

ADDITIONAL READING MODULE 6

Information on brainwaves taken with permission from "*The Norwegian University of Science and Technology (NTNU). "Brain waves and meditation." ScienceDaily. ScienceDaily, 31 March 2010.*" <www.sciencedaily.com/releases/2010/03/100319210631.htm>.

"Given the popularity and effectiveness of meditation as a means of alleviating stress and maintaining good health, there is a pressing need for a rigorous investigation of how it affects brain function," says Professor Jim Lagopoulos of Sydney University, Australia. Lagopoulos is the principal investigator of a joint study between his university and researchers from the Norwegian University of Science and Technology (NTNU) on changes in electrical brain activity during nondirective meditation.

Constant brain waves

Whether we are mentally active, resting or asleep, the brain always has some level of electrical activity. The study monitored the frequency and location of electrical brain waves through the use of EEG (electroencephalography). EEG electrodes were placed in standard locations of the scalp using a custom-made hat

Participants were experienced practitioners of Acem Meditation, a nondirective method developed in Norway. They were asked to rest, eyes closed, for 20 minutes, and to meditate for another 20 minutes, in random order. The abundance and location of slow to fast electrical brain waves (delta, theta, alpha, beta) provide a good indication of brain activity.

Relaxed attention with theta

During meditation, theta waves were most abundant in the frontal and middle parts of the brain.

"These types of waves likely originate from a relaxed attention that monitors our inner experiences. Here lies a significant difference between meditation and relaxing without any specific technique," emphasizes Lagopoulos.

"Previous studies have shown that theta waves indicate deep relaxation and occur more frequently in highly experienced meditation practitioners. The source is probably frontal parts of the brain, which are associated with monitoring of other mental processes."

"When we measure mental calm, these regions signal to lower parts of the brain, inducing the physical relaxation response that occurs during meditation."

Silent experiences with alpha

Alpha waves were more abundant in the posterior parts of the brain during meditation than during simple relaxation. They are characteristic of wakeful rest.

"This wave type has been used as a universal sign of relaxation during meditation and other types of rest," comments Professor Øyvind Ellingsen from NTNU. "The amount of alpha waves increases when the brain relaxes from intentional, goal-oriented tasks. This is a sign of deep relaxation, -- but it does not mean that the mind is void."

Neuroimaging studies by Malia F. Mason and co-workers at Dartmouth College NH suggest that the normal resting state of the brain is a silent current of thoughts, images and memories that is not induced by sensory input or intentional reasoning, but emerges spontaneously "from within."

"Spontaneous wandering of the mind is something you become more aware of and familiar with when you meditate," continues Ellingsen, who is an experienced practitioner. "This default activity of the brain is often underestimated. It probably represents a kind of mental processing that connects various experiences and emotional residues, puts them into perspective and lays them to rest."

Different from sleep

Delta waves are characteristic of sleep. There was little delta during the relaxing and meditative tasks, confirming that nondirective meditation is different from sleep.

Beta waves occur when the brain is working on goal-oriented tasks, such as planning a date or reflecting actively over a particular issue. EEG showed few beta waves during meditation and resting.

"These findings indicate that you step away from problem solving both when relaxing and during meditation," says Ellingsen.

Nondirective versus concentration

Several studies indicate better relaxation and stress management by meditation techniques where you refrain from trying to control the content of the mind.

"These methods are often described as nondirective, because practitioners do not actively pursue a particular experience or state of mind. They cultivate the ability to tolerate the spontaneous wandering of the mind without getting too much involved. Instead of concentrating on getting away from stressful thought and emotions, you simply let them pass in an effortless way."

Take home message

Nondirective meditation yields more marked changes in electrical brain wave activity associated with wakeful, relaxed attention, than just resting without any specific mental technique.

Information on the brain, meditation and stress taken with permission from "*Max Planck Institute for Human Cognitive and Brain Sciences. "Mental training changes brain structure and reduces social stress."* *ScienceDaily. ScienceDaily, 4 October 2017.* <www.sciencedaily.com/releases/2017/10/171004142653.htm>."

Meditation is beneficial for our well-being. This ancient wisdom has been supported by scientific studies focusing on the practice of mindfulness. However, the words "mindfulness" and "meditation" denote a variety of mental training techniques that aim at the cultivation of various different competencies. In other words, despite growing interest in meditation research, it remains unclear which type of mental practice is particularly useful for improving either attention and mindfulness or social competencies, such as compassion and perspective-taking.

Other open questions are, for example, whether such practices can induce structural brain plasticity and alter brain networks underlying the processing of such competencies, and which training methods are most effective in reducing social stress. To answer these questions, researchers from the Department of Social Neuroscience at the Max Planck Institute of Human Cognitive and Brain Sciences in Leipzig, Germany conducted the large-scale ReSource Project aiming at teasing apart the unique

effects of different methods of mental training on the brain, body, and on social behaviour.

