

# MINDFULNESS FOR THE MASSES

By Emma Klug

Nearly two thirds of Americans are smartphone users.<sup>1</sup> As of 2015, 64% of Americans owned smartphones, and it is reasonable to suspect that this proportion has only grown within the past 2 years. As we are spending more and more time interacting with these devices, scientists are beginning to ask how this technology is affecting our brains, bodies, and behavior. This inquiry is highly warranted, as it has been reported that we check our smartphones about 85 times each day, accumulating to a total of five hours.<sup>2</sup> These numbers might seem shocking, and recently, a number of studies have reported the negative effects of smartphone use on our wellbeing, particularly regarding attention and mood regulation.

Media multi-tasking describes a person's consumption of more than one item or stream of content at the same time. For example, switching back and forth from writing an email to responding to a text, all while scrolling through your Facebook feed. Historically, evidence has indicated humans are poor multi-taskers.<sup>3</sup> This prompted researchers at Stanford University to question how our simultaneous use of numerous applications on our smartphones affects our cognition. They found that media multitasking places new demands on our cognitive processing, specifically our allocation of attention.<sup>4</sup>

Consistent with the notion that we are not predisposed to multitasking, participants classified as "heavy" media multi-taskers

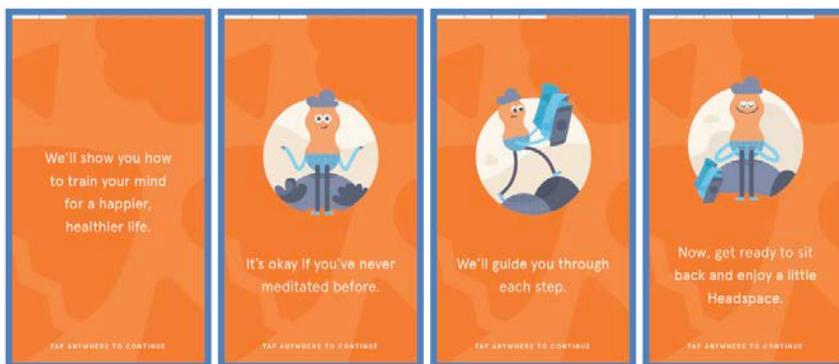


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performed consistently worse across three measures of attention compared to "light" media multi-taskers<sup>4</sup>. Unsurprisingly, heavy media multi-taskers were less capable of filtering out irrelevant information or thoughts.<sup>4</sup> What is perhaps most troubling about these results is that they suggest the effects of our media consumption persist even after we lock our screens.

Not only has smartphone usage placed unwelcome strains on our cognitive load, but a growing body of evidence suggests it may also negatively effect our wellbeing. Older generations of smartphone users have reported feeling "happy" and "productive" when engaging with their devices<sup>1</sup>. However, younger smartphone users seem to experience a wider range of emotions, also reporting feelings such as "distracted" and "angry".<sup>1</sup>

In line with this, a 2014 study of more than 300 universi-



Screenshots of the app, Headspace, taken by Emma Klug.

ty students revealed higher smart phone usage was correlated with increased depression, anxiety, poor sleep quality, and daytime dysfunction.<sup>5</sup> Further analyses demonstrated that high levels of depression, anxiety, and younger age were predictive factors of smartphone overuse, demonstrating the vulnerable position of young smartphone users who grow increasingly more dependent on their devices.<sup>5</sup>

The rise and spread of smartphone technology has been accompanied by the rise of the field known as mobile health. While smartphone use has been associated negative health outcomes, the mobile health field recognizes the incredible staying power of this technology. Therefore, it aims to take advantage of the overwhelming presence of smartphones in people's lives in order to deliver effective healthcare interventions. Specifically, in its Mental Health Action Plan 2013-2020, the World Health Organization recommended "the promotion of self-care, for instance, through the use of electronic and mobile health technologies".<sup>6</sup> Ironically, while accumulating evidence suggests smartphone usage wages war on our cognitive systems, they may also provide an easy and effective opportunity to get some piece of mind.

### Mindfulness: A Brief History

Mindfulness is famously described by scientist and educator Jon Kabat-Zinn as a way of paying attention on purpose.<sup>7</sup> It is a state



of being aware of what is taking place in the present moment, in an accepting, compassionate, and nonjudgmental manner.<sup>8</sup> Simply put, mindfulness is pretty straight forward—when your mind is fully attending to whatever you're doing, seeing, or experiencing, you're being mindful. Many have developed this way of approaching the world through years of meditation training. Lucky for us, the foundations of mindfulness are now available on the app store.

