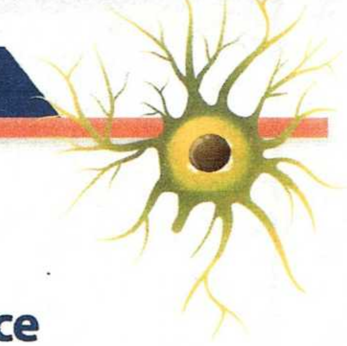

Beyond the waking brain: How the neuroscience of sleep can inform clinical practice

How often have you been told that you need to get a good night's sleep? For adults, "good" often means eight hours, but requirements increase for adolescents (nine hours), early adolescents (10 hours) and children (11 hours). Though we spend nearly a third of our lives asleep, historically, few resources have been devoted to understanding this phenomenon, and science has just begun to reveal how vital sleep is to our mental well-being.

Clients frequently mention troubles with sleep, such as sleeping too little, sleeping too much or experiencing nightmares. Such comments are often said in passing, with little recognition of the significance of such troubles. Why is sleep so critical, and how can knowledge of brain functioning during those restful, or not so restful, hours inform our ability to support both our clients and ourselves?

According to Mary Carskadon and William Dement, two leaders in sleep science, sleep is an intricate physiological process and behavioral state of perceptual disengagement from, and unresponsiveness to, the external environment. This ability to disengage proves critical to physiological allostasis and, ultimately, our survival. Sleep is a time of restoration and renewal but also of learning, memory, immune functioning and emotional processing. It is a dynamic process affecting our bodies on every structural level.

Perhaps the most recognized aspect of sleep is that it comprises two predominant types: rapid eye movement (REM) sleep and nonrapid eye movement (NREM) sleep. These types are found in nearly every species and are as distinct as sleep and wakefulness. The activity in the body and brain form characteristic patterns during REM and NREM sleep, with the two distinguished by differences in brain wave activity, muscle activity and eye movements.

NREM and slow wave sleep

NREM sleep is divided into three stages (historically it has been four, but the American Academy of Sleep Medicine reduced this to three stages in 2007). Each stage represents a slower, deeper level of sleep. During NREM, the brain experiences declines in activation in virtually every area, including the thalamus, hypothalamus, limbic regions, brainstem and prefrontal cortex. Such decreases become more pronounced with each advancing stage of NREM.

Stage 1 NREM sleep occurs between wakefulness and sleep. A person's heart rate begins to slow, and brain wave frequencies progressively decrease from beta (wakefulness) and alpha (relaxation) to lower frequency and higher amplitude theta waves (reduced consciousness). One can easily be roused from sleep at this stage because we are still aware of outside sounds and smells.

As a person enters stage 2 NREM sleep (N2), his or her breathing grows deeper and brain wave frequencies become slower, as theta waves predominate. Interestingly, N2 is characterized by oscillating periods of K-complexes (sudden periods of higher amplitude waves) and sleep spindles (sudden periods of higher frequency waves), which may have a role in memory. Muscle activity decreases even more, and a person's awareness of outside stimuli diminishes. Individuals typically spend more time in this stage of sleep than any other.

Stage 3 or N3 (classically defined as stages three and four) is known as slow wave sleep or deep sleep. Delta waves of even lower frequency are characteristic of this stage, with a person having little to no awareness of the outside world. Body temperature, breathing, heart rate and blood pressure decrease to their lowest levels. This is our most restful sleep and the most challenging from which to wake. When you wake feeling delirious and incoherent, you are likely coming out of N3 sleep. As the night progresses, our time spent in N3 sleep decreases with each successive sleep cycle.

Homeostasis and body repair are among the foremost functions of slow wave sleep. The longer one is sleep deprived, the longer one tends to spend in N3, a process of homeostatic regulation known as recovery sleep. The body craves this restorative process and will work to try and make up for what it misses.

