



## WHAT HAPPENS IN YOUR BRAIN WHEN YOU MEDITATE?

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### YOUNG REVIEWERS:



**ST ALBANS  
SECONDARY  
COLLEGE**

AGES: 14–15



**TAMMY**

AGE: 11

In everyday life, we are often distracted by our thoughts and feelings. We can even fail to notice that we are distracted and spend a lot of time daydreaming when we want to be focusing on something else. Sometimes, even if we notice that we are distracted, it can be hard to turn our attention back to whatever we were doing. Distraction and difficulty controlling attention can cause various problems. For example, some students find it difficult to learn because of frequent distractions and not paying attention in class. For other people, repeatedly thinking about bad memories or worries can affect their moods. Luckily, research suggests that we can learn to control our attention and manage distractions by practicing meditation. In this

article, we introduce a simple method of meditation and describe what is going on in the brain when we meditate.

## DISTRACTIONS IN DAILY LIFE

People often find themselves distracted when trying to focus on an activity or while listening to someone. For example, during a classroom lecture, a student may experience distracting thoughts (such as, "I wonder what is for dinner?"), emotions (like sadness over an argument with a friend), or sensations (like hearing bird sounds from outside, or itchiness), which can cause the student to mentally drift away from the classroom. While doing homework, students may find themselves browsing social media without full **awareness** of how it even happened. Such distractions can sometimes lead to mistakes on homework or exams, affecting learning and possibly lowering grades [1].

Often, we do not realize that we are distracted until we experience some immediate negative consequences. For instance, a student may not necessarily realize they were thinking about weekend plans during a classroom lecture until the teacher asks a question. It can be quite challenging to control attention and manage distractions. Using social media or reminiscing about funny stories can be useful and important, but can also interfere with concentration and negatively impact important activities like learning or listening [1].

Sometimes, when distracting thoughts are sad or worrisome, they can cause stress and affect mood. For example, some people struggle with **negative self-talk**, or repeatedly think about past or future worries. Such thought patterns can also impede the ability to concentrate and can affect memory, learning, friendships, and overall mental health. In some extreme cases, patterns of negative thoughts, extreme worry, or intense emotions can lead to mental health problems like anxiety and depression.

## HOW CAN MEDITATION HELP WITH DISTRACTIONS?

Even if we want to, it can be challenging to control our attention and manage distractions. However, research suggests that regular practice of meditation can equip us with greater awareness of distracting thoughts and feelings, and can make it easier to manage these distractions [2]. Out of the many types of meditation, **focused attention meditation** is one of the most basic and widely practiced techniques [3].

During focused attention meditation, you simply pay attention to the feeling of breathing: at your nose, abdomen, and/or chest. Inevitably, distracting thoughts will interfere and pull your attention away from

### AWARENESS

Knowing or having knowledge of something.

### NEGATIVE SELF-TALK

Saying negative things about yourself using your inner voice (e.g., "I am not good enough at this", or "I am going to fail in this exam").

### FOCUSED ATTENTION MEDITATION

A type of meditation practice, often focused on the breath, that works to train attention and awareness of our thoughts and feelings.

breathing. Whenever this happens and you realize that you are no longer paying attention to your breathing, you just try to let go of the distraction and shift your attention back to breathing (Figure 1) (for a simple guide to meditation, see [this Frontiers for Young Minds article](#)).

### Figure 1

In the focused attention meditation technique, a person who tries to meditate cycles between four different states. First, they are focused on their breathing. Then, distracting thoughts arise. Eventually, the person notices the distraction and switches their focus back to breathing. With practice, the person can stay focused on breathing for longer and notice distractions sooner.