The most downloaded mindfulness app is Headspace.<sup>8</sup> The creator of the app, a former Buddhist monk, describes the app as a "gym membership for your brain".<sup>8</sup> Headspace consists of daily, guided meditations, teaching beginners the fundamentals of mindfulness-based meditation practices. Users begin with the "take 10" program, practicing mindfulness meditation just 10 minutes daily, for 10 days. Users build on this practice for an additional 20 days until they have completed the foundations course, at which point they are given access to advanced content related to health, relationships, and performance.

Mindfulness meditation dates back to over 2,500 years ago to the Buddhist vipassana meditation techniques practiced by Gau-

tama the Buddha, himself. In the mid-20th century, mindfulness practices began to evolve into key components of secular psychological interventions, due their ability to reduce stress and improve emotional wellbeing. Currently, mindfulness-based programs have proven successful in treating a number of disorders, including anxiety, depression, post-traumatic stress disorder, and addiction.<sup>9-11</sup> Further studies also support the use mindfulness practice in improving the wellbeing of nonclinical populations.<sup>12</sup>

Advocates of mindfulness interventions boast it has the ability to improve one's self-control, capacity to deal with stress, regulation of emotions, and concentration.<sup>9</sup> But does this bite-sized Buddhism have the power to counteract the deleterious effects of smartphone overuse? As mindfulness has gained popularity over the past 2 decades, researchers have set out to answer this question.

### Your Brain & Mindfulness

Much of the research surrounding the efficacy of mindfulness train-



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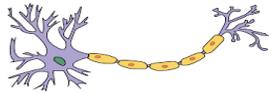
ing looks to define existing differences in experienced mindfulness meditators compared to inexperienced individuals. For example, studies show that mindfulness meditators with years of experience perform better on laboratory tasks probing attentional processing compared to non-practicing control subjects.<sup>13</sup> Specifically, participants experienced in mindfulness were significantly better at directing and re-directing their attention, most likely a result of years of practice in efficiently engaging and disengaging from stimuli in their environment.

Interestingly, differences in attentional processing can be observed even after just brief mindfulness training.<sup>14</sup> Research shows that after just five, 20-minute meditation sessions, novice mindfulness meditators exhibit improvements in measures of executive attention, or our ability to resolve conflict between discrepant incoming information, detect errors, and plan responses.<sup>14,15</sup> Not only did participants display marked improvements in attentional processing, they reported decreased feelings of depression, fatigue, anxiety, and anger, and increased feelings of vigor, all previously reported benefits of mindfulness.<sup>14</sup>

The brief mindfulness training also affected the way participants' bodies responded to stress. Cortisol is a hormone released in response to stress, and acts as a common laboratory measure for tracking how we respond to stressful situations. To induce stress, participants in this study

*What is Myelin?*

Myelin is a highly specialized membrane that wraps around axons, the long thin projections that extend from the main body of the neuron. Myelin acts as an electric insulator, increasing the velocity of signals being transmitted from the neuron cell body to its target. Myelination of axons occurs differently in the central and peripheral nervous systems. Specialized cells in the central nervous system called oligodendrocytes reach out and wrap sections of multiple axons. In the peripheral nervous system, a different specialized cell known as a Schwann cell, individually wraps around a single axonal segment. Myelin is essential for proper nervous system function, as exhibited by the debilitating effects of demyelinating diseases such as multiple sclerosis.



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were challenged with mental math task. Those who had received the five-session crash-course in mindfulness meditation displayed lowered salivary cortisol levels after the math test compared to participants who had completed the same amount of time practicing standard relaxation techniques.<sup>14</sup> These results indicate that the mindfulness intervention promoted regulation of the participants' physical response to stress.

From attentional processing to hormonal regulation, changes in our bodies and behavior are precipitates of changes in our brain. Synaptic plasticity refers to the capacity of neural activity generated by an experience to modify the strength of neural circuits.<sup>16</sup> This, in turn, modifies our subsequent thoughts, feelings, and behaviors. In other words, when we change our habits, our brain is happy to change with us. Therefore, structural and functional adaptations are made in the brain as a result of mindfulness practice,

resulting in improved attention and mood, and reduced stress.

Tang's group at the Dalian University of Technology in China, along with collaborators at the University of Oregon, have conducted comprehensive research on the capacity of mindfulness meditation to change the structure and function of our brains. Indeed, they have strong evidence that mindfulness training leads to changes in our brain's white matter, or myelin, specifically in areas known to regulate attention and emotion.<sup>17</sup>

The anterior cingulate cortex (ACC) has connections to both the “cognitive” pre-frontal cortex and the “emotional” limbic system.<sup>18</sup> The ACC is a part of a circuit involved in a form of attention that serves to regulate both cognitive and emotional processing.<sup>19</sup> Tang and colleagues report that mindfulness training was able to strengthen the connectivity in this region, either through prompting increases in myelin-

ation, or the reorganization of existing myelin tracts.

