

## DIGITAL MEDITATION FOR IMPROVING FOCUS

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**3 HAWKS**  
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While there have been many new treatments discovered for brain disorders over the past few decades, we are still facing a major problem when it comes to treating these disorders throughout the world. This means we need better tools for improving mental health. Meditation is a technique that people have used for thousands of years to learn how to better regulate their minds. Although the benefits of meditation are well known, many people never learn how to meditate, often because it can require having many meetings with people who teach meditation. To try to solve this problem, scientists have begun to use modern technology (like smartphones) to help people learn how to meditate. This article will explain how meditation can improve the brain's ability to focus, how apps can be important tools for teaching people how to meditate, and how using meditation apps can benefit mental health.

## INTROSPECTION

An observation or awareness of one's own thoughts, actions, and feelings.

## ELECTROENCEPHALOGRAPHY (EEG)

A tool for measuring brain waves.

## COGNITION

Various types of thinking that allow us to make sense of the world, like focusing, making decisions, learning, and remembering.

## SUSTAINED ATTENTION

The ability to hold focus on something for a long time.

## BRAIN WAVES

Electrical activity produced in the brain.

## WHAT IS MEDITATION?

Meditation is an exercise in controlling attention, and people have been practicing it for thousands of years. Meditators use a range of practices, such as keeping their focus on their breathing, or trying to pay attention to the body, the mind, and the world all at the same time. By using these attention exercises, meditators strengthen the ability to take control over what their minds are doing, and they learn **introspection**, which is an awareness of their current internal thoughts, sensations, and actions. Experienced meditators carry the lessons they learn from meditation into other areas of their lives. As a result, they are in better control of their focus, stress, and moods, making them better at keeping calm during hard times.

While the communities that have traditionally practiced meditation have experienced its benefits for thousands of years, science in the U.S. only recently discovered that meditation is a way to improve mental health. Modern technologies, such as **electroencephalography (EEG)** and other tools for measuring brain activity, have helped scientists understand that meditation is a powerful tool for improving focus and the health of both the brain and the body [1].

## HOW IS MEDITATION GOOD FOR OUR BRAINS?

To understand how meditation is good for our brains, we first need to understand some of the thought processes that happen inside our heads while we meditate. **Cognition** is a term that describes all the thoughts and behaviors (like focusing, making decisions, learning, and remembering) that allow us to make sense of the world and live happily in it. Meditators are really good at using several cognitive abilities while meditating. They work hard at staying focused. When they lose focus, they do not beat themselves up about it, but instead they simply say, "ok, my focus slipped," and they bring their attention back to the meditation. They know they have lost focus through introspection. Meditators quickly learn that their minds wander *a lot*, and that no one is perfect at meditating! Accepting this allows them to have patience with themselves when they lose focus.

The mental effort of meditation is good exercise for the brain. Science has shown that this exercise can improve **sustained attention**, which is how well a person is able to keep their attention on something hard for a long time—like when you take a long test. Scientists can measure improvements in sustained attention by looking for increases in certain **brain waves**, using EEG, while a person is keeping their attention on a boring task. Scientists believe that these changes in brain waves caused by meditation tell us that it is easier for the brain areas involved in attention to communicate with each other [2]. Groups of brain regions

## BRAIN NETWORKS

Groups of brain regions that communicate with each other.

## COGNITIVE FLEXIBILITY

The ability to purposefully redirect thoughts and attention.

## CLOSED-LOOP

A feature of a digital meditation app that uses information from the user to drive the app's difficulty.

that communicate are called **brain networks**, and good mental health depends on the ability of brain networks to communicate well.

Each time meditators bring their attention back to their focus after their minds wander, it is like doing a mental push-up. All these mental push-ups end up strengthening their **cognitive flexibility**, or their ability to change their thoughts based on what they are doing right now (like switching from doing math to reading when you change classes). Meditation can even change the way that their brain networks communicate, by bringing new, helpful brain regions into the conversation or getting rid of a brain region that is too loud and distracting. As a result, meditators get better at focusing their attention away from negative thoughts and feelings that are putting them in a bad mood and into a good mood instead. They notice more easily when they are in a bad mood, too.

