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How Light Exposure Plays a Role in Cognition

Analysis by Dr. Joseph Mercola | May 11, 2024

STORY AT-A-GLANCE

- A preprint study conducted by researchers from the University of Liège in Belgium explored how different levels of light exposure influence your cognitive function
- The researchers noted that higher levels of light exposure among participants led to better cognitive performance in executive tasks
- To harness the power of light exposure, you can use photobiomodulation devices that emit red and near-infrared light
- Photobiomodulation can help boost mitochondrial function, which may result in better cognitive function

Can bright light exposure lead to a sharper mind and heightened alertness? Researchers from the University of Liège in Belgium sought out the answer to this. In the 2024 preprint study titled "Regional Response to Light Illuminance Across the Human Hypothalamus,"[1] they investigated how light exposure affects cognitive function in humans.

According to Neuroscience News,[2] "The study … is described by the editors as of fundamental importance, and represents a key advancement to our understanding of how different levels of light affect human behavior."

Light Affects the Emotional and Executive Areas of Your Brain

For context, prior research conducted on animals established that light exposure affects many subcortical structures,[3] which are the parts of your brain that play "a pivotal role in cognitive, affective and social functions in humans."[4] Now, the researchers are investigating if the same effects are seen in humans, making the study a first of its kind.

Speaking to NeuroScience News,[5] lead author Islay Campbell, Ph.D., from the University of Liège, Belgium, commented:

> *"Translating findings on how light exposure affects the brain in animal models to humans is a difficult process, as the later maturation of the cortex in human beings enables much more complex cognitive processing.*
>
> *In particular, the question of whether hypothalamus nuclei contribute to the stimulating impact of light on cognition is not established."*

The Effects of Light on the Hypothalamus

Campbell and her team recruited 26 participants to complete two cognitive tasks designed to stimulate the emotional and executive areas of the hypothalamus while being subjected to varying levels of light intensity.[6] They used seven Tesla MRI (magnetic resonance imaging) machines to monitor brain activity in real time and record the results.

The hypothalamus is responsible for managing the endocrine system. Essentially, it acts as a central station, receiving signals from other parts of your brain to release and inhibit hormones essential for maintaining life. These include the thyroid gland, adrenal gland and reproductive organs. The hypothalamus also helps regulate your appetite and temperature.[7]

Inside the hypothalamus, which all mammals have, lies the center master clock – the suprachiasmatic nuclei (SCN). The SCN cannot function on its own but requires environmental stimuli to synchronize the body clock. This allows you to follow a pattern of wakefulness and sleep.[8]

The hypothalamus is generally divided into two areas regions — anterior and posterior. The anterior region handles the production of hormones needed by the body, while the posterior region is where oxytocin and vasopressin are stored after being produced in the anterior region. Oxytocin and vasopressin are hormones that perform crucial functions such as maintaining mood and regulating temperature.[9]

For the study, the researchers subdivided the two parts of the hypothalamus into five. This approach helped them identify which specific areas of the hypothalamus experienced a reaction while under light exposure. Here's an illustration from the study to help you visualize the intricacy of the divisions.

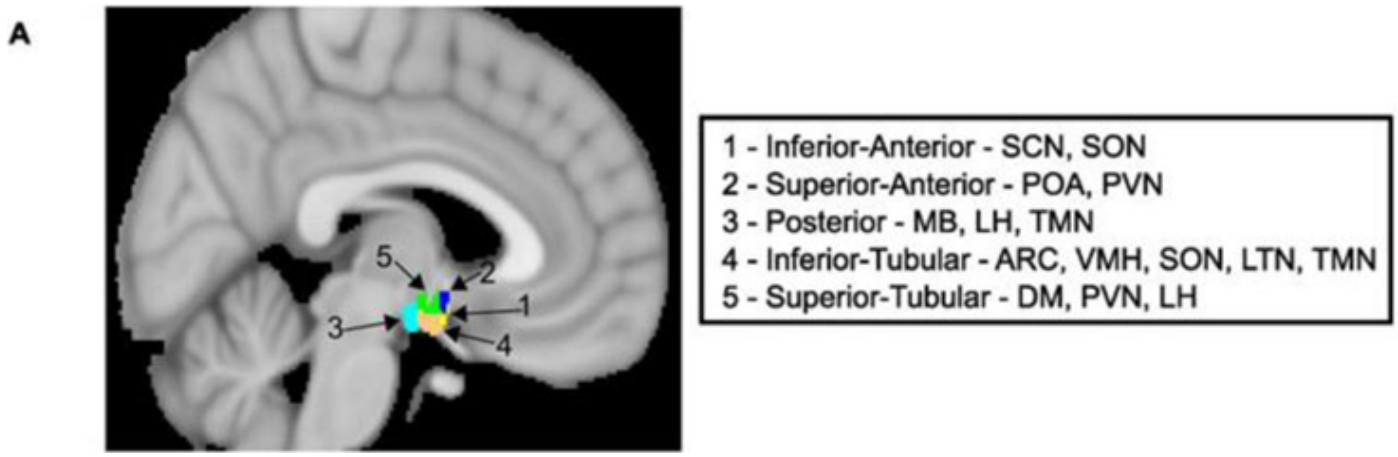

Image credit: eLife, "Regional Response to Light Illuminance Across the Human Hypothalamus," Figure 2A[10]

