

Mindfulness in the Brain Injured Patient

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What is meditation?

Conceived in the east by Patanjali (5)

It is consequently described as a state of pure attention without any thought content. (5)

State of pure “contentless attention” and is described in Sanskrit as the state of “sat chit ananda” which translates as a state of pure attention and joy. (5)

Meditation encompasses a family of complex practices that include mindfulness meditation, mantra meditation, yoga, tai chi and chi gong. (14)

Mindfulness meditation has received attention in neuroscience research over the past two decades. (14)

Origins of Meditation

Meditation is a practice that has existed for many centuries. (9)

It involves different techniques and can be found in a variety of cultural traditions. (9)

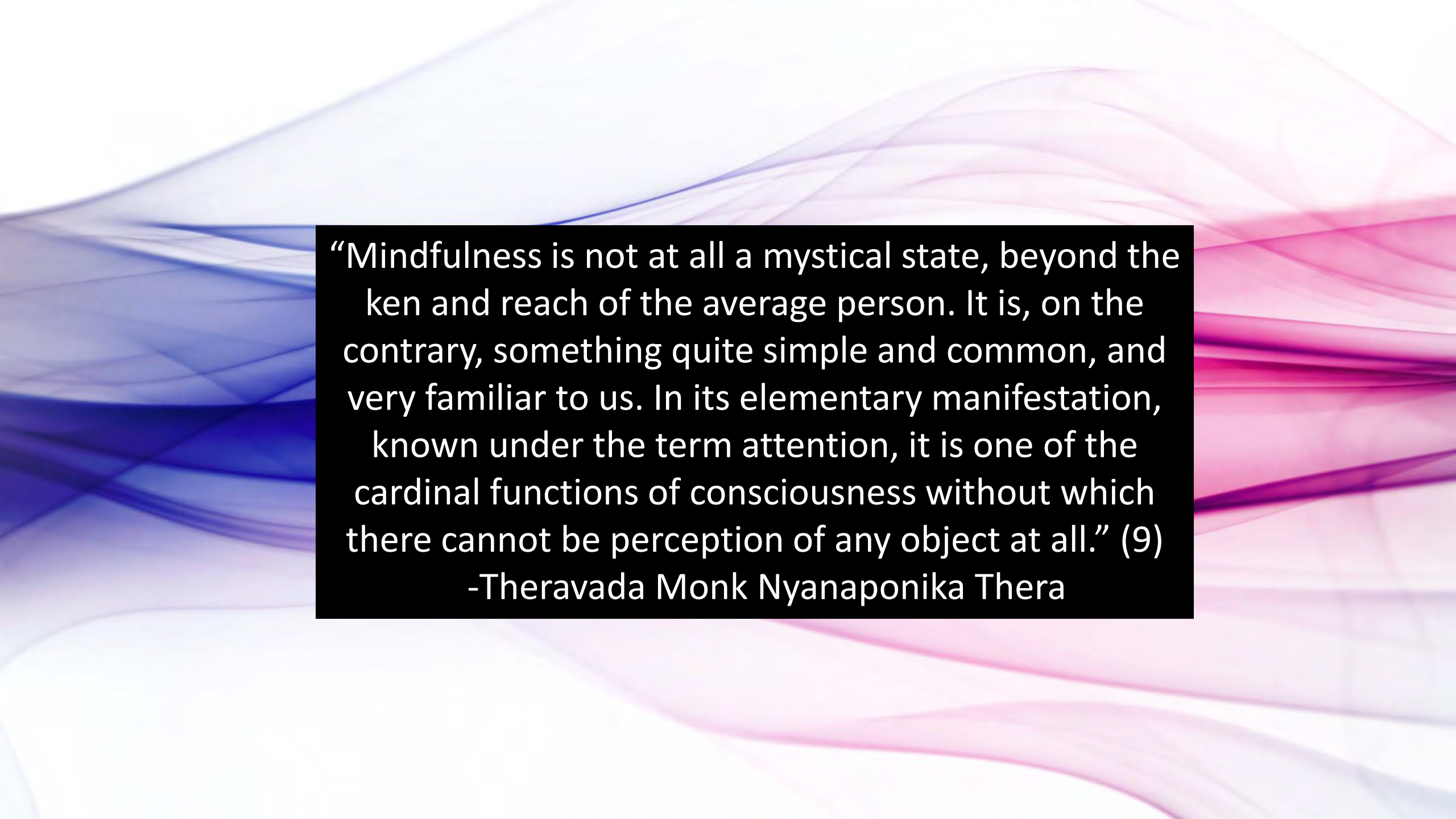
Eastern culture and spirituality, especially with the Indian religion of Hinduism whose ancient scriptures (the Vedas) report the earliest references to this practice and the philosophy of Buddhism which holds meditation as a key part of its doctrine. (9)