Our brain is composed of gray matter in addition to white matter. Gray matter is the darker tissue in the central nervous system, consisting primarily of neuronal cell bodies and their branching dendrites. Regional differences in gray matter are generally assumed to arise due to repeated activation of the region.<sup>20</sup> This makes sense as differences in gray matter have been associated with performance abilities and the acquisition of new skills, suggesting that increased gray matter corresponds to improved functioning in that particular brain region.<sup>21</sup>

Dr. Britta Hölzel's group at Harvard Medical School identified increases in gray matter density in multiple brain regions associated with some of the generally accepted benefits of meditation.<sup>21</sup> For example, the temporoparietal junction has been suggested as a crucial structure for the conscious experience of one's self. Furthermore, the posterior cingulate cortex, not far from the anterior cingulate cortex mentioned previously, is associated with assessing the relevance or significance of a stimulus for oneself. Taken together, Hölzel suggests that mindfulness practices increase gray matter density in these regions as a result of repeated activation during the meditative process.<sup>20</sup>

### **Your Body & Mindfulness**

Beyond changes in our brain, mindfulness interventions have induced measurable changes in our

physiological functioning, especially in response to stress. Mindfulness-Based Stress Reduction is a standardized 8-week training program that includes mindfulness education and practice.<sup>22</sup> This practice has proven efficacious in reducing blood pressure in response to stressful situations.<sup>22</sup> Furthermore, participants in this same study reported lower levels of perceived stress and negative mood after the intervention, complementing previous research that mindfulness meditation also improves our overall wellbeing.<sup>12</sup>

Researchers have attempted to measure these differences in physiological responses to stress in a number of ways. Rosenkranz's group at the University of Wisconsin-Madison demonstrated that individuals experienced in mindfulness meditation displayed significantly reduced cortisol levels in response to a laboratory stress challenge compared to a group of inexperienced participants.<sup>23</sup> To further probe just how all-encompassing the effect of mindfulness practice is on physiological responses, the researchers measured a skin response to capsaicin, the active component of chili peppers known to trigger inflammatory responses in any tissue with which it comes in contact. Remarkably, they observed that experienced meditators displayed a less severe inflammatory skin response compared to inexperienced individuals.

Despite this research, it remains unclear how mindfulness meditation reduces our physiological response to stress. One

possible explanation could be that through extensive practice, experienced mindfulness meditators have learned a controlled, diminished stress response. This diminished response would be characterized by reduced activation of inflammatory compounds that are normally triggered when we find ourselves in stressful situations.<sup>23</sup> Control of physiological responses at this level suggests that the effects of mindfulness meditation may extend into processes regulating how our DNA is interpreted and expressed.

### **Your DNA & Mindfulness**

Epigenetics was first described by Conrad Waddington in 1942 as, "the branch of biology which studies the causal interactions between genes and their products, which brings the phenotype into being".<sup>24</sup> Since Waddington, the field of epigenetics has evolved, and there are several existing definitions. For our purposes, epigenetics can be seen as how our environment impacts our DNA. Specific biochemical changes are made to our DNA that influence how it is read and transcribed, resulting in the unique expression of genes without changing the actual DNA. With this knowledge, researchers have questioned if mindfulness meditation can induce changes in our epigenome.

Evidence from the lab of Rosenkranz's Barcelonian counterparts demonstrated that after a day of intense mindfulness practice, experienced meditators exhibited lower levels of key epi-

genetic modifiers compared to a group of untrained participants.<sup>25</sup> More specifically, these modifiers are proteins known to be key regulators of inflammatory pathways. In light of this, researchers also examined whether or not meditators would exhibit reduced expression of known pro-inflammatory genes. Indeed, they found medita-

tors exhibited reduced expression of two pivotal genes that regulate inflammatory processes, supporting the notion that after years of mindfulness meditation, these participants' bodies had learned how to better regulate responses to stress.<sup>25</sup>

Further interested in how mindfulness could be affecting stress-induced inflammation, researchers measured participant's levels of the stress hormone cortisol after performance of a laboratory task shown to induce psychosocial stress. Interestingly, they reported that lower levels of the aforementioned DNA-modifying proteins were correlated with faster recovery of resting cortisol levels. Taken together, these findings suggest that a day of intense mindfulness practice triggers an anti-inflammatory response in experienced meditators that is not observed in inexperienced control subjects.<sup>25</sup>

### Mobile Mindfulness

The benefits of mindfulness meditation have been widely documented. Not only do meditators self-report feelings of increased attentional capabilities and elevated mood, but a great body of evidence shows that this practice holds the power to change our bodies in addition to our mind. The rise of mobile health offers a unique opportunity to deliver these positive interventions to a wider population by increasing access and reducing time commitments. However, the majority of studies reporting the benefits of

mindfulness have utilized in-person delivery methods. Therefore, the question remains whether or not the many apps on your mobile device are capable of delivering a mindfulness practice with the same efficacy.