Light Intensities Can Have Varying Effects on Different Parts of the Hypothalamus

The participants were asked to get an MRI scan one week before the trials began. They were also required to get around seven hours of sleep, and were prohibited from consuming caffeine and alcohol, as well as undergoing strenuous exercise.[11]

To create the test environment, the researchers used a lightbox that illuminated a cable on both ends, allowing them to vary the intensity while the participants performed the tasks.[12] The participants were then asked to complete two tests to identify the effects of light exposure on their cognition. Here's a breakdown, summarized in a report by Sleep Review:[13]

1. **Executive task —** The participants were asked to determine if the current sound played to them was the same as one they heard two playbacks earlier, or if it contained the letter "K."

2. **Emotional task —** They were asked to determine the gender of a voice that used either a neutral tone or angry tone.

Throughout the study, the participants were alternatively placed in darkness or exposed to bursts of light exposure through four levels of illumination. The researchers noted:[14]

> *"In the executive task, participants were exposed to 30s to 70s (median 30s) of light blocks separated by 10s of darkness (< 0.1 lux) and the light blocks were repeated 11 times for each light condition. For the emotional task, participants were exposed to 30 to 40s (median 35s) light blocks separated by 20s of darkness (< 0.1 lux) and the light blocks were repeated five times for each light condition."*

Once results were recorded, the researchers noticed that higher light intensity increased activity in the posterior hypothalamus among the participants.[15] At the same time, higher light intensities resulted in decreased activity in the anterior and ventral sections of the hypothalamus. Furthermore, higher light intensities resulted in better performance in the executive task.[16]

The Role of the Hypothalamus in Your Cognitive Function

The response to this preprint study is positive, as it could not only help identify light's effects on various brain structures but may also support further research into noninvasive treatments for sleep problems and cognitive fatigue.

According to Neuroscience News, "The strength of evidence is praised as compelling, supporting the authors' analyses of the complex interplay between light exposure, hypothalamic activity, and cognitive function."[17]

Previously published evidence also support the findings of this research. In a 2020 study[18] published in Physiology & Behavior, researchers noted that sections of the brain such as the cortex, hippocampus and amygdala have been studied extensively in the role of cognition, but not the hypothalamus. Through the course of their research, they observed that the hypothalamus may play a role in cognition:[19]

> *"Such hypothalamic control of memory-related synaptic machinery may enable gating/thresholding/permissive/tagging operations within yet poorly defined logic gates for memory updating. Hypothalamic signals may thus facilitate cost-benefit analysis of learning and memory in real-world settings."*

In another study,[20] published in Frontiers in Neurology, authors noted that light exposure increases physiological arousal in the brain, leading to increased alertness.

The data from this preprint study clearly illustrate that light exposure can have a profound effect on your cognitive performance. So, how can you take advantage of it? Through a process called photobiomodulation (PBM), which is actually one of my favorite biohacks.

How Photobiomodulation Can Benefit Your Health

PBM refers to the process of using light therapy to benefit your health. Typically, this process involves using red and near-infrared wavelengths (with enough intensity) that your body can utilize.

One of the most notable benefits of near-infrared exposure is the increase in ATP (adenosine triphosphate) production in your mitochondria. Essentially, ATP is the energy currency used to power biological processes essential for life, such as muscle contractions, ion transport and chemical synthesis.[21]

As noted in a study published in Biology Letters, near-infrared exposure helped increase ATP in animal subjects and even reduced inflammation. Fruit flies exposed to near-infrared light also gained a significant increase in lifespan.[22]

Another fantastic benefit of near-infrared exposure is melatonin production — 95% of melatonin is produced in your mitochondria in response to near-infrared light. The melatonin released by your pineal gland account for just 5% of the melatonin in your body.[23]

Now, you might be wondering how mitochondria underscore these benefits. According to published research, your mitochondria play an important role in cognition. Here's a succinct explanation, according to a study[24] published in Mitochondrion:

> *"Mitochondria have a crucial role in brain development and neurogenesis, both in embryonic and adult brains. Since the brain is the highest energy consuming organ, it is highly vulnerable to mitochondrial dysfunction. This has been implicated in a range of brain disorders including, neurodevelopmental conditions, psychiatric illnesses, and neurodegenerative diseases."*

In another study, published in the International Journal of Molecule Sciences,[25] mitochondrial dysfunction has been implied to be a common mechanism involved in the most recognizable features of Alzheimer's disease.

Linking all points together, harnessing the power of PBM can help boost mitochondrial health. In turn, healthy mitochondria can help maintain optimal cognitive function.

Can Home Saunas Provide the Same Benefits as PBM?

Electric saunas designed for your home typically emit far-infrared light, which can still provide detoxing benefits. However, with some tinkering, they can be modified to function as a PBM device as well, which can save money since you won't need a dedicated PBM device.