These changes take a long time and a lot of work. One day of meditation will not do it. People need to meditate consistently by making it a habit. When people are first learning how to meditate, guidance from an experienced meditation teacher can be very helpful for staying on track. It is important for people to feel good about what they are doing when they meditate and to get advice to make sure that they are doing it right. A high-quality app that teaches beginners how to meditate can help to make meditation a habit.

## MAKING MEDITATION AVAILABLE TO EVERYONE

If we want to make meditation available to everyone, the biggest challenge is teaching more people how to do it. Learning how to meditate can be hard. Expert meditation teachers who can guide people through meditation lessons and give them personalized feedback can be helpful, but the number of teachers available is limited. Because so many people have access to smartphones and are used to using apps, some scientists (including the authors of this paper) have made apps that can train people how to meditate [3, 4]. Like the lessons a meditation teacher would give, these digital meditation apps provide tips and they make the meditation times longer (or shorter) as people get better (or worse) at staying focused on their breath. We call this feature a **closed-loop** design, and it is the key ingredient for making sure everyone is meditating at their own level. Some people can focus on something for a very long time without being distracted and others (most of us!) need to start at an easier level and work our way up. The closed-loop design makes sure that the people who can focus for longer have to meditate for longer, and the people who have a harder time focusing get more small breaks throughout meditation sessions. Of course, the goal is to be able to focus for longer, so the meditation sessions get longer as the person gets better at focusing. **Figure 1** shows an example of what a meditation app with a closed-loop design looks like [4].

### Figure 1

Screenshots of a digital meditation app. The meditator rests the tablet on their lap while the screen on the top right is shown. The app asks whether the meditator has been maintaining focus throughout the session. Answering “yes” will extend the length of the meditation session and answering “no” will shorten it. This makes the meditation training harder or easier, depending on how the meditator is doing. This is the closed-loop feature. This app also provides a library of meditation teachings, a calendar to track progress, and a graph to show people their daily progress (Figure credit: Ziegler et al. [4]).



Figure 1

## HOW DO WE KNOW THAT THE APPS WORK?

Showing that a meditation app is an effective way of teaching people how to meditate is hard to do. When designing studies, scientists are careful to show that meditation apps can affect the brain in the same ways that old fashioned meditation does. The most common way of testing if these apps work is by measuring people’s brain waves with EEG before and after they use a meditation app for several weeks. While measuring brain waves, the people do experimental tests on a computer that challenge a number of cognitive abilities, such as cognitive flexibility and sustained attention. Figure 2 shows the parts of the brain where a specific type of brain wave increased after people meditated using an app for 6 weeks [4]. The brain waves seen in these areas are known to be very important for sustained attention.

### Figure 2

Brainwave changes after 6 weeks of digital meditation. Participants who completed a digital meditation training had changes in brain waves (A) in the fronts and (B) in the backs of their brains while doing a sustained attention test. These areas are parts of a network that is important for sustained attention (Figure credit: Ziegler et al. [4]).

