfair to blame such babbling on the cortex. It is obviously functioning in a different workshop when asleep. While great amounts have been learned, we still do not understand many aspects of mental activity in sleep. We can monitor only the cerebral cortex; we cannot implant electrodes in the multitudinous lower centers in a human brain, the most complex organ in creation. The exact nature of nighttime interaction between the cortex and deeper structures remains a mystery.

Research personnel are also human, and engage in frequent speculation. We may also hazard the guess that thought processes may occur in sleep that are completely alien to our present concepts. As the cerebrum communicates with its staff of assistants, we may be listening to a foreign language.

Sleepwalking

The legendary exploits of somnambulists are frequently heard; some of them are true. They have actually walked along window ledges 12 stories high, tightroped along the edges of roofs, and performed other feats that would have left them terror-struck had they been attempted while awake. Some sleepwalkers are less adroit, crashing into furniture, falling from windows, and walking into walls. Evidently, even subconscious brains vary in intelligence.

What is the status of the sleepwalker? Is he asleep, half asleep, or awake? There are conflicting reports, the only agreement being that sleepwalkers never remember their adventures. Amnesia is complete. His eyes are usually open, he may be able to open dors and turn keys, but his appearance is that of a robot; his movements are slow and rigid, his face is devoid of expression. No support is found for the popular notion that it is extremely dangerous to awaken a sleepwalker; it may be more hazardous not to wake him.

Published opinion about somnambulism has tended to be more psychiatric than physiologic, leaving many issues in doubt. Amnesia and failure to recognize danger indicate that cortical function is low during such excursions. The sleepwalker is reportedly less stable emotionally, often characterized by frequent temper tantrums, nightmares, enuresis, and phobias of various sorts. Most writers agree that anxiety is a strong component of the situation. Sleepwalking episodes may follow emotional upsets or a series of distressing dreams.

There is no evidence that sleepwalking interferes greatly with myofunctional therapy. We would certainly prefer a period of calm, routine sleep. The clinician might be alert to the fact that homework, pressures to over-achieve, exciting prebedtime incidents, or even extreme fatigue may trigger sleepwalking.

Night Work

Some of us have patients who do rotating shift work, meaning that every week or so they work, and therefore sleep, during a different portion of the day or night. Many companies operate around the clock, work 3 shifts, establish the "fair" requirement that each worker take a turn on each shift, and thus assure themselves of a crew that is constantly tired, sometimes disoriented, frequently dyspeptic, and never performing at full efficiency.

It might appear that adjustment to such a schedule could be accomplished within a day or so. Unfortunately, sleep habits are not simply "mind over matter." The subtle physiological rhythms discussed above are stubborn and persistent. Such modifications during sleep of metabolism, secretion, excretion, and other biologic functions resist time changes; several weeks may be required to make a full adjustment.

This same condition is produced with the connivance of airplanes: "jet lag" is now common. The wisdom of the tourist's body disputes the local clocks, claiming that they are off by several hours. Adjustment to the new time is equally difficult, depending on the number of time zones crossed.

The oral myologist cannot, of course, order circumstances in ideal fashion. We cannot request the worker to quit his job without jeopardizing our fee. We can wait for the traveler to readjust, and we can try to time therapy so that the shift worker is scheduled for some combination of day and swing shifts during the critical period of subconscious mastery.

SUMMARY

No specific methodology has been proposed herein whereby newly-acquired patterns of behavior can be extended into nighttime function. Some of the physiologic actualities, proven or suspected, have been listed for consideration. Whatever the technique employed by the clinician, it is felt that cognizance should be taken of the limitations and opportunities presented by sleep.

Therapy must be complete. In order to be complete, it must be consistent with body demands, mental and physical, waking and asleep.

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