You can modify your sauna by using incandescent heat bulbs that emit the majority of their energy as near-infrared light. While it may take some work, the effort will be worth it.

If you want to save time and energy, consider near-infrared bulbs from SaunaSpace.[26] All their bulbs contain metal guards that prevent the glass from accidentally breaking and injuring you. Use the instructions to hang the new incandescent bulbs in your old sauna.

This simple trick can increase the benefits you experience in your sauna since you're also getting the benefits of PBM from the new bulbs. Done correctly, eight incandescent red bulbs can heat up to 160 degrees Fahrenheit in about 20 minutes, which is far better than typical far-infrared saunas.

It's also good to test your sauna for electromagnetic field (EMF) radiation. If it does have EMFs, I recommend shielding your sauna as best as you can to protect your health.

As for the actual sauna session, it's always important to start out slowly. Listen to your body so you can decide how much heat stress you can tolerate. Ideally, sauna sessions should last anywhere between 15 and 30 minutes. Also, remember to stay hydrated before, during and after, since you'll be sweating a lot.

Sunlight Is the Ideal Light Source

While a PBM device (or a modified sauna) can be a fantastic addition to your health routine, you shouldn't shun proper sun exposure. Ideally, spend more time outdoors whenever possible. Only use PBM devices to get red and near-infrared light you need if you cannot get enough regular sun exposure.

Humans need direct sun exposure in order to optimally thrive, and while artificial lighting sources offering specific light spectrums may be helpful for various problems, ideally, we need the full spectrum of light that natural sunlight offers.

If you're going out to get sunlight, I recommend doing it during solar noon. For those living in areas that implement Daylight Saving Time, it should be 12:30 to 1:30 PM. Scheduling your daily walk around this time allows you to maximize the benefits of ultraviolet B rays and near-infrared radiation from the sun.

Blocking Blue Light at Night Can Help Transform Your Sleep

Last but not least, light exposure during the day has a major impact on your sleep quality, which in turn affects health in countless ways. Getting bright light exposure first thing in the morning and mid-day helps properly "set" your circadian clock, while bright light from artificial lighting and screens in the evening prevents melatonin release, inhibiting sleep.

Normally, your brain starts progressively increasing the hormone melatonin around 9 or 10 pm, which makes you sleepy. Melatonin acts as a marker of your circadian phase or biological timing.

In a nutshell, this hormone influences what time of day or night your body thinks it is, regardless of what time the clock on the wall displays. Besides regulating your sleep cycle, it also provides other important health benefits, including helping to **prevent cancer**.

Somewhere between 50 and 1,000 lux is the activation range within which light will begin to suppress melatonin production. However, wavelength is also important. Red and amber lights will not suppress melatonin while blue, green, and white lights will.

The reason for this is because these are the wavelengths are the most common outdoors during daytime hours. So, you'll want to avoid the blue light wavelength after sunset. This includes artificial light, and light emitted by electronics such as your TV, computer, and other electronic screens.

The blue light range (400–490 nm) can also induce photoreceptor damage in your eyes, so besides disrupting your sleep this is another potential problem with light emitting screens. As noted in one recent study,[27] "it is important to consider the spectral output of LED-based light sources to minimize the danger that may be associated with blue light exposure."

Ways to Limit Blue Light Exposure at Night

There are several ways to avoid blue light in the evening depending on your lifestyle and personal preferences:

1. Turn off or dim all lights after sunset and avoid watching TV or using light emitting electronics for at least one hour before bedtime (ideally two hours or more). Research[28,29] shows that using an electronic device within one hour of bedtime can delay falling asleep for more than an hour.

   Another study[30] that compared melatonin profiles in individuals exposed to standard room light (<200 lux) vs. dim light (<3 lux) found that exposure to room light before bedtime shortened the time of elevated melatonin levels by about 90 minutes.

   That means it may take you an extra hour and a half before you're sleepy enough to fall asleep once you're in bed. Combine room light and electronic displays right before bed and it's easy to see how sleep may remain elusive for hours on end.

2. After sundown, shift to a low-wattage bulb with yellow, orange or red light if you need illumination. A salt lamp illuminated by a 5-watt bulb is an ideal solution that will not interfere with your melatonin production. If using a computer or smart phone, install blue light-blocking software like f.lux. The program automatically alters the color temperature of your screen as the day goes on, pulling out the blue wavelengths as it gets late.

3. One of the easiest solutions is to use amber colored glasses that block blue light. This way, you don't have to worry about installing programs on all your devices, or buying special light bulbs for evening use. Once you have your glasses on, it doesn't matter what light sources you have on in your house.

   Studies[31,32,33] have confirmed that when using blue-blocking glasses, people produce as much melatonin as they do in dim light, even if they're in a lit room or using light emitting technology. Other studies[34] have shown that people using blue-blocking glasses had major improvements in both sleep quality and mood. Shift workers who use them before bedtime (i.e. in the morning when it's bright out) also report improved sleep.[35]

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