What is mindfulness?

Moment to moment awareness, cultivated by paying attention in a specific way, in the present moment, as non reactively, non judgmentally and open heartedly as possible. (2)

Google's business practices, available as standard psychotherapy via the national health service in the UK and most recently part of standard education for approximately 6,000 school children in London. (2)

Additionally, it has become a major area of study across subdisciplines of psychological science, including social/personality, industrial/organizational, experimental, clinical, cognitive, health, educational and many others. (2)

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“Mindfulness is not at all a mystical state, beyond the ken and reach of the average person. It is, on the contrary, something quite simple and common, and very familiar to us. In its elementary manifestation, known under the term attention, it is one of the cardinal functions of consciousness without which there cannot be perception of any object at all.” (9)
-Theravada Monk Nyanaponika Thera

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Styles of Meditation

Styles of Meditation

Concentration meditation: focusing on a specific object such as the breath or a mantra.

“Samatha bhavana” = “to foster concentration.” (9)

Mindfulness meditation: technique does not use a focal object but rather encourages the exploration of the very changing experience as it unfolds through time. “vipassana bhavana” = “to foster interior awareness.” (9)

Loving kindness meditation: with this technique the mind is led to concentrate on gentle statements such as “may I and all other creatures be safe, happy, healthy and live in simplicity.”

“Metta bhavana” = “to foster fondness.” (9)

Mindfulness Neuroscience

Interdisciplinary field that is discovering relevant associations between mindfulness practice, brain networks and neuroplasticity, such as increased gray matter density and alterations in brain connectivity. (13)

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Functional Medicine

What is functional medicine?

Combines conventional treatment methods with complementary, genetic, holistic and nutritional therapies. (11)

Assess the patient as a whole person (11)

“A personalized, systems oriented model that empowers patients and practitioners to achieve the highest expression of health by working in collaboration to address the underlying causes of disease.” (11)

Acupuncture, ayurveda, chiropractic manipulation, detoxification programs, herbal and homeopathic supplements, specialized diets, massage, meditation and mindfulness practices, neurobiofeedback, nutritional supplements, physical therapies, tai chi and yoga. (11)

Morphometric Changes in the Brain

In the past decade, 21 studies have investigated alterations in brain morphometry related to mindfulness meditation. Studies have captured cortical thickness, grey matter volume and/or density. (14)

Most have made cross sectional comparisons between experienced meditators and controls, however a few have investigated longitudinal changes in novice practitioners. (14)

The locations of the reported effects are diverse and cover multiple regions in the brain. Effects reported include cerebral cortex, subcortical grey and white matter, brainstem and cerebellum, suggesting that the effects of meditation might involve large scale brain networks. (14)

This is not surprising as mindfulness practice involves multiple aspects of mental function that use multiple complex interactive networks in the brain. (14)

Morphometric Changes in the Brain

8 brain regions were found to be consistently altered in meditators:

1) The frontopolar cortex which could be related to enhanced meta awareness following meditation practice.

