Sleep Fragmentation and the Impact on Memory Decline

A Research Paper by the All4Smiles Research Team

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Abstract

It is common for many older adults to notice changes in their sleep. This includes lighter rest, feeling less energized in the morning, and more frequent disturbances during the nighttime. Poor sleep contributes to impacted mood and focus. Fortunately, common medications as well as non-drug methods are able to improve sleep quality. Sleep fragmentation goes beyond mood and focus, affecting long-term memory as well. This month, we will be exploring the connection between sleep fragmentation and the acceleration of decline in memory and cognitive thinking in seniors. We will look at what happens in the brain during broken sleep, and how it contributes to memory loss and conditions like Alzheimer's.

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Neurophysiological Effects of Sleep Fragmentation and Memory Decline in Seniors

By: Joyce Sato

Inflammation in the Brain

Studies show that brain cells called microglia are typically used to protect the brain. However, these cells can negatively impact thinking and memory if they become overactive, which occurs when sleep is often interrupted. A longer study with over 700 seniors found that there was a correlation between those who had more sleep interruptions and those who developed Alzheimer's. Poor quality of sleep also led to higher risk of memory loss and thinking in addition to a higher risk of developing Alzheimer's.

Mental Fatigue and Decline in Concentration

In seniors who experience sleep fragmentation consistently, alpha and beta waves show very active brain waves while engaging in activities that require focus or relatively intense usage of cognitive thinking abilities. This shows that the brain needs to work harder while thinking or concentrating, ultimately leading to brain fatigue or fog in addition to a harder time focusing.

Deep Sleep and Memory

While we are in a deep sleep, our brain will store and organize our memories. During this time, long term memories are sent from a part of the brain called the hippocampus to the cortex where memories are stored. While processing and storing memories, sleep disturbances can contribute to the loss of long term memories if this process is interrupted or ceased.

Brain Chemicals and Structure

Poor quality of sleep and frequent interruptions can lead to lowered amounts of chemicals in the brain that are essential for making connections, helping brain cells grow, and producing proteins that are responsible for forming long term memories. One key contributor for Alzheimer's is a buildup of the chemical called amyloid-beta. When there is a lack of chemicals and proteins from good sleep, we are more susceptible to harmful chemicals to buildup in the brain. As we age, the prefrontal cortex and other parts of the brain will shrink. This results in lighter and easily-disturbed sleep, and becomes one of the core causes of Alzheimer's.

Sleep fragmentation and Alzheimer's progression

By: Aria Fernandes

Maintaining a consistent sleep pattern is crucial to preserving one's health and memory, but conditions like Sleep fragmentation can make it difficult to rest peacefully. Sleep fragmentation is a common disorder found in around 40-50% of older individuals, having sleep fragmentation entails the repeated interruptions of sleep, tiredness throughout the day and gradual cognitive impairment. This cognitive decline can lead to conditions such as Alzheimer's disease.

The leading causes of sleep fragmentation are frequently linked to preexisting medical conditions, mental health disorders and aging. It is found that these conditions often induce stress. When stressed, the body raises cortisol levels. Cortisol has a negative effect on sleep and might cause one to develop forms of insomnia over time. Most mental health disorders are undiagnosed in older patients which often leads to discovering the impacts of sleep disruption when it is more developed and harder to treat.

Interestingly, elevated levels of cortisol is also found in many Alzheimer's patients, It is linked to a worse prognosis. Cortisol is thought to contribute to the degeneration of neurons in the brain. Sleep is intricately tied to cognitive health and information processing. While asleep, the brain is able to get rid of harmful toxins. However, the lack of rest reduces the connection between systems in the brain. The loss of sleep also affects judgement and reasoning. When one is more tired they tend to be less able to make rational decisions or be productive. Similarly, sleep deprivation disrupts memory consolidation and electrical communication between neurons.

Electrical communication between neurons in the body helps to relay signals about the present situation one might be involved in. These signals help with making rational judgements based on memories and sensory input. If the disruption of these signals is consistent over a long period of time, the individual may be at higher risk for developing Alzheimer's disease.

Alzheimer’s is a common disease for those 65 and older, those who have it develop a progressive form of dementia. Alzheimer's impairs spatial awareness, recognition, memory, and reasoning, through the gradual disruption of communication through neurons in the brain. It also causes the degradation of neurons in the brain, leading to lasting impacts on neurological health and executive functions. Neurons naturally degrade with aging, but Alzheimer's disease accelerates apoptosis at a more damaging rate.

