

Brain science for mindfulness students

Why bother with brain science?

Knowing how something works, and how it malfunctions, informs us about how to get around a problem. The working of the brain is of course complex, but we know a lot about it, and research with experienced meditators has shown incredible results. When Matthieu Ricard (a French Buddhist monk) was given MRI scans by cognitive scientists¹, he showed 'extraordinarily high levels of upbeat activity and almost invisible levels of negative emotions', giving him his popular attribution as the 'happiest man on earth'.

The good news from this research is *neuroplasticity*; the term which describes the brain's capacity to adapt, re-learn, create new habits, and as a consequence change our interpretation of life around us and our behaviour.

As Hanson and Mendius² put it: 'When your mind changes, your brain changes'; for example, taxi drivers develop a larger hippocampus (the visual-spatial memory area).

The brain contains about 1 trillion cells, 100 billion neurons, and each neuron has about 5000 synapses or connections. These neurons communicate, relaying messages, creating pathways of connectivity. As these pathways get strengthened, through repeated experience, they get stronger, forming habits of emotional reaction and response. We're a bit like English law, which is based on precedent; when such and such occurs, we check back to see what the judges in previous cases did, and act in accordance with that.

For the most part we're pretty dull creatures of habit. About 95% of the thoughts we have today, are exactly those we had yesterday. And our reactions are most likely just the same. We are slaves to our conditioning, repeating old emotions to similar stimuli.

Physiology of the brain

The physical structure of the brain is in 3 parts, reflecting our evolution as a species:

- The brain stem / limbic system – gives rise to fast reactions eg fight or flight – a reptilian type of brain
- The sub-cortex – a mammalian type of brain which includes memory
- The cortex, which houses conceptualising capabilities and is uniquely developed in humans; this divides into two hemispheres, left for mathematical/language activity, and the right for visual/spatial activity.

The challenge for the brain, is to maintain equilibrium, between signals in different parts of the brain. For example, the pre-frontal cortex may say stop doing xxx, while the limbic system creates arousal to act. Regulation of any system happens automatically, sending us signals eg 'I'm hot, do something', so then we act i.e. take off a jumper. These feelings, which swell up unbidden, create all kinds of cravings – 'I want, or I don't want'.

Because the world around us is always changing, we're always getting these messages. Our brain keeps reacting, and we can get destabilised, distracted, and start creating an illusion or

¹ Laboratory for Affective Neuroscience in Wisconsin

² Rick Hanson and Richard Mendius, 'Buddha's Brain', 2009

story as we try to make sense of what's happening. A lot of the time we're reacting to things that have already happened and past, so we miss what's happening right now.

For example, we're having a nice walk in the woods when we see something that is long, brown and curvy. The hippocampus (part of the limbic system which holds long term memory) quickly checks its known danger list and figures it might be a snake, so it sends a signal to the amygdala (which processes emotions) which sounds an alarm bell, so we jump away. Meanwhile the prefrontal cortex (which does logical thinking and can suppress emotions) gets into gear, and recognises that it's also static and woody and in fact a stick; so we walk past it. We reacted appropriately to neutral, then unpleasant, then pleasant brain experiences, and all below our conscious level.

All this is chemically controlled. There are three main types of neurochemicals:

- Neurotransmitters, like glutamate which excites neurons to fire
- Neuromodulators, like serotonin which regulates mood, or dopamine which signals reward or approach behaviour
- Neuropeptides, like oxytocin which promotes loving behaviours
- Others like cortisol, which is released by the adrenal glands at times of stress (or perceived stress), stimulates the amygdala and suppresses the hippocampus

We are a sea of chemicals. For example, dopamine pushes us to seek out the things that our brain has learned are nice. When the reward is not felt as expected, dopamine falls, and we feel unsatisfied, and left with a craving that we can't pinpoint.

Similarly if we've learned that something gives us a good feeling (eg an oxytocin surge), the neural circuits that recognise that opportunity get stronger, and we become more likely to notice that object next time. We get selective; ignoring or just not 'seeing' things that we've learned not to bother to see.

Suffering

One of the core themes in Buddhist teaching is about suffering, which is about how we react to pleasant or unpleasant events and change. In a nutshell, because things will always change, like getting ill and dying, and we don't like it, we get distressed.

Our simplistic reaction to things that are unpleasant (which humans developed to survive in a hostile world), is to:

- Create a separation between us and the unpleasant stimuli – a disconnection from the world. (One part of the brain, the parietal lobes, specifically acts to make us feel separate. This is a good survival tool. But the more this feeling deepens, the more threatening the world outside seems.)
- Turn away from unpleasant things
- Try to stop things changing
- Try to hold on to nice things

When these approaches don't work, we get distressed. But all of this distress is created in our brain – which also means that we can learn to avoid letting the distress develop.