During slow wave sleep, we experience a marked increase in growth hormone, which stimulates cell reproduction and regeneration. The immune system is also especially active during this time. We experience a surge of proinflammatory cytokines, which may help facilitate the distribution and replenishment of lymphocytes (white blood cells) in lymph nodes, according to Luciana Besedovsky of the University of Tübingen. During slow wave sleep, our bodies are mustering all of their resources to heal, protect and grow.

Slow wave sleep also serves an integral role in learning and memory. Memories are initially encoded as a memory trace, but this initial encoding must be consolidated, with help from the hippocampus, to make the memory stable. Although the exact mechanisms remain unclear, the consolidation of episodic (fact-based, nonemotional) memories likely occurs during slow wave sleep.

Giulio Tononi of the University of Wisconsin–Madison suggests a somewhat paradoxical view of memory and learning during this stage, indicating that the rest and repair of the brain during slow wave sleep also extends to the resetting of neuronal connections. During the day, our brains encode a lot of information. As a result of all this learning, the synaptic strength among various brain structures increases. Tononi and his colleagues suggest that the purpose of slow wave sleep is to selectively decrease the synaptic strength of some connections to their baseline rate of firing so they will be ready to form new connections the next day. Only the strongest connections remain for further processing later in sleep. This is why if someone experiences sleep deprivation, his or her learning and memory the following day may be compromised.

REM sleep

Best known for being the stage of sleep in which we dream, REM sleep is the last stage in the sleep cycle. As the name implies, REM sleep is characterized by intermittent, rapid back-and-forth eye movements. During REM, the muscles are virtually paralyzed as muscle neurons are hyperpolarized — a phenomenon known as atonia. However, brain waves during REM nearly resemble those of a wakeful brain. Individuals spend about 25 percent of sleep time in REM sleep, with the duration of time spent in REM increasing over successive sleep cycles.

The pons and midbrain areas regulate REM sleep. Electrical potentials generated by the pons are sent to the lateral geniculate nucleus (the primary connection point between the retina, optic nerve and visual cortex) of the thalamus and on to the occipital lobe (the primary visual cortex). These waves signal the start of REM sleep and produce the characteristic eye movements. During REM sleep, we also experience a deactivation of the prefrontal cortex coupled with an increased activation of the brain's limbic regions. This pattern of activation is thought to underlie the function of REM sleep.

REM sleep is critical to emotional memory consolidation. Interestingly, Matthew Walker and Els van der Helm of the University of California–Berkley suggest that REM sleep not only facilitates this process but also helps decouple the memory itself from the affective experience of that event. In other words, the memory becomes separate from the way that experience made us feel. Walker and van der Helm go on to say that as the emotional memory becomes reinforced over subsequent REM cycles, the affective power of the memory decreases. Thus, REM sleep helps with daytime emotional regulation and the processing of emotionally charged events. REM sleep may also be essential in learning and brain development, serving to stimulate adaptive neuronal connections, which may complement the passive process experienced in slow wave sleep.

Sleep cycles

As we sleep, we experience cycles of NREM and REM sleep roughly every 90 to 120 minutes. During early cycles, individuals spend the predominant amount of time in slow wave sleep. As an individual moves through sleep cycles, the longer periods of slow wave sleep are condensed to allow for more REM sleep, suggesting a trade-off between these two.

Scientists do not yet fully understand why this trade-off occurs or why it happens in this order (a process known as sleep architecture), but the balance between them plays a notable role in many mental health disorders.

Sleep initiation, thermoregulation and arousal

Our ability to sleep and our sleep patterns are largely dictated by our biological clock. The anterior hypothalamus and adjacent basal forebrain are key brain areas associated with our circadian (diurnal) and circannual rhythms and the initiation of NREM sleep and sleep-wake cycles.