Overall, managing sleep fragmentation and cognitive decline can be challenging, but there are measures that can limit their progression. The most important step in preventing sleep fragmentation is understanding the connection between sleep and cognitive health. Obtaining adequate rest not only helps with memory and Alzheimer’s prevention, but also supports general mental well-being. Ensuring that one gets enough sleep each night is not only recommended for older populations, but for everyone.

Deep Sleep and Memory Consolidation in Older Adults

By Hiya Patel

As people get older, their sleep patterns undergo many changes. One of the most significant changes is a reduction in the duration of slow-wave sleep (SWS), also known as deep sleep. Although many view changes in sleep patterns as a normal consequence of aging, evidence suggests that they have serious consequences, particularly in memory consolidation. Evidence suggests that poor-quality deep sleep contributes directly to memory decline, one of the most common cognitive issues in older adults (Mander et al.) Fortunately, ongoing research has identified strategies to preserve memory through improving one's sleep health.

Deep Sleep and Memory Formation

Deep sleep, the most restorative stage of sleep, plays a pivotal role in memory consolidation. The brain replays the day's events during this stage and strengthens any necessary neural connections. This process involves communication between the hippocampus and neocortex, the two parts of the brain responsible for processing and storing explicit long-term memories such as facts and personal experiences, and is supported by multiple types of neuronal activity patterns such as slow oscillations, thalamo-cortical spindles and sharp wave-ripples. When SWS is shortened or disrupted, the brain gets worse at consolidating memories, resulting in increased forgetfulness during the day (Diekelmann and Born).

The Decline of Deep Sleep

As people get older, the time they spend in deep sleep decreases. It has been found that older adults can experience up to an 80% reduction in slow-wave sleep compared to when they were younger. Additionally, age-related changes in the prefrontal cortex, a region where slow-wave activity exists, can lead to increased forgetfulness (Ohayon et al.). Older adults experiencing less SWS are able to retain fewer new words and show reduced communication between memory centers in the brain when compared to individuals with normal amounts of deep sleep (Diekelmann and Born).

Helping Seniors Maintain Deep Sleep

New technologies and therapies are being developed to help seniors improve the quality of their deep sleep. A new method is auditory stimulation during deep sleep. Through playing white noise or other similar relaxing sounds while sleeping, people's memory can be improved the following day (Ngo et al.). Cognitive behavioral therapy for insomnia (CBT-I) has also been shown to improve sleep depth and duration. CBT-I is able to help older adults achieve deeper, more restorative sleep and improve their memory performance. CBT-I is a non-medication based treatment for insomnia focused on changing negative thought and behavior patterns related to sleep habits, thus making it an effective method while still being non-invasive (Newsom).

In conclusion, there is a strong and well-supported link between deep sleep and memory consolidation in older adults. As SWS declines with age, so does the brain's ability to form and retain long-term memories. Nevertheless, there are methods to counteract this decline. New therapies and changes in lifestyle habits can help maintain deep sleep, thus protecting memory in seniors. Deep sleep is invaluable in supporting brain health in an aging population.

Nighttime Awakenings and Their Effect on Mood and Function

By: Evelyn Yao

Everyone hates the feeling of being interrupted from a peaceful dream. One second, you're snoozing, and the next, you are rudely awakened into consciousness. Nighttime awakenings are not only frustrating, but also significantly affect one's mood and function. For the elderly, especially, sleep is essential to remaining healthy and at their full ability. As longevity increases, so does one's irritability towards these awakenings. Causing a reduced quality of life, these interruptions elicit irritability and mood swings and can exacerbate previous medical conditions.

When one wakes up during the night, it is often difficult for them to fall asleep again. Because of this, the lack of sleep contributes to increased irritability. Not only is the senior missing out on necessary rest, but the fatigue from continuously waking up or remaining awake takes a toll on their mood. Seniors are more prone to mood swings and face difficulty when trying to control their emotions. Additionally, if seniors wake up frequently during the night, they are at a higher risk of developing sleep disorders like insomnia and dealing with sleep deprivation. The more frequently a senior wakes up during the night, the more likely they are to develop mood disorders like depression and anxiety. In conjunction to the nighttime awakenings, depression also comes with sleep awakenings. For the elderly who are already dealing with depression, anxiety, or other mental health conditions, these nighttime awakenings only worsen these disorders. As a result, seniors face more worry, agitation, and restlessness.