The brain learns and adapts in three modes:

- Regulation – green and red lights
- Learning - strengthening neural connections
- Selection – on the basis of former experience

We can actively adapt the functioning of each of these modes, to develop more wholesome brain patterns that make us happier and more compassionate.

Experienced meditators have the insight that the true nature of our mind, its default position, is one of clarity, equanimity, and a loving outlook. Gaining confidence in this insight allows us to see that stress is a temporary state, a construction in our heads.

Why we keep going wrong

Our human tendency is to notice negatives more acutely than positives; the brain is drawn to bad news. This helped cave men keep safe from predators. By contrast, positives, like eating sweet berries, are not so essential, so we are less likely to notice berries.

This happens at the level of personal interaction too. We register fearful or angry faces more quickly than happy or neutral ones, as the amygdala lights up when there is possible danger.

As what we notice is what we notice more, it's natural to store a big library of negatives and to keep reinforcing our fears. This can give us a background hum of anxiety or pessimism.

To make matters worse, we don't just react to negative stimuli, we then respond to the reaction; the so-called '*second darts*' that we throw at others or ourselves. For example, we trip on a shoe and bump into the chair, which hurts; we then get angry, blame someone else, or feel unloved because someone left the shoe there without considering how it might affect us. The first dart is real; the second is a story. If we trip again on another shoe, we *know* that our story is real.

This can even happen with positives. Someone complements our work; but we think they may be just saying it and not mean it, because the story we have stored is that we don't really believe that our work is good enough – the compliment acts to reinforce this story!

What's even worse, is that just *thinking* about a possible negative event can trigger all the same processes.

These second darts cause mental suffering. Mindfulness helps us to see the response and story process unfold, and with practice, to re-programme our brains so that we stop suffering from our own second darts. This is why doctors now prescribe mindfulness for depression – it works better than drugs.

In simple terms, negative reactions can be seen as one of three types:

- Greed – wanting something, chasing carrots
- Hatred – not wanting something, avoiding sticks
- Delusion – believing to be true what may be an idea of your own creation (pieced together from a raft of interpretations)

The last of these, delusion, sounds worse than it is. Reality for us, is what our mind perceives it to be. What we experience as real is manufactured in our minds from surprisingly little real time data. For example, our focused visual field is a tiny cone of about 3 degrees wide; everything beyond that is made up from inexact visual information and a lot of memory. What we see 'out there', is actually mostly created 'in here'. That capacity gives humans amazing creativity and imagination; it also means that a lot of what we take to be true is manufactured in our brain. We live in a simulation.

It's also evident that we miss a lot. Because there are so many stimuli out there, we learn to notice only a small selection, and ignore the rest. There have been many experiments that point to this fact (see Monkey Business video³).

In our mind, or simulator, we use memory clips to inform possible outcomes. These clips may be associated with limiting beliefs eg 'of course it will fail, it always does'. As neural pathways strengthen, they build our patterns of behaviour, based on old experiences that may no longer be relevant.

We can, however, strengthen the positive responses of the simulator. For example, by actively being compassionate to self and others, we actually enlarge the part of the brain that also creates a habit of happiness.

In this way your mind is like a big TV screen. It can play any movie. The screen itself (our default mind) before the signals arrive, has no image and no predisposition, yet it can play anything we like. The good news is that the brain is continually changing - we can choose the channel and make the 'nice channels' more likely to be selected.

Lets go back to chemistry.

When things get stressful, the hypothalamus tells the pituitary gland to release stress hormones. Epinephrine increases the heart rate, neopinephrine shifts blood to your muscles, cortisol stimulates the amygdala and suppresses the hippocampus. Emotions intensify, and control by the pre-frontal cortex gets suppressed. We over-react, get violent, scream at people. Not so useful in the office! And definitely not so useful when the cause of all this chemistry is a second dart reaction, or even a fantasy.

These stress hormone patterns also deplete or suppress 'good' chemicals such as serotonin, which triggers good feelings.

There's also a physical cost to this happening too often. This kind of chemical stimulation can cause gastro-intestinal and cardiovascular damage, reduces the immune system, and disturbs the endocrine system. We get ill and enter a downward spiral.

So what can we do about it?

Happily, we can create new patterns of behaviour, train our brains, and take the power out of the old patterns. Even old dogs can learn new tricks!

