Whilst meditation practice dates back thousands of years, scientific research into the effects of meditation and its potential benefits for the mind and body only began in the last century. It is also during this same period that worldwide advancements have expedited at an unpreceded rate and could be considered a key factor in the current day demise of society's mental and physical wellbeing.

Historically, the psychological and physiological benefits of meditation were disregarded by scientists. However, this changed in the 1990s ("the decade of the brain"), when scientific research and neuroscientific equipment e.g., MRI scanners and EEGs, evidenced that the brain is not "hard wired"; it can and does change.

American Neuroscientist Richard Davidson stated, "*attention can be trained, and in a way that is not fundamentally different than how physical exercise changes the body*" (7.1). and he has been able to prove through extensive research and the use of sophisticated machinery that regular meditation does in fact alter the brains' structure and the way it functions.

Neuroplasticity is defined as "*the lifelong capacity of the brain to change and rewire itself in response to the stimulation of learning and experience*" (7.2).

Repeated practice of a skill causes neurons to fire together in different ways, resulting in a change to the physical structure in the part of the brain responsible for that skill. This means that as the grey matter in the brain increases, that part of the brain grows stronger, and studies have shown that regular meditation can greatly assist in making changes to grey matter. Also, different types of meditation will impact different parts of the brain e.g., strengthening parts of the brain responsible for logical thinking, cognitive functioning, positive emotion, empathy, memory, body temperature, blood pressure, hunger and thirst; whilst weakening parts of the brain responsible for causing stress, fear response and mind chatter.

These physiological changes in the brain are identified by scientists and medics who use equipment such as fMRI's (Functional Magnetic Resonance Imaging) which record blood flow, or EEGs (Electroencephalography) which directly record the brain's electrical activity (7.3). Other sophisticated tools include neuroimaging, brain mapping technology and gene research.

Whilst still in its infancy, scientific research into the effects of meditation are constantly developing and changing. In 2022, Richard Davidson and his team published research that suggested the "state" effects (the impact during practice) meditation has on our brain can be seen in a shorter period of time, whilst the trait effects (those that remain in place after meditating) generally result after many hours of consistent meditation practice (7.4).

Brainwaves (electrical signals) show the speed at which our brains work and can be measured through an EEG. There are five types of brainwaves: Gamma, beta, alpha, theta, and delta. Each operates in a frequency range and change according to "state of mind".

Scientific research using EEGs on meditators, for example by Fred Travis, PH.D Director of the Centre for Brain, Consciousness & Cognition, who has been recording brainwaves for 20 years (7.5), has demonstrated the way in which the brain changes as brainwaves are affected during practice. Also, in 2010, Travis & Shear conducted a study that showed how different meditation techniques have different effects on brainwaves. They noted that focused attention techniques are associated with gamma brainwaves, which operate at the highest frequency, 30+ Hz and are attributed to heightened awareness.

Beta brainwaves, 12-30 Hz, function when we are in an active, problem-solving state of mind. A higher frequency in this state, indicates a busy mind, with the left brain dominating, creating a "monkey mind" and anxious thinking; much of the stress of modern life comes from the dominance of these beta waves.

Alpha brainwave frequencies are 8-12 Hz and indicate a state of relaxed wakefulness (meditation).

In adults, the theta brainwave rhythm at 4-8 Hz, indicates our most creative stage and occurs when we dream; it can produce a feeling of bliss. It is during this brainwave that Travis and Shear, 2010, identified the connection with open monitoring techniques such as some mindfulness practices.

Finally, delta, the lowest frequency brainwaves 0.5-4 Hz are detected in slow wave sleep in adults (7.6).

Scientific research using an EEG has also shown that during meditation, where we enter a state of relaxed awareness, brainwave activity slows down and there are changes to the alpha, theta, and gamma brainwaves; alpha activity increases, and if we enter into a deeper meditation, there is also an increase in theta waves.

There are a range of scientific studies to support the physiological benefits of practicing meditation on the body as well as the brain e.g., managing stress, anxiety, and depression, reducing blood pressure, strengthening the immune system, improving memory, regulating mood, managing pain, increasing self-awareness, and improving sleep (7.7).

Meditation can directly impact our stress response by tapping into the nervous system. Our sympathetic nervous system, which operates the stress response (fight or flight) begins to calm during practice and the parasympathetic system is activated to stimulate rest and relaxation, having profound benefits on our body's functionality.

In the 1970's, Dr Herbert Benson, a professor at Harvard Medical School, was one of the first scientists to conduct research on meditation. Benson was responsible for developing an understanding of how various meditation techniques can trigger the relaxation response (7.8) by reducing the body's heart and breathing rates, as well as muscle tension; therefore, enabling the body to naturally neutralise the fight or flight response in stressful situations. His study also demonstrates that by triggering the relaxation response, meditation could also reduce stress, anxiety, and high blood pressure.

Research has shown how hormones and DNA are also affected by meditation. Stress hormones such as cortisol and adrenaline can be reduced as the sympathetic nervous system begins to calm, whilst increases in serotonin, dopamine, endorphins, melatonin, and DHEA can improve functions such as sleep, digestion, positive thinking, happiness, and even slow down aging.

The immune system can also benefit, with factors such as more sleep and less stress providing the body with the time it needs to repair and rejuvenate. In 2012, Barrett et al conducted a study over several months with 150 adults aged 50+; all who were susceptible to colds. The trial concluded that practicing mindfulness could reduce susceptibility to colds, with sick days being around 50% less for those in the mindfulness and exercise group. Also, two years later, in 2014, Schutte & Malouffe found that practicing mindfulness meditation leads to increased telomerase activity in white blood cells, leading to better cell protection.

Scientific research into the impact of meditation is ever increasing, and becoming more widely recognised by scientists and society for the ways in which it can benefit health and wellbeing. Whist more still needs to be done to prove the overall effects of meditation, scientific research to date, already proves that meditation has a significant impact on the brain and body.

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