Unlike neurons in other parts of the brain, neurons in the preoptic area of the hypothalamus are more active during transitions from waking to NREM sleep. Dennis McGinty and Ronald Szymusiak at UCLA detail how these neurons are also temperature sensitive, with increasing temperatures inducing slow wave brain activity and NREM sleep. Interestingly, core body temperature dips at the onset of sleep and stays lower until waking. Individuals with depressive symptoms often have elevated nocturnal core body temperatures, which may contribute to sleep disturbances.

Furthermore, melatonin, commonly released at night, not only increases growth hormone but also increases skin temperature of the hands and feet. This increase in distal skin temperature leads to heat loss and an overall decrease in core body temperature. Melatonin is produced by serotonin in the pineal gland and decreases with age. Roy Raymann, Dick Swaab and Eus Van Someren demonstrated that increasing distal skin temperature in older adult patients increased their time spent in slow wave sleep and decreased early morning waking. Furthermore, exercising in the afternoon can increase melatonin and influence core body temperature during the evening, priming individuals for restorative sleep.

The diurnal rhythms generated by the suprachiasmatic nucleus, home to our biological clock, also regulate hormone secretion and physiological arousal. During slow wave sleep, the body experiences a downregulation in the hypothalamic-pituitary-adrenal (HPA) axis and sympathetic nervous system (SNS), as well as associated decreases in cortisol, epinephrine and norepinephrine. According to Theresa Buckley and Alan Schatzberg of Stanford University, elevated levels of corticotropin-releasing hormone, which triggers the production of cortisol in response to stress, decreases time spent in slow wave sleep. This might be one reason that periods of high or traumatic stress, which amplify HPA axis and SNS activity, can disrupt sleep.

Sleep deprivation's impact on physical, mental well-being

Insufficient sleep has countless physiological, neurological and behavioral consequences. Disrupted sleep is both a cause and symptom of numerous disorders and can be a self-perpetuating factor in the chronicity of others.

Less than six hours of sleep per night is associated with higher blood pressure; increased risk of obesity, diabetes and cardiovascular disease; inflammation; and impaired immune functioning. Even 24 hours of deprivation increases stress hormones such as cortisol and norepinephrine, suggest Eun Yeon Joo and Cindy Yoon at the Sungkyunkwan University School of Medicine. Psychologically, impaired sleep can lead to compromised cognitive functioning and memory; intensified aggression and impulsivity; increased externalizing and negative affect; and decreased emotion regulation across all age groups. Nearly every psychological disorder is linked to impaired sleep, including attention-deficit/hyperactivity disorder, bipolar disorder, substance use and relapse, depression, anxiety, posttraumatic stress disorder (PTSD) and schizophrenia.

In 2007, Seung-Schik Yoo of Harvard Medical School reported that one night of sleep deprivation led to participants having a greater than 60 percent increase in amygdala reactivity in response to aversive images and a significant decrease in the communication between the amygdala and prefrontal cortex. As a result, the prefrontal cortex was no longer as efficient at regulating the activity of the amygdala. Sleep reinforces the ability of the executive control region of our brain to regulate the emotional centers, a process that influences not only emotional regulation but also other regulatory processes such as impulse control, decision-making and social engagement. Such disruptions in brain processes are thought to underscore the association between sleep disruption and mental health disorders.

As further reviewed by Walker and van der Helm, sleep disturbances are often one of the very first symptoms of depression and represent onset of recurrent depressive episodes. Individuals experiencing depression tend to spend more time in REM sleep, with REM sleep starting earlier in the sleep cycle. This means they spend less time in slow wave sleep, which may explain impaired cognitive functioning and episodic memory in depression. Depression also has close connections with immune system functioning and has been conceptualized as an immune system disorder. Given the role that sleep, and especially slow wave sleep, plays in immune functioning, addressing sleep may help alleviate both inflammation and symptoms of depression.