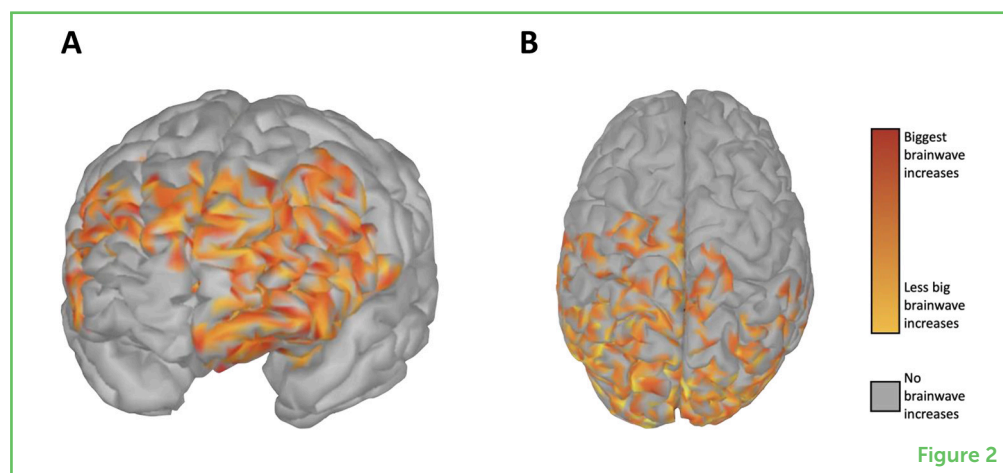


Figure 2

New studies like this have found that some meditation apps can make people better at sustained attention tasks, as well as increase the strength of brain waves and the brain networks that make it possible

to focus [3, 4]. One of these studies tested whether a meditation app (MediTrain), created based on scientific data, could improve brain function in teenagers (ages 10–18) who were in foster care in India. The results were pretty cool—researchers saw that using the app for 6 weeks improved the teenagers' sustained attention, made them less hyperactive in school, and they even started getting better grades [3]! Overall, scientific studies suggest that meditation apps can improve brain health and lead to real-world improvements.

## DIGITAL MEDITATION AS MEDICINE

Digital meditation could even be used to help people with certain mental health issues. For example, people with depression have changes in some cognitive abilities that meditation can improve, such as sustained attention and cognitive flexibility. In fact, scientists believe that one of the key features of depression is the inability of a person to pull their attention away from bad or dark thoughts. Using digital meditation to boost cognition in depressed people may be a new way to help lessen their depression [5].

Another condition that digital meditation might be used to treat is attention-deficit/hyperactivity disorder (ADHD). As the name suggests, people with ADHD have trouble with attention and focus. Because digital meditation appears to improve attention and focus, it makes sense that it could be a great tool for helping people with ADHD improve their sustained attention. At least one study has found that digital meditation can help improve difficulties associated with ADHD [6].

Right now, the main treatments for depression and ADHD are medicines, but the medicines that are most often used to treat these conditions can have bad side effects and they do not work for everyone. This means there is a need for other therapies to help these patients. Digital meditation could become a powerful new treatment for depression and ADHD because it can challenge and improve attention in these patients without any bad side effects. It is unlikely that digital meditation will completely cure these disorders, but it could help to decrease patients' symptoms.

## CONCLUSIONS AND FUTURE DIRECTIONS

In this article, we have reviewed how meditation can improve brain health, and how these benefits can be delivered to more people using digital meditation apps. While some digital meditation apps have been carefully studied by scientists, there are some commercially available apps that have been less carefully evaluated. Not all apps are equal. So, it is important to be skeptical at first about whether an app can really improve attention and focus. Some apps available in app stores

may say they can improve attention, but do not have any supporting research. In general, apps that have scientific studies to back up their claims are likely to be more effective (such as the Headspace app [7]). Once the quality of most digital meditation products in the app store is as good as the ones that have been carefully studied, more people everywhere will have access to this powerful tool for improving their focus. Also, while the potential for using digital meditation apps to improve cognition in conditions such as depression and ADHD seems promising, more research is needed before we will know for sure if digital mediation can be used as a type of medicine. If so, we will also need to figure out if it will replace medicines or if it will be used in addition to other treatments.

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The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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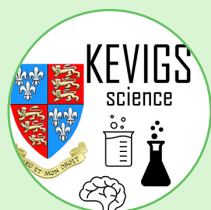
### 3 HAWKS, AGES: 13–15

Three of us reviewed this article from Hug High Science class. We do not meditate, but we might start now after reading this paper. We all like science, and it was cool to read about apps and brains. Our group plays D&D on weekends.



### KING EDWARD VI GRAMMAR SCHOOL, AGE: 15

Hello! We are a group of Year 10 students interested in science and psychology. We think that being Young Reviewers will expand our own horizons of knowledge and help researchers and scientists with their work!



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