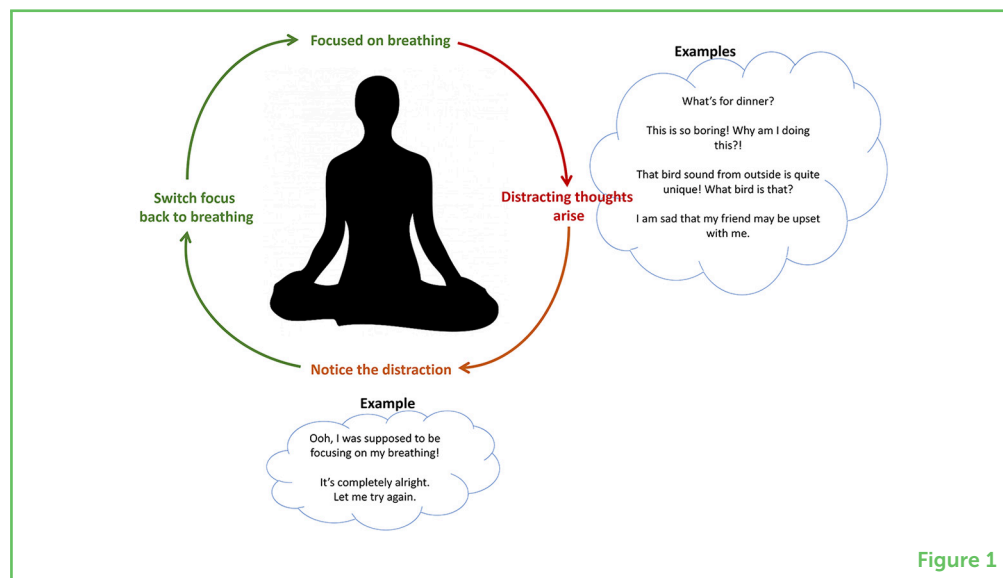


Figure 1

## WHAT HAPPENS IN THE BRAIN WHEN WE HAVE DISTRACTING THOUGHTS?

Using an advanced brain-measurement technology called **functional magnetic resonance imaging** (fMRI), researchers can look at what happens in the brain during an activity or mental state (for more information on the brain and MRI scanners, see [this Frontiers for Young Minds article](#)). Researchers have been using fMRI to understand what happens in the brain when a person thinks about something. fMRI scanning measures changes in blood flow across different parts of a person's brain, caused by the activity of brain cells when they are resting or performing a task. When people are instructed to let their minds wander and think freely, fMRI scanning shows that a group of brain regions working together, called the **default-mode network**, becomes active [4]. Interestingly, research shows that the same network becomes active when people get distracted while doing an activity. In other words, thinking and distracting thoughts are both largely supported by a highly active default-mode network [4].

## BRAIN ACTIVITY DURING MEDITATION

Recently, findings from all the fMRI studies on focused attention meditation conducted all over the world (involving 721 participants

### FUNCTIONAL MAGNETIC RESONANCE IMAGING

Technology used to measure changes in blood flow caused by changes in the activity of brain cells in response to a task or state of mind.

### DEFAULT-MODE NETWORK

Group of brain areas that work together and support thinking and day-dreaming.

### SALIENCE NETWORK

Group of brain areas that work together and support the processing and awareness of internal bodily signals (like breathing, heart beats).

### CONTROL NETWORK

Group of brain areas that work together to help manage our attention and flexibly switch our focus from one behavior/task to another.

in total) were combined and analyzed [3]. The aim was to identify the most consistent brain responses during focused attention meditation, compared to usual thinking and daydreaming. It was found that the default-mode network, which is usually quite active during distractions, reduces its activity during meditation. Two other brain networks were also found to be involved during meditation: the **salience network** and the **control network**. The salience network is generally active when a person processes and becomes aware of input signals from their body, such as breathing. The control network, on the other hand, helps a person switch their attention from one signal or activity to another. Like a referee judging and awarding points during a boxing match, the control network mediates and resolves conflicts between two or more competing signals in the brain (e.g., breathing signals vs. distracting thoughts).

## A DETAILED BRAIN PICTURE OF FOCUSED ATTENTION MEDITATION

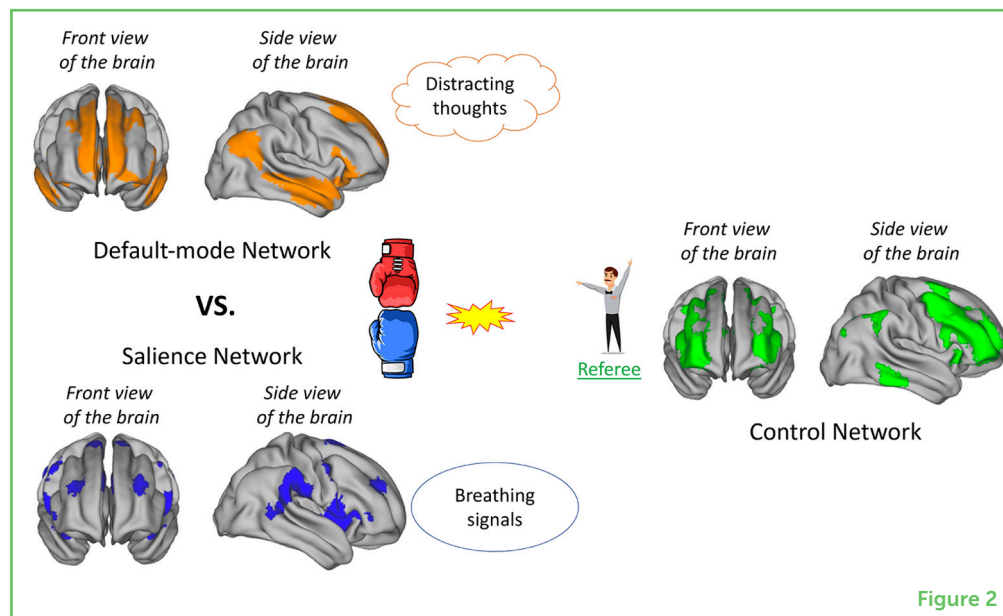
So, how might these three brain networks be involved in focused attention meditation [3]? When a person begins to meditate by turning their attention to breathing, a conflict arises in the brain between two competing signals—breathing signals and distracting thoughts. Using the analogy introduced above, think of this as a boxing match between the salience network (that processes breathing signals) and the default-mode network (that supports distracting thoughts) (Figure 2). To moderate this boxing match, the referee (control network) comes online. If the person purposefully tries to focus their attention on the breathing signals, this improves the chances of the salience network “throwing stronger punches” and being awarded points by the control network. As a result, the default-mode network becomes less active. This is when the person may feel focused and highly aware of their breathing, with very few or no distracting thoughts.