2) The sensory cortices and insula - areas related to body awareness.

3) The hippocampus - related to memory processes.

4-6) Anterior cingulate cortex (ACC), mid cingulate cortex and orbitofrontal cortex - areas known to be related to self and emotional regulation.

8) Superior longitudinal fasciculus and corpus callosum - areas involved in intra and inter-hemispherical communication. (14)

Morphometric Changes in the Brain

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Review

Is meditation associated with altered brain structure? A systematic review and meta-analysis of morphometric neuroimaging in meditation practitioners



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Morphometric Changes in the Brain

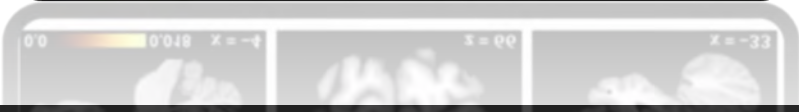
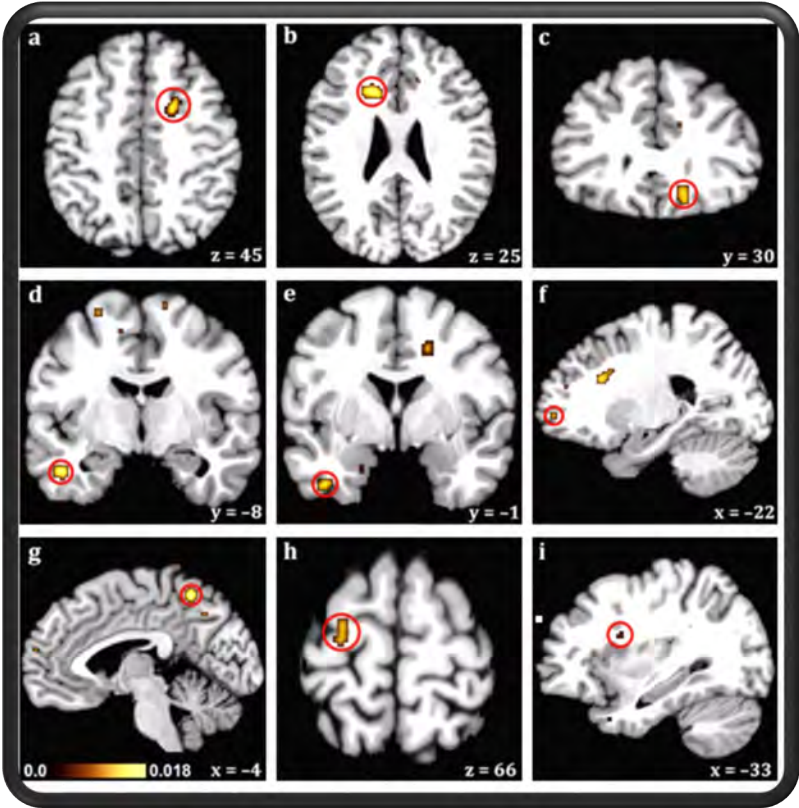
Table 5

Regions that show brain structure differences after brief meditation training in novices.

Region	Approximate BA
<i>Gray matter regions</i>	
Anterior cingulate cortex	24/32
Posterior cingulate cortex	31
Insular cortex	13
Temporoparietal junction	39/40, 22
Cerebellum	-
Hippocampus	-
Caudate nucleus	-
<i>White matter pathways</i>	
Corpus callosum	-
Superior longitudinal fasciculus	-
Sagittal stratum	-
Thalamic radiation	-
Corona radiata	-

Regions reported (in one or more studies) in novices after brief meditation training, from a qualitative review of all results (Table S1). BA: Brodmann area.

