

CHANGEY



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OUR MIND

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New evidence is showing that a particular form of meditation can make us happier and less anxious by altering the structure of our brains. **Dr Michael Mosley** gave it a try...

Additional reporting: Andy Ridgway

EVER FIND YOURSELF going for a long drive and reaching the end without being aware that you were driving, lost as you are in your own musings? Or do you find yourself wide awake at 3am, largely unhelpful thoughts rattling around inside your head, each thought competing for your attention to the point where you have to get up and do something boring to drown them out? If so, then you are not alone. Studies suggest that many of us spend up to half of our waking lives wrapped up in our own internal world. We over-think – and like overdoing anything, over-thinking tends to have negative consequences. It can lead to a negative spiral of indecisiveness, self-loathing, depression and insomnia.

But a growing number of us are trying to overcome these problems using mindfulness meditation. I had been intending to try it for some time, but never quite got round to it. But while filming for the *Horizon* programme *The Truth About Personality*, I finally got the chance to give it a go. Inherited from Buddhism, mindfulness meditation has been gaining popularity in the West since the 1970s. There are as



➔ many definitions of mindfulness as there are practitioners, but at its core it involves paying attention to the present moment in a non-judgmental way.

There have been many claims about the technique's abilities, but until recently relatively little convincing proof. But now more rigorous studies and new technology that allows us to see what's happening inside the brain like never before has given it scientific credibility.

Before throwing time and effort into mindfulness, I wanted to find out what science had to say about it. It turns out that a study published in the January 2011 issue of the journal *Psychiatry Research: Neuroimaging* provides one of the most convincing pieces of evidence

that mindfulness meditation does actually work.

A research team at Massachusetts General Hospital (MGH) in the US gave a group of 16 mindfulness novices a brief training programme. These volunteers spent, on average, around half an hour a day doing mindfulness exercises.

They reported improvements in their mood and stress levels, but it's what was going on inside their heads that was more impressive. When the researchers looked at 'before and after' magnetic resonance imaging (MRI) brain scans, they were surprised to see an increased density of the grey matter in the volunteers' hippocampi, the area of the

"Mindfulness meditation has been gaining popularity in the West since the 1970s"

brain important for learning and memory. The researchers also saw decreased grey matter density in the amygdala, a part of the brain that is implicated in feelings of anxiety and stress.

What's particularly impressive is that all these changes were recorded after just eight weeks. "Previous studies had compared long-term mindfulness practitioners to non-meditators and found differences," says Dr Sara Lazar, who led the research at MGH. "But these differences may be due to something other than meditation. For instance, meditators tend to be vegetarian and live healthy lifestyles.

"This study was the first to take people who had never practised meditation before and compare them to a control group [a group that did not take part in any meditation]. So the changes are highly likely to be due to meditation practice."

A BRAIN CHANGER

In short, in just two months, mindfulness meditation appears to change the brain. So does this mean that its benefits will continue, even when someone is not engaged in it? "This is our hypothesis," says Lazar. "Though we need to do some testing to show that the changes in the brain actually confer some sort



Dr Michael Musley has electrical activity in his brain measured while practising mindfulness meditation



PHOTO: UNIVERSITY OF WISCONSIN, BBC



Dr Sara Lazar has been studying how mindfulness changes the structure of the brain

INSIDE THE MEDITATING MIND



WHILE SEVERAL STUDIES have looked at what happens to the brain after meditation programmes, few have looked at what's going on *during* meditation. But one researcher, Zoran Josipovic at New York University (NYU), has done just that. He enlisted the help of some volunteers particularly adept at meditation – Tibetan Buddhist monks from monasteries around New York. But even then it was a challenge.

After all, a functional magnetic resonance imaging (fMRI) machine is hardly a natural environment in which to meditate.

"The noise is around 110dB and you have to lie down in a very confined space with your head immobilised," says Josipovic, director of NYU's Contemplative Science Lab. So Josipovic and his team have an interesting way to find out whether volunteers will be able to meditate in their fMRI machine. "We

Buddhist monks have done their thing inside brain scanners to show the profound effect that meditation can have

1. Activity in the **medial prefrontal cortex**, the **medial parietal cortex** and the **temporoparietal junction** increase when people reflect on themselves. Activity in these areas – also known as the intrinsic network – reduces in focused and mindfulness meditation.

2. Several regions of the brain are involved with performing tasks and working memory. **These regions become active** during focused and mindfulness meditation.

