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Reviews

Zen Meditation: An Integration of Current Evidence

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Abstract

Objective: Despite the growing interest in the neurobiological and clinical correlates of many meditative practices, in particular mindfulness meditations, no review has specifically focused on current evidence on electroencephalographic, neuroimaging, biological, and clinical evidence about an important traditional practice, Zen meditation.
Methods: A literature search was conducted using MEDLINE, the ISI Web of Knowledge, the Cochrane collaboration database, and references of selected articles. Randomized controlled and cross-sectional studies with controls published in English prior to May 2008 were included.
Results: Electroencephalographic studies on Zen meditation found increased alpha and theta activity, generally related to relaxation, in many brain regions, including the frontal cortex. Theta activity in particular seemed to be related to the degree of experience, being greater in expert practitioners and advanced masters. Moreover, Zen meditation practice could protect from cognitive decline usually associated with age and enhance antioxidant activity. From a clinical point of view, Zen meditation was found to reduce stress and blood pressure, and be efficacious for a variety of conditions, as suggested by positive findings in therapists and musicians.
Conclusion: To date, actual evidence about Zen meditation is scarce and highlights the necessity of further investigations. Comparison with further active treatments, explanation of possible mechanisms of action, and the limitations of current evidence are discussed.

Introduction

In recent years growing attention has been given to the role of spirituality in mental and physical health.[1,2] Among different spiritual practices, one of the main foci of the present investigation was the field of meditation;[3–5] in particular, a subgroup of meditation practices called mindfulness meditations.[6–8] This type of meditation comprehends many different practices, unified by the concept of paying total attention to the present moment with a nonjudgmental awareness of inner and outer experiences.[9] Mindfulness has been suggested to be one of the two main poles of meditation in contrast to the concentrative forms of meditation,[10] even though many mindfulness protocols themselves suggest the practice of some concentrative techniques before reaching the mindfulness state,[11,12] and many authors agree in describing meditative practices as a continuum between these two poles.[5]

Despite the growing interest in mindfulness meditations, however, current research is focused on new clinically oriented practices, including mindfulness-based stress reduction[6] and mindfulness-based cognitive therapy.[13] Less attention has been given to one of the main traditional mindfulness forms of meditation: Zen meditation. Historically, Zen meditation is one of the main Buddhist meditations belonging to the pole of mindfulness meditation, first introduced in China by the Buddhist monk Bodhidarma, and called Chan, and then in Japan where it was called the well-known name of Zen.[14,15]

Zen meditation comprehends various types of practices whose difficulty levels usually grow with the meditator's experience. A complete description of these practices is beyond the scope of the present review.[14,16] Although specific differences can occur among different Zen sects, the first meditation often practiced by novice meditators is *Su-soku*, a meditation

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more similar to concentrative meditations where the practitioners count their breaths so as to focus their attention. With ongoing practice, counting is omitted and the meditators remain simply aware of the present experience: this practice is called *Shikantaza* and is considered the most advanced form of Zen meditation.[16] It is important to underline, however, that at least in one of the major Zen sects, the Soto school, the prescribed meditation practice of *Shikantaza* (or *Za-zen* or simply sitting) is exactly the same for novices and monks with decades of practice.

Even though many papers are currently available on the physical and psychological effect deriving from several meditations, to date no review has specifically investigated Zen meditation. Thus, the aim of the present work is to evaluate the electroencephalographic, neuroimaging, biological, and clinical evidence of the effects of Zen meditation.

Methods

Literature search

A literature search was conducted using MEDLINE, the ISI Web of Knowledge, the Cochrane database, and the references of retrieved articles. The search included articles and congress abstracts indexed in the above mentioned web-based electronic bibliographic databases, published before May 2008. The search strategy considered only studies published in English. The search terms were: Zen meditation, Za-zen, neuroimaging, electroencephalography, mental disorders, physical disorders, and healthy subjects in various combinations of the above.

Selection of trials

Studies and congress abstracts indexed or mentioned in identified reviews which focused on the relationship between Zen meditation practice and neurobiological or clinical outcomes in patients with mental and physical disorders as well as in healthy people were screened by one reviewer to be considered for inclusion (Fig. 1). Included studies had to: 1) be randomized controlled, controlled, or cross sectional studies with controls; 2) include both active and inactive comparators; 3) provide quantitative data supported by statistical methodology; and 4) focus on electroencephalographic, neuroimaging, or biological data or, alternatively, on clinical data in healthy subjects or in clinical samples. Reasons for exclusion were: 1) qualitative reports; 2) absence of a control group; 3) statistical methodology not reported; 4) articles focusing on types of meditation other than Zen meditation, and 5) reviews and meta-analyses. A formal quality assessment of the studies was not conducted; implications of this limitation will be considered in the discussion section.