Morphometric Changes in the Brain



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Benefits of Meditation

Benefits: General

Improvement in depression, physical health related quality of life and mental health related quality of life. (6)

Decrease the experience of one's own bodily pain.(7)

Quality of life of patients with drug resistant epilepsy: mood, seizure frequency and verbal memory. (9)

MBSR program - 8 weekly 2.5 hour sessions and one full day session between sixth and seventh sessions. Significant improvements were achieved for mental fatigue and on the neuropsychological tests measuring information processing speed and attention. (4)

Benefits: Attention

A sufficient degree of attentional control is required to stay engaged in meditation, and meditators often report improved attention control as an effect of repeated practice. (14)

ACC enables executive attention and control by detecting the presence of conflicts emerging from incompatible streams of information processing. (14)

Other attention related brain regions in which functional changes have been observed following mindfulness meditation include the dorsolateral prefrontal cortex where responses were enhanced during executive processing. (14)

Although there is evidence that brain regions relevant for the regulation of attention show functional and structural changes following mindfulness meditation practice, it has not been determined whether these changes are actually related to improved attentional performance. (14)

Benefits: Emotion

Diminished activation of the amygdala in response to emotional stimuli during mindful states as well as in a resting state suggesting a decrease in emotional arousal. (14)

ACC, PFC, PCC, insula, striatum (caudate and putamen) and amygdala seem to show consistent changes associated with mindfulness meditation: core regions involved in self regulation of attention, emotion and awareness following mindfulness training. (14)

Benefits: Stress Reduction

The brain is a target for stress and stress related hormones. It undergoes functional and structural remodeling in response to stress in a manner that is adaptive under normal circumstances but can lead to damage when stress is excessive. (14)

Evidence suggests that the vulnerability to stress induced brain plasticity is prominent in the prefrontal cortex, hippocampus and amygdala and other areas associated with fear related memories and self regulatory behaviors. (14)

The interactions between these brain regions determine whether life experience lead to successful adaptation or maladaptation and impaired mental and physical health. (14)

A study has shown that chronic stress induces less flexibility in attention shifting in the rodent and human adult. Effects of chronic psychosocial stress on the PFC function and connectivity are plastic and can change quickly as a function of mental state. Studies have also shown that moderate to severe stress seems to increase the volume of the amygdala but reduce the volume of the PFC and hippocampus. (14)

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Pathophysiology

Pathophysiology

Inducing dendritic branching, synaptogenesis, myelinogenesis or even adult neurogenesis. (14)

Affects autonomic regulation and immune activity, which may result in neuronal preservation, restoration and/or inhibition of apoptosis. It is well known that mindfulness based techniques are highly effective in stress reduction and it is possible that such stress reduction may mediate changes in brain function. (14)

Sympathetic adrenal medullary and hypothalamic pituitary adrenal axes by increasing activity in the parasympathetic nervous system; thus, mindfulness meditation could prevent sympathetic nervous system fight or flight stress responses. Indeed, some research has suggested that mindfulness leads to increased activity of the parasympathetic nervous system. (14)

A combination of all of these mechanisms may even occur. It is also important to realize that the direction of the observed effects of mindfulness have not been consistent across all studies. (14)

Pathophysiology

Brief mindfulness training increased functional connectivity between a hub in the executive control network (the dlPFC) and dorsal and ventral corticolimbic circuits involved in cognitive control. Attention, interoception, and emotional processing increases during active meditation and dlPFC connectivity is strengthened following stress reduction interventions, by identifying specific neural circuits in which rsfc is enhanced by a mindfulness training intervention in a high stress participant sample. (12)

Increased resting state functional connectivity between dorsal stream regions and dlPFC suggests that the focused attention trained by mindfulness may be enhancing the ability of the dlPFC to exert top down control for attention and action selection via strengthening of this dorsal neural circuit. (12)

Theory that mindfulness training strengthens a resting state ventral control pathway for salience processing and emotion regulation. Strengthens the functional connections between executive control and salience responding ventral attentional regions. (12)

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Brain Injury & Stroke Research