3. Other research has shown that over time, the density of the part of the **hippocampus** involved with memory increases with mindfulness meditation. While the density of the **amygdala**, involved with fear, anxiety and stress, declines.

have a hockey mask and we ask people to lie down with the mask on and pillows around their head, while playing MRI sounds through headphones. If they can meditate like that, they can try it in the scanner."

THE MAN MACHINE

Some of the volunteers were asked to undertake 'focused attention' meditation in the fMRI scanner, a machine that measures blood flow – and therefore activity – across the brain. A similar practice to mindfulness, in focused meditation subjects concentrate their minds on something that involves the senses, such as sights or sounds, or their own breathing. "Here we see increased activity in the brain's extrinsic system – areas involved with performing tasks and processing information from the environment," says Josipovic, who practises Buddhist meditation himself. "There's also a reduction in activity in areas usually active when people reflect on matters that involve themselves."

"In more advanced meditative practices there's another kind of awareness that contextualises both the immediate sensory awareness and the higher order cognitive processes. Extrinsic and intrinsic systems are active at the same time, and more integrated."

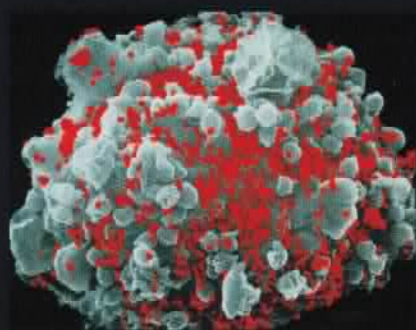
Josipovic is currently studying the meditating mind to understand how the practice affects more specialised areas of the brain, such as those involved in decision-making.



Richard Davidson of the University of Wisconsin (third from left) has also been scanning the brains of meditating monks

THREE OTHER BENEFITS OF MINDFULNESS

It's not just about keeping calm...



FIGHTING HIV

Mindfulness meditation helps to preserve a vital component of the immune system. CD4⁺ T cells, which co-ordinate the activity of the immune system, are attacked by HIV, the virus that causes AIDS. But researchers at the University of California, Los Angeles, found that stressed, HIV-positive adults who followed a meditation programme didn't have the usual decline in CD4⁺ T cell numbers.



MAKING MUSIC SOUND BETTER

A spot of meditation can make listening to music an even more pleasurable experience. Dr Frank Diaz at the University of Oregon asked students to listen to 10 minutes of an opera and rotate a dial to measure their emotional response. Those who carried out mindfulness exercises beforehand were able to dedicate more attention to the music and feel more 'in the zone'.



IMPROVING SEX

Mindfulness can improve your sex life. Researchers at Brown University in the US showed students photos, some of them erotic. Women who completed a 12-week meditation course became much quicker at registering their body's response to the sexual slides than they were before mindfulness training. It's thought that mindfulness's ability to get people to focus on the present is behind the change.

➔ of benefit, but we are working on that now."

What's not completely clear is exactly how these increases in grey matter density manifest themselves – whether it's down to neurones [brain cells] appearing or disappearing, or connections between the neurones being made or lost. "There could also be changes in the helper cells that surround the neurones or the blood vessels," says Lazar. "All have been associated with changes in behaviour and learning, but the resolution of the MRI scans is unable to reveal this."

SELF-EXPERIMENTATION

I found this convincing enough to try a six-week course of mindfulness meditation. There are lots of different approaches (see 'Simple mindfulness exercises', on p65), but the one I went for was a guided meditation via an app.

You sit in a comfortable chair, normally at the start of the day, rest your hands on your thighs, close your eyes and then for the next few minutes try and focus on your breath.

You pay attention to the sensation of the breath going through your nostrils, filling your chest, expanding and

"We were surprised to see that it actually improved working memory"

Dr Elizabeth Stanley, Georgetown University



contracting your diaphragm. You try to stay focused on the task and when you notice that your thoughts have drifted, which they will, gently bring them back to the breath. You have to treat thoughts like balloons that drift into your consciousness; once you have noticed they are there you simply allow them to drift away.

I say 'simply', but this is really hard to do. Initially I found that I spent much of the allotted time (10 minutes a day at first, building up to 20) absorbed in my usual concerns. But like any form of exercise it slowly got easier to do, though I rarely managed more than a few minutes of focus at a time.

As well as sitting quietly, I also tried building mindful moments into my day. Instead of just gulping down a coffee, I'd hold it and feel the warmth and try to focus on the muscle activity involved in bringing it to my lips. I'd feel the warm liquid trickle down my throat.