Disrupted REM sleep is also a hallmark of other disorders, including bipolar disorder, substance use disorder and PTSD. Shannon Kenney and colleagues at Loyola Marymount University found that poor sleep significantly predicts negative alcohol consequences and relapse, even after controlling for drinking motivations. Furthermore, PTSD represents a unique disorder of impaired sleep. Difficulty with emotional memory processing may serve to in part cause the disorder, and the hyperarousal associated with the disorder, including impaired HPA and SNS functioning, may negatively affect slow wave sleep processes, perpetuating the challenges faced in PTSD, suggests Scott Williams of Womack Army Medical Center.

Nearly every mental health concern has some link to sleep. Sleep is vital to our ability to self-regulate, process emotions, learn and maintain our physical and mental wellness — all attributes that counselors address on a daily basis. Sleep is also influenced by many psychotropic medications. When choosing psychotropic medications, it is essential to consider sleep patterns. Different medications can have disparate effects on sleep and thus run the risk of perpetuating the disorder being treated.

Implications for counselors

Recognizing and addressing sleep concerns can benefit clinical assessment, client conceptualization and client care. Understanding the nature of our clients' sleep challenges can help us to better grasp how such challenges are affecting our clients' brains and, in turn, their waking behaviors, thoughts and emotions, their ability to learn new ways of coping and, ultimately, their healing. This information helps us to be intentional in our choice of theories and techniques and to advocate for our clients with other medical care providers. Such knowledge also allows us to explain to our clients possible contributing factors to their mental health and the links between what is going on in their brains and bodies as a result. This psychoeducation can be very empowering for clients.

Lastly, as much as we discuss the importance of counselor self-care and its implications for burnout and compassion fatigue, we cannot forget that our own sleep quality has an impact on our work with clients. The functioning of our cortical and limbic structures is affected by sleep and can impact our emotional empathy, suggests Veronica Guadagni of the University of Calgary. Possessing such knowledge for both you and your client can turn the passive nagging suggestion of "you need to get plenty of sleep" into a priority that needs addressing. The following suggestions can be used to assess and enhance the sleep and associated well-being of not only your clients but also yourself.

1) Assess sleepiness. A client's sleepiness can be a good sign of his or her sleep quality and quantity. Derk-Jan Dijk, director of the Surrey Sleep Research Centre, contends that sleepiness is an undervalued yet critical early indicator of impaired sleep. A number of sleepiness scales can be used, including the Karolinska, Stanford and Epworth scales. There are even pictorial sleepiness scales based on cartoon faces for children developed by Claudia Maldonado, Alison Bentley and Duncan Mitchell.

2) Track sleep. A sleep diary can help clients track their sleep habits and the associated quantity and quality of their sleep. You can review the sleep diary with clients and assess potential areas of concern and improvements based on sleep hygiene. The National Sleep Foundation provides an example at *sleepfoundation.org/sleep-diary/SleepDiaryv6.pdf.* Fitness trackers that include sleep tracking capabilities and mobile apps that require individuals to keep their phones beside them as they sleep also provide ways of tracking sleep. These gadgets measure body movements and help to show when people fall asleep, how often they wake up, when they are in REM sleep and so on. Although these tools may not be as accurate as tracking devices in a sleep lab, they can help augment a sleep diary and provide useful information about sleep patterns and how waking activities such as exercise, eating and stress affect sleep.

3) Practice sleep hygiene. Good sleep hygiene, such as going to bed at the same time each night, establishing a nighttime routine, not using electronics in bed, keeping your bedroom cool, exercising in the early afternoon and avoiding substances before bedtime, can significantly improve sleep quality and quantity. Discussing the importance of sleep hygiene both in general and in relation to sleep tracking can be beneficial. Additional information about sleep hygiene can be found at *sleepfoundation.org.*

Sleep is an underrecognized and underappreciated aspect of mental health. Knowing what happens to the brain and body during sleep and sleep deprivation can help us better understand, empower, support and advocate for our clients. Although the complexities of sleep are just now being unraveled, I hope this introduction will pique your curiosity regarding the power of this mysterious process and the light it can shed on our clients' concerns.

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