The ReSource Project consisted of three 3-month training modules, each focusing on a different competency. The first module trained mindfulness-based attention and interoception. Participants were instructed in classical meditation techniques similar to those taught in the 8-week Mindfulness-based Stress Reduction Program (MBSR), which requires one to focus attention on the breath (Breathing Meditation), on sensations in different parts of the body (Body Scan), or on visual or auditory cues in the environment. Both exercises were practised in solitude.

Training in the second module focused on socio-affective competencies, such as compassion, gratitude, and dealing with difficult emotions. In addition to classical meditation exercises, participants learnt a new technique requiring them to practise each day for 10 minutes in pairs. These partner exercises, or so-called "contemplative dyads," were characterised by a focused exchange of every-day life affective experiences aiming to train gratitude, dealing with difficult emotions, and empathic listening.

In the third module, participants trained socio-cognitive abilities, such as metacognition and perspective-taking on aspects of themselves and on the minds of others. Again, besides classical meditation exercises, this module also offered dyadic practices focusing on improving perspective-taking abilities. In pairs, participants learnt to mentally take the perspective of an "inner part" or aspect of their personality. Examples of inner parts were the "worried mother," the "curious child," or the "inner judge."

By reflecting on a recent experience from this perspective, the speaker in dyadic pair-exercise trained in perspective-taking on the self, thus gaining a more comprehensive understanding of his or her inner world. By trying to infer which inner part is speaking, the listener practices taking the perspective of the other.

All exercises were trained on six days a week for a total of 30 minutes a day. Researchers assessed a variety of measures such as psychological behavioural tests, brain measures by means of magnetic resonance-imaging (MRI), and stress markers such as cortisol release before and after each of the three three-month training modules.

"Depending on which mental training technique was practised over a period of three months, specific brain structures and related behavioural markers changed significantly in the participants. For example, after the

training of mindfulness-based attention for three months, we observed changes in the cortex in areas previously shown to be related to attention and executive functioning.

Simultaneously, attention increased in computer-based tasks measuring executive aspects of attention, while performance in measures of compassion or perspective-taking had not increased significantly. These social abilities were only impacted in our participants during the other two more intersubjective modules," states Sofie Valk, first author of the publication, which has just been released by the journal *Science Advances*.

"In the two social modules, focusing either on socio-affective or socio-cognitive competencies, we were able to show selective behavioural improvements with regard to compassion and perspective-taking. These changes in behaviour corresponded with the degree of structural brain plasticity in specific regions in the cortex which support these capacities," according to Valk.

"Even though brain plasticity in general has long been studied in neuroscience, until now little was known about the plasticity of the social brain. Our results provide impressive evidence for brain plasticity in adults through brief and concentrated daily mental practice, leading to an increase in social intelligence. As empathy, compassion, and perspective-taking are crucial competencies for successful social interactions, conflict resolution, and cooperation, these findings are highly relevant to our educational systems as well as for clinical application," explains Prof. Tania Singer, principal investigator of the ReSource Project.

Besides differentially affecting brain plasticity, the different types of mental training also differentially affected the stress response. "We discovered that in participants subjected to a psychosocial stress test, the secretion of the stress hormone cortisol was diminished by up to 51%. However, this reduced stress sensitivity was dependent on the types of previously trained mental practice," says Dr Veronika Engert, first author of another publication from the ReSource Project, which describes the connection between mental training and the acute psychosocial stress response, also recently published in *Science Advances*. "Only the two modules focusing on social competencies significantly reduced cortisol release after a social stressor. We speculate that the cortisol stress response was affected particularly by the dyadic exercises practised in the social modules. The daily disclosure of personal information to a stranger coupled with the non-judgmental, empathic listening experience in the dyads may have "immunised" participants against the fear of social shame and judgment by others -- typically a salient trigger

of social stress. The concentrated training of mindfulness-based attention and interoceptive awareness, on the other hand, had no dampening effect on the release of cortisol after experiencing a social stressor."

Interestingly, despite these differences on the level of stress physiology, each of the 3-month training modules reduced the subjective perception of stress. This means that although objective, physiological changes in social stress reactivity were only seen when participants engaged with others and trained their inter-subjective abilities, and participants felt subjectively less stressed after all mental training modules.

"The current results highlight not only that crucial social competencies necessary for successful social interaction and cooperation can still be improved in healthy adults and that such mental training leads to structural brain changes and to social stress reduction, but also that different methods of mental training have differential effects on the brain, on health, and behaviour. It matters what you train," suggests Prof. Singer. "Once we have understood which mental training techniques have which effects, we will be able to employ these techniques in a targeted way to support mental and physical health."

For example, many currently popular mindfulness programmes may be a valid method to foster attention and strengthen cognitive efficiency. However, if we as a society want to become less vulnerable to social stress or train social competencies, such as empathy, compassion, and perspective-taking, mental training techniques focusing more on the "we" and social connectedness among people may be a better choice.