At the end of six weeks I felt noticeably calmer in my everyday life. Not only that, but also more able to focus on tasks – particularly the more complex ones. That's likely to be down to the fact that mindfulness meditation is effective at improving

working memory – your brain's ability to hold different bits of information in your mind at the same time.

The most powerful demonstration of mindfulness's effect on working memory came from a group of US Marines being prepared for deployment to Iraq. During pre-deployment training, where the Marines are put through incredibly stressful situations to 'inoculate' them against the horrors of war, 31 were given eight weeks of mindfulness training. Another 17, the control group, were not. The researchers at the University of Pennsylvania and Georgetown University in the US found that during this stressful training period, working memory capacity fell in the control group but *increased* in those who had meditated.

"Since pre-deployment training is stress inoculation training in the extreme, we had expected everyone's working memory to decline," says Dr Elizabeth Stanley, who served as a US Army military intelligence officer in Korea and Bosnia before becoming an associate professor at Georgetown. "We were surprised to see that mindfulness actually improved working memory among the high practice group [those who practised on average 15 minutes a day over the eight weeks outside of class]."

Already the same techniques have been tried with firefighters and police officers, with what Stanley describes as "great anecdotal success". So mindfulness training might well become part of many of our working lives in the future.

COMPASSION BOOST

But mindfulness doesn't just turn us into calmer, more productive professionals. One reason I was attracted to meditation was because there are claims it can make you a nicer human being. Earlier this year, researchers at Northeastern and Harvard universities in the US announced they had found evidence of this.

The psychologists asked volunteers to do an eight-week mindfulness course. When they attended a follow-up session they were asked, one by one, to go into a waiting room. In the room, a stranger – who was in fact an actor – was sitting, fiddling with his phone. Then someone else – another actor – came into the room, on crutches and in obvious pain. The man fiddling with the phone completely ignored the person in pain.

The question was, how would the volunteers react? About half of the meditators tried to help the man in pain, compared to only about 15 per cent of

SIMPLE MINDFULNESS EXERCISES



Dr James Carmody, associate professor of medicine at the University of Massachusetts Medical School and mindfulness instructor, shows you how to calm your mind



As you do these exercises, you will notice a couple of the mind's habits that profoundly affect your wellbeing. First, sensations and what we think about them are two separate things. Also, our attention does not stay on our sensations, but keeps defaulting to the mental commentary the mind has about them. This commentary is concerned with meeting our needs and the needs of those we care about. As such it tends to be threat-based and generate unpleasant feelings. But the sensations of breathing are 'arousal neutral' and when we redirect our attention to them, we feel better.



EXERCISE 1

- Bring your attention to the sensations in your legs. You may notice the sensation of your clothing; there may be sensations of warmth or coolness. Do the muscles in your legs feel tense or relaxed? There are no right or wrong sensations – just become aware of whatever sensations happen to be present.
- Notice also the difference between the sensations themselves and the commentary your mind automatically generates about them. Learn to distinguish between the sensations and the thoughts you have about them.
- Now move your attention further up your body to the sensations in your pelvis, chest and abdomen – again just noticing whatever sensations happen to be present, and the difference between these and the commentary your mind may have about them.
- In a similar way, continue directing your attention through the rest of your body, in your own time.

If possible, try these exercises in a quiet environment with minimal distractions. You can close your eyes if you find it easier.

EXERCISE 2

- Focus your attention on the sensation of your breathing, wherever you happen to feel it: the movement of the chest or abdomen, the sensation of air in the nostrils. You don't need to adjust how fast or deeply you are breathing.
- You will soon notice that your attention does not stay focused on these sensations – it will wander to thoughts, memories, plans etc.
- When you notice that the attention has wandered, gently bring your attention back to the sensations of breathing.



a control group who had not taken the mindfulness course. The meditation seems to have made the volunteers more compassionate.

So if you like the idea of being less stressed, keeping your working memory active and being more virtuous, why not give mindfulness a go? I certainly found it helpful – and I plan to go on making it part of my daily life. ■

DR MICHAEL MOSLEY trained as a medic before becoming a BBC TV presenter



WHAT DO YOU THINK?

Have you ever tried mindfulness? Email your experiences to reply@sciencefocus.com

Find out more

Wherever You Go, There You Are: Mindfulness Meditation For Everyday Life

By Jon Kabat-Zinn (Piatkus, 2004)

<http://vimeo.com/64517179>

Watch a lecture by James Carmody and try some mindfulness exercises