Researchers have begun to investigate whether these applications will provide the same beneficial results as in-person methodology. Bennike's group, based in Denmark, asked whether or not mindfulness training via the Headspace app could improve laboratory measures of cognitive performance as well as reduce mind wandering.<sup>26</sup> After 4 weeks of training with Headspace, researchers reported decreased mind wandering, measured by better performance on a laboratory measure of sustained attention.

Results of participants using the Headspace app were compared to those using another app, Luminosity, for the same period of time. Luminosity is a "brain training" app, reported to show improvements in a number of cognitive abilities including memory, attention flexibility, and problem solving. This comparison allows us to make direct conclusions about the beneficial effects of mindfulness practice *specifically*, in contrast to another app that claims similar cognitive improvements.

Other researchers have investigated if the positive effects on mood seen after traditional mindfulness meditation are still visible with use of the Headspace app. Howell's group at the University of East London recruited active "happiness" seekers to par-

### Epigenetic Modifications

DNA methylation is a process in which methyl groups are added to DNA molecules, changing the activity of a segment of DNA without changing its sequence. DNA methylation is critical to normal development, and plays a role in silencing repetitive DNA sequences in organisms from fungi to humans, inactivation of the X chromosome in female mammals, and mammalian imprinting. Irregular methylation has been implicated in many human cancers.<sup>28</sup>

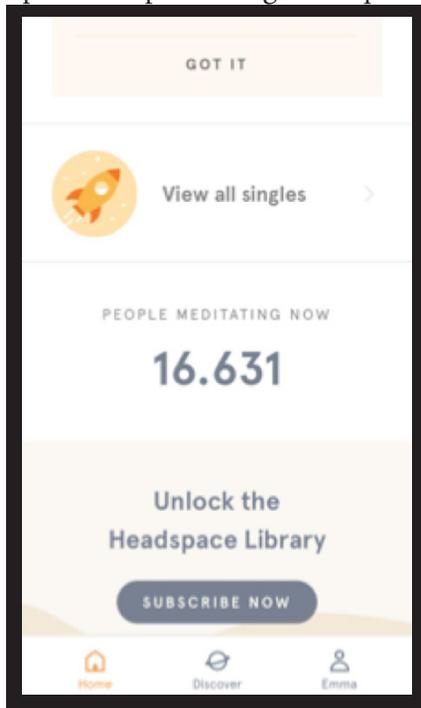


"DNA White Male 3D" by Peggy und Marco Lackmann-Anke is licensed by CC0.

In our chromosomes, DNA is tightly wound around histones. The addition of chemical groups to histone proteins alters this structure, making our DNA available for transcription, and therefore, expression. Further, these modifications often recruit the transcriptional machinery to specific segments of the DNA.<sup>28</sup>

ticipate in the Headspace “take 10” program. Researchers investigated positive affect by measuring participant’s satisfaction with life, positive and negative affect, as well as depression. In line with previous research, they saw significant improvements in positive affect and depression levels in Headspace users compared to control participants who had interacted with a neutral app. These results led researchers to suggest that smartphones are an effective method of delivering mindfulness interventions that make people significantly happier.<sup>27</sup>

Currently, Headspace is the only app to be utilized in randomized control trials. However, scientific evaluation of more apps is beginning to take place. Researchers well-practiced in mindfulness, as well as professionals who had delivered it as a part of their psychological practice, developed an expert rating scale quan-



Screenshot of the app, Headspace, taken by Emma Klug.

tifying the features of high-quality mindfulness apps.<sup>29</sup> High quality apps share features with many of your favorites— quality graphics, and simple and easy to use interfaces. Additionally, these apps require mindfulness education and a soothing voice for guided practice to earn high expert ratings.

Most importantly, high quality apps need to provide an “app community” — a social network allowing users to identify mutual meditators and share experiences. While mobile health technology is highly accessible, versatile, and cost-effective, its most powerful feature may be the opportunity to engage with an active community of users. A supportive app community provides a forum to share and discuss accomplishments and challenges of daily practice.

There is no current evidence indicating sharing user status on other social platforms, or engaging with an app community increases the effectiveness of app-based interventions. However, developments over the past decade have demonstrated the power of social networks— like Twitter, Facebook, or Instagram— to guide and change our behavior. If similar networks can be built to encourage healthy habits, like mindfulness, we may see welcomed increases in the wellbeing of the smartphone society. So, download one these mindfulness apps now, and spend a fraction of the five hours you’ll spend on your phone today feeling mindful.

## References

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### *Top 5 Mindfulness Apps to Download Now:*

1. Headspace
2. Smiling Mind
3. iMindfulness
4. Mindfulness Daily
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