Rehabilitation Setting

BRAIN RESEARCH 1640 (2016) 139–151

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Brain Research

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Review

Complementary and alternative medicine (CAM) following traumatic brain injury (TBI): Opportunities and challenges

 CrossMark

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Fatigue

 **frontiers**
in Psychology

REVIEW
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Clinical Utility of Mindfulness Training in the Treatment of Fatigue After Stroke, Traumatic Brain Injury and Multiple Sclerosis: A Systematic Literature Review and Meta-analysis

Kristine M. Ulrichsen^{1}, Tobias Kaufmann², Erlend S. Dørum^{1,2,3}, Knut K. Kolskår^{1,2,3}, Geneviève Richard^{1,2,3}, Dag Alnæs², Tone J. Arneberg⁴, Lars T. Westlye^{2,3*} and Jan E. Nordvik¹*

Aphasia

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Research Report

Brief mindfulness meditation group training in aphasia: exploring attention, language and psychophysiological outcomes

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Warnings

Warnings

The NIH states that “meditation could cause or worsen certain psychiatric problems” but does not provide any practice guidelines beyond a boilerplate disclaimer to “check with your doctor” before trying meditation. (2)

Increased likelihood of suicidality, depression, negative emotions, and flashbacks during meditation for individuals with trauma histories. Oxford mindfulness center has published recommended exclusion criteria for standard MBSR and MBCT, both excluding current suicidality and/or any current psychiatric disorder. In addition, many centers attempt to make clear that mindfulness is not intended to replace standard psychiatric care. (2)

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Limitations in Research

Limitations in Research

- 1) Strong bias towards the publication of positive or significant results. Few are actively controlled longitudinal studies and sample sizes are small. (14)
- 2) Pre-existing differences in the brains of meditators? (14)
- 3) Similar changes have been observed following other forms of mental and physical skill acquisition. (2)
- 4) Researchers should stress specifically that individuals who already have meditated over many years or who - though not yet experts - are personally attracted to meditation, may have characteristics that differentiate them from the general population even before experimentation. (2)

Limitations in Research continued

5) Various possible meanings of mindfulness have to be clarified.

6) Need precisely focused, terminology for referring to the various distinct mental and physical states as well as overt behaviors often associated with mentions of mindfulness.

7) Need more uniformity and better controls. Provide warnings regarding the extent to which their research findings generalize to clinical practice. Address the potential adverse effects stemming from mindfulness practices. (2)

Resources

- 1) Increased Gamma Brainwave Amplitude Compared to Control in Three Different Meditation Traditions. Claire Braboszcz et al. PLoS One. 2017
- 2) Mind the Hype: A Critical Evaluation and Prescriptive Agenda for Research on Mindfulness and Meditation. Nicholas T Van Dam et al. Perspect Psychol Sci. Jan 2018
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- 5) "Increased Grey Matter Associated with Long-Term Sahaja Yoga Meditation: A Voxel-Based Morphometry Study." Hernández, Sergio Elías, et al. Plos One, vol. 11, no. 3, 2016, doi:10.1371/journal.pone.0150757
- 6) Mindfulness Meditation for Chronic Pain: Systematic Review and Meta-analysis. Lara Hilton et al. Ann Behav Med. 2017
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- 8) Meditation is associated with increased brain network integration. van Lutterveld R, et al. Neuroimage 2017. PMID 28663069

Resources continued

- 9) Mindfulness Meditation and Consciousness: An Integrative Neuroscientific Perspective. Jordi Manuella et al. Conscious Cogn. Feb 2016
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- 13) Clinical Utility of Mindfulness Training in the Treatment of Fatigue After Stroke, Traumatic Brain Injury and Multiple Sclerosis: A Systematic Literature Review and Meta-analysis. Ulrichsen KM, et al. Front Psychol 2016 - Review. PMID 27445888
- 14) The Neuroscience of Mindfulness Meditation Yi-Yuan Tang et al. Nat Rev Neurosci. Apr 2015.