When these nighttime awakenings translate into daily life, they affect everyday mood and function. For instance, if they occur frequently, they disrupt established sleep cycles and reduce restorative sleep. Thus, seniors will be excessively tired and sleepy during the day, inhibiting their productivity and energy levels. Poor sleep quality and disrupted sleep also are linked to memory decline and cognitive impairments in older adults. Getting reduced amounts of sleep hinders the brain's ability to clear out toxins and consolidate memories. The fatigue that results from sleep disruptions can lead to an increased risk of accidents and falls, potentially causing severe injuries. Furthermore, sleep deprivation can worsen the seniors' quality of life, such as being able to interact with others and participate in social activities. Nighttime awakenings can also worsen other conditions like hypertension, diabetes, and heart disease, leading to higher inflammation levels and worse health outcomes.

Ultimately, the impact of nighttime awakenings on elders cannot be overstated. These disruptions provide serious disturbance that exemplify existing mental and physical disorders like depression and diabetes. The sleep deprivation caused by these awakenings cause irritability and reduced quality of life that is a source of mental anguish for the elderly. It is important to seek professional advice and help if one is facing this issue.

Medications and Conditions that Cause Fragmented Sleep

By: Sri Patel

Fragmentation of sleep, or repeated waking or disruption throughout the course of an evening, is increasingly a problem—particularly for older adults. Far too often, though, overlooked is the impact of sleep fragmentation on physical health, psychologic function, and activity of daily living. This essay addresses two of the main causes of sleep fragmentation: disease states and commonly prescribed medication. To reveal how such influences disrupt sleep can be helping towards better treatment routines and healthier sleeping.

Sleeping is necessary in order to repair physically, stabilize feelings, and be mentally capable. Yet, many individuals struggle to sleep throughout the whole night. disrupted sleep—marked by frequent interruptions in the sleep-wake pattern—is not letting the body have or maintain deep, restorative levels of sleep. On a cumulative, long-term basis, this may result in daytime fatigue, memory deficit, mood disorder, and heightened hazards to health. The two main causes of sleep fragmentation are underlying medical illness and side effects of some medications. Identification and treatment of the cause can enable clinicians and patients to collaborate in enhancing the quality of sleep and overall well-being.

Medical Illnesses That Compromise Sleep

A number of chronic illnesses get in the way of sleep by actively disrupting the process of sleep or being bothersome enough during the night to wake someone up.

Sleep Apnea: The most common cause of disrupted sleep is obstructive sleep apnea (OSA), an illness in which the airway collapses with each breath at sleep. Every event makes the brain

momentarily wake up the sleeper for re-establishing normal breathing. The frequent arousals, not perceived by the sleeper, result in disrupted sleep continuity and decreased deep sleep. OSA becomes apparent and remains undiagnosed with advancing age (Nair & Loh, 2017).

Chronic Pain; Arthritis, fibromyalgia, or neuropathy pain can force the sleeper to wake up a number of times overnight. Pain wakes the sleeper up in an effort to keep the body from continuing in its usual pattern of sleep cycles and to break the resumption of sleeping.

Nocturia; Nocturia or excessive nighttime urination is another condition that most elderly have. It is caused by diabetes, prostate hypertrophy, congestive heart failure, and medications. Getting up a number of times during the night to visit the bathroom results in disruption of the sleep cycle and causes day-time fatigue the next day (Nair & Loh, 2017).

Mental and Neurological Disorders: Psychiatric conditions such as anxiety and depression are known to interfere with sleep maintenance in the form of waking very early and insomnia at night. Neurological diseases such as Alzheimer's disease and Parkinson's disease interfere with the architecture of sleep by affecting circadian rhythm as well as causing nighttime agitation, confusion, and movement.

Medications That Cause Sleep Fragmentation

Other than medical diseases, most medicines—both prescription and over-the-counter—are also sleep interrupters. These types of medicine have the ability to induce stimulation, hormonal disturbance, or body effects that interfere with sleep.

Decongestants and Cold Medicines: Stimulant drugs in cold medications, including pseudoephedrine and phenylephrine, are said to affect the nervous system. The effects lead to restlessness, rapid heartbeat, and insomnia, especially when taken at night (AARP, 2024).

Asthma Inhalers: Short-acting bronchodilators like albuterol have to be taken to relieve asthma but can cause jitteriness, tremor, and hyperexcitability. These are particularly disturbing when taken at night.

Blood Pressure Medications: Some antihypertensive drugs have been discovered to have an impact on sleep. Beta-blockers, including propranolol and metoprolol, reduce the level of body endogenous melatonin, a critical chemical in sleeping rhythms regulation. ACE inhibitors cause a chronic cough that disturbs night patients (AARP, 2024).

Antidepressants and Stimulants: Most antidepressants, the SSRIs and NDRIs, will induce REM interference and result in intense dreams or sleep awakenings at night. Stimulants employed in the management of attention-deficit conditions will similarly interfere with sleep or result in insomnia or sleep fragmentation if not administered appropriately.