But this decrease in default-mode activity is often short lived and lasts only while the person stays in the focused state. Due to the nature of meditation practice, distractions tend to arise quickly, especially for beginners. Whenever the person loses focus on breathing due to distracting thoughts, the default-mode network becomes more active and “throws stronger punches”, prompting the control network to award points to the default-mode network. This can reduce the salience network’s activity (Figure 2).

Every time the default-mode network wins some points and distractions arise, the meditator must gently acknowledge the distracting thoughts and avoid frustration. After noticing that they have been distracted, they must then try again to focus attention on breathing without giving up. If the meditator gives up or becomes frustrated, the default-mode network may end up taking a substantial lead in points. Although the battle between the

## Figure 2

Three brain networks are involved in focused attention meditation: the default-mode network, the salience network, and the control network. Orange represents brain areas belonging to the default-mode network, which is active during distracting thoughts. Dark blue represents brain areas belonging to the salience network, which processes breathing signals. Green represents brain areas belonging to the control network, which resolves conflicts between competing signals like breathing vs. distracting thoughts. During meditation, when we try to focus on breathing, the control network acts as a referee moderating the “boxing match” between the default-mode network and the salience network.



salience and default-mode networks may seem never ending in the beginning, training attention regularly can boost a person’s chances of overcoming the default-mode network. With more practice and experience, meditators can learn to wield attention more skillfully and notice distracting thoughts sooner. Research shows that regular meditation practice can improve concentration during activities and learning, and can reduce the tendency to get mentally lost in the past or future. This can also minimize the impact of stress on mood and mental health.

Remember that an active default-mode network is certainly useful for learning, creativity, and having fun. Mind wandering can help us come up with novel ideas and develop creative solutions to problems. The goal of meditation is not to completely shut down this brain network or stop thoughts altogether. It is rather to help people have better control over their default-mode network and thinking processes, so that learning, listening, and having fun can become more enjoyable and productive, with fewer distractions.

## LIMITATIONS AND CONCLUSION

Like any research field, some challenges need to be considered. Although there is plenty of evidence showing that meditation practice can improve happiness, emotional wellbeing, and mental health, it can sometimes cause unpleasant effects and become overwhelming for some people suffering from severe mental illness. So, it is important to learn and practice meditation with appropriate guidance. With advanced brain-measurement technologies like fMRI, we can try to understand the basis of some of these unpleasant effects. Additionally, to develop a more detailed and reliable picture of how the brain works



during meditation, the field needs **large international collaborations** as well as young minds interested in this field. There is still so much about meditation and the brain waiting to be explored by young scientists around the world.

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## YOUNG REVIEWERS

### ST ALBANS SECONDARY COLLEGE, AGES: 14–15

St Albans Secondary College is a 7–12 co-educational school located 18 kms northwest of central Melbourne. The St Albans community has welcomed new arrivals to Australia since its establishment in the 1950's and this is reflected in the culturally and linguistically diverse in backgrounds of our students as well as in the multicultural vitality of our community. We would like to individually acknowledge Lina, Julien, Selina, Neha, Richard, Vincent, Leyna, Josephine for this review!



### TAMMY, AGE: 11

Tammy is 11-years-old and is currently in the fifth grade of elementary school. She has a keen interest in science, especially neuroscience. Tammy enjoys painting and is also learning piano and ballet. She has a cute younger brother. Although they sometimes argue, he is her best playmate, and together they explore the world hand in hand.

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Saampras is a Ph.D. student with the Biomedical Engineering department at the University of Melbourne, Australia. His research aims to understand the effects of meditation on brain function and daily life, and how meditation and mindfulness can be made more accessible for beginners and psychiatric patients using technology. Saampras is a co-chair of the world's first international neuroimaging consortium (ENIGMA-meditation) in meditation, which aims to study the brain effects of meditation. Saampras' research is supported by multiple international collaborators in the USA and UK. \*[saamprasg@student.unimelb.edu.au](mailto:saamprasg@student.unimelb.edu.au)





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