Living happily (which is good both for us and for other people) means working positively with three aspects of brain physiology:

- The pre-frontal cortex – which allows us to make good decisions
- The parasympathetic nervous system – which calms us
- The limbic system – which controls emotions

Mindfulness is the tool we use to open up our experience in a less pre-selected manner, to literally see more, and to recognise the feelings in the body of all this brain chemical washing that is going on. We can then choose how to respond. It is an objective tool; it does not judge; and it takes the 'me' out of the equation or perception. In this way it mirrors the default, un-programmed, underlying state of mind.

Mindfulness is the skill by which we pay attention to what's going on around us and our reaction to it. Gaining wisdom is a process of gaining insights into how this happens; ie what has a positive or a negative effect.

³ www.youtube.com/watch?v=IGQmdoK_ZfY

Practical steps to take

One of our allies in this re-programming is the parasympathetic nervous system (PNS). The PNS conserves energy, regulates and helps create a relaxed, stable feeling where we can think clearly. Happily, this is the normal resting state of the brain.

We can deliberately help the PNS to kick in. Here are several ways to do this:

- Take some deep breaths, and actively make the out breath longer (also known as 7:11 breathing)
- Smile (just a little smile will do) and touch the lips
- Bring attention to the feelings in the body and the flow of the breath
- Imagine being in nature somewhere peaceful
- Spend more time noticing nice things (like birdsong, a comfy chair, the nuances of a good coffee)
- Meditate!

With practice -and repeated practice is the key - our response habits start to change and the stress cycle gives way to the PNS baseline, more and more quickly.

We can also coach ourselves to react differently by visioning. For this to work well we need to employ visual, emotive and aural patterning. We create a strong fantasy of the kind of behaviour we want as our new pattern, and, critically, ask ourselves what will that *look like*, *feel like*, and *sound like* (or what we'll say to ourselves). For example, if I want to stop feeling hurt when my boss says I've done something wrong, and instead feel pleased to have learned something useful, I might imagine what happens next time he criticises me, like this: I see myself nodding and looking thoughtful, I feel myself getting stronger because I'm getting better at what I do, and I say 'thanks, Mike, that's really helpful'. This really works; there are great coaching stories about people who can't catch a ball, for example; by imagining what it looks like, feels like and sounds like to catch the ball, they start being able to catch it.

With practice too, we can learn just to *be* with whatever arises, accepting and allowing the unfolding of the present. We can stay finely tuned to real time experience, with minimal negative reactivity. It's this state of mind that allows martial arts masters⁴ to respond so effectively to physical challenges.

Given that we need to learn new tricks, we need to know how to do that effectively. When we experience a pleasant experience, the first thing is to *savour* it. Don't just gulp down that coffee, take the time to notice its diverse tastes and how different flavour components appear in succession. The longer something is deliberately held in awareness, the more those neural pathways build, and the dopamine release strengthens this. Also, after 10,000 hours of practice, you could get a job as a coffee taster!

Once again, just *thinking* about something has a real effect on the brain, like the basketball players who became as proficient at netting the ball by rehearsing it mentally, as did their colleagues who practiced for real.

Stored memories are inexact and in shorthand. Moreover, they get associated with emotional responses. The more you think negatively about something that's happened, the stronger the emotional charge gets if that event re-appears. That's why we need to learn to love our demons. They're not really demons anyway, they are just misguided protectors, who need re-educating.

⁴ for example Aikido master Morihei Ueshiba <https://www.youtube.com/watch?v=XxPIQGxvoy0>

This approach needs to be pro-active. We need to deliberately cultivate positive experiences and associations, to re-balance our predisposition to see threats and danger.

The good news...

is that there is a well tested way out of all this bad programming!

When the Buddha first taught the Four Noble Truths⁵, he made clear that there is a path out of suffering. His insight was that suffering comes from ignorance or a 'wrong view', and he set about teaching how to overcome that wrong view.

Modern, secular mindfulness is still based on this ancient teaching.

Through mindfulness, our awareness becomes finer tuned to the presence of our habits, so that they can be changed. We can stop being a slave to our history, and see the world with fresh eyes. We can also gain insight into the default, underlying and innate nature of our own mind; a pristine, clear and non-judging ground of awareness. As this confidence develops, we become more resilient to whatever happens around us.

However, a pitfall of modern secular teaching of mindfulness, is that it can be seen as a *technique*. By itself, heightened and non-judging present-moment awareness can be used in many ways; for example it is used by the US military to create more effective killers. To embed meaningfully, mindfulness must be underpinned by a strong set of altruistic values, such as selflessness, generosity and compassion, and other conditions such as patience and interest.

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⁵ There is suffering; there is a cause of suffering; there is a state of not suffering; and there is a path out of suffering.