Corticosteroids: Steroid medications such as prednisone are also prescribed to manage a wide inflammation but also cause alertness and energy. Thus, users consequently have complaints of difficulty in falling asleep and remaining asleep, particularly when taken in the afternoon or evening.

Cognitive Enhancers for Dementia: Drugs like donepezil, which are prescribed for treating Alzheimer's disease, are meant to enhance alertness and memory. They also cause nocturnal

restlessness, muscle spasms, and increased agitation, all of which contribute to disrupted sleeping patterns.

Defeating Fragmented Sleep

Treatment of disrupted sleep starts with recognition of the cause. If the cause is medical—say, sleep apnea, or nocturia—then its elimination can be located in treatment such as CPAP treatment, fluid intake adjustment, or drug adjustment. Lifestyle modifications with improved sleep hygiene and compliance with consistent sleep–wake cycles can also improve sleep.

In case drugs are thought to interfere with sleep, the patients ought to first visit their physician prior to making any change. Reducing time, substituting them with other drugs, or decreasing their dosage is usually effective in reducing sleep side effects.

Non-pharmacologic strategies, especially Cognitive Behavioral Therapy for Insomnia (CBT-I), have been proved to be effective and usually more preferred compared to sedatives.

Disturbed sleep has many potential causes, but medical illness and medication are two of the most significant. Disruption is particularly common among older persons and typically occurs without warning or notice. Treatment of these disorders involves a multidisciplinary strategy of drug evaluation, behavioral treatment, and medical management. Accurate diagnosis and treatment of underlying causes of disturbed sleep enable individuals to have improved nights and healthier days.

Non-Drug Interventions to Improve Sleep and Cognition

By: Sue Nguyen

Non-drug interventions are recognized as effective strategies for improving sleep quality and cognitive function for various age groups. By focusing on behavioral, lifestyle, and psychological approaches, these interventions are just as safe and sustainable compared to medication-based treatments.

Sleep-Focused Interventions

Cognitive Behavioral Therapy for Insomnia (CBT-I)

CBT-I is a program designed to help individuals improve their sleep by addressing both the cognitive and behavioral aspects of insomnia. It is structured to focus on identifying negative thoughts and behaviors that interfere with sleep and then changing them. CBT-I also focuses on developing healthy sleep habits. This program is considered the first-line treatment for chronic insomnia by offering a drug-free approach for better sleep quality and duration.

Sleep Hygiene Education

Poor sleep hygiene can negatively impact both sleep quantity and quality. It's important to set your sleep schedule by having a bed time as well as a wake up time. Naps can throw off sleep at night so it's best to avoid longer naps. Following a nightly routine is recommended for an easier time falling asleep. Being active and avoiding smoking and drinking are some good habits. Sleep hygiene education encourages good sleep habits like consistent sleep schedules, limiting screen time before bed, and reducing caffeine.

Mindfulness and Relaxation Techniques

These techniques include meditation, deep breathing, and progressive muscle relaxation. Practices listed help reduce racing thoughts, ease physical tension, and promote a sense of calmness. Reducing stress and anxiety can improve one's sleep.

Light Therapy

Also known as phototherapy, can be effective for certain sleep disorders and mood disorders that interfere with sleep. It uses a light box or other light source to regulate the body's natural sleep-wake cycle, or circadian rhythm. Through being exposed to specific light wavelengths and intensities at the right times, this therapy can help reset the body's internal clock and improve sleep quality.

Cognition-Focused Intervention

Cognitive Training Programs

These programs often use brain games, puzzles, memory tasks, and strategy-based learning that improves attention, working memory, and problem solving. They aim to stimulate the brain and promote neuroplasticity which is the brain's ability to reorganize itself by forming new neural connections.

Mindfulness Meditation

A practice that involves focusing on the present moment, being aware of your thoughts, feelings, and sensations without judgement. It reduces stress and anxiety by helping individuals develop a

sense of calmness. If it is often practiced, you can gain a deeper understanding of your thoughts, emotions, and behavioral patterns.

Adequate Sleep

Adequate sleep, generally 7-9 hours for adults, is extremely important for optimal cognitive function. Sleep deprivation can lead to the impairment of cognitive processes like memory, attention, decision-making, and overall brain health. Contrastly, good sleep quality and duration enhances memory consolidation, cognitive performance, and brain development.

Social Engagement

This includes conversations, group activities, and community involvement. Staying connected can help the mind stay sharp, reduce the risk of cognitive decline, and potentially delay or prevent dementia. By engaging in social activities, stress is reduced and mental health is promoted, both contribute to better brain health.

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