Outcome measures

The main outcome measures were: 1) differences between electroencephalographic patterns in Zen meditators and controls; 2) differences between neuroimaging patterns in Zen meditators and controls; 3) differences between biological measures in Zen meditators and controls; 4) differences between clinical outcomes (positive emotions and blood pressure levels) in Zen meditators and controls; and 5) differences between further miscellaneous findings in Zen meditators and controls.

Data extraction and synthesis

The data were extracted by a single reviewer using a comprehensive and pretested data extraction form.[3] Studies were grouped together according to the type of investigated outcomes: neurobiological studies, clinical studies, and miscellaneous findings. On the basis of the investigated outcomes, neurobiological studies were further divided into: electroencephalographic (EEG) studies, neuroimaging studies, and biological studies. Clinical studies were further divided in physical disorders and healthy subjects. Findings that did not fit into previous outcomes were grouped as miscellaneous findings.

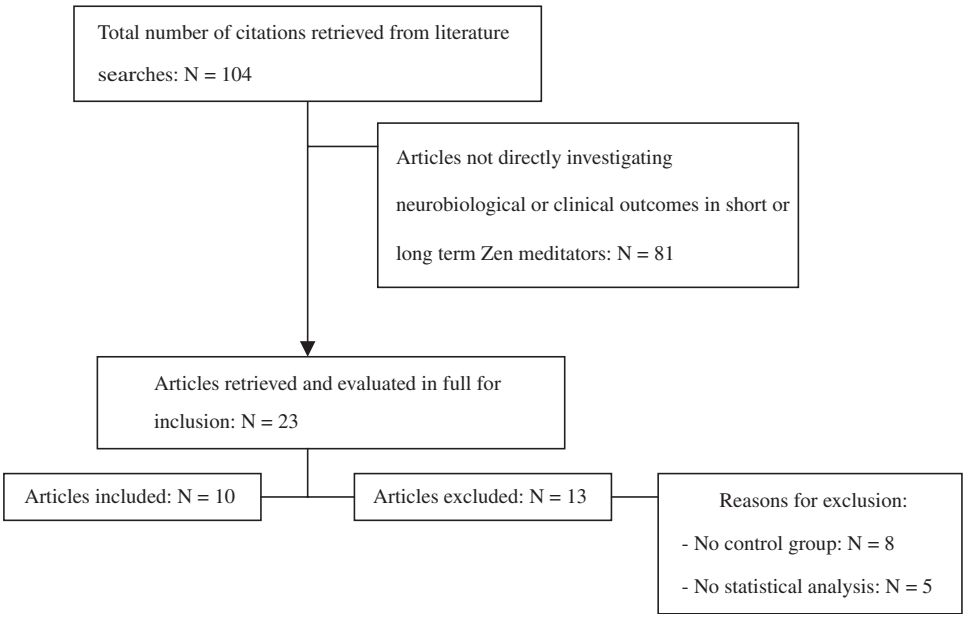

FIG. 1. Flow diagram of the review process.

Results

Search results

The original search retrieved 104 papers, of which 81 were excluded because their primary focus was not the investigation of neurobiological or clinical outcomes in short- or long-term Zen meditators (Table 1). After the first screening, 23 papers remained. After the inclusion and exclusion criteria were applied, 10 studies remained in the present review: 6 crossover,[17–22] 1 controlled,[23] and 3 randomized controlled studies (Table 2).[24–26]

Characteristics of included studies

A first division was performed between neurobiological studies (5 studies),[17–21] clinical studies (3 studies),[22–24] and miscellaneous findings (2 studies).[25,26] On the basis of the investigated outcomes, the first group of studies was further divided into: electro-encephalographic (EEG) studies (3 studies),[17–19] a neuroimaging study,[20] and a biological study.[21] The second group of studies was further divided in physical disorders (2 studies on subjects with hypertension)[23,24] and a study of healthy subjects.[22] Findings that did not fit with previous outcomes were grouped as miscellaneous findings.[25,26] Because of the scarcity of data and the differences of investigated outcomes and study designs, data were reported in narrative form.

Neurobiological evidence

Electroencephalographic studies. The first historical EEG study on Zen meditation was performed on meditators with different degrees of experience and controls, in eyes open and meditation conditions.[17] The authors observed decreased alpha frequency, frontal alpha activity, and theta bursts, the last correlated with the level of experience, as well as nonhabituating alpha blocking in meditators compared to controls, suggesting a state of being present but relaxed moment by moment in Zen meditation practitioners. Unfortunately, the poor methodological quality of this study, only partially supported by statistic analysis, limits the generalizability of these findings. A following study[18] investigating habituation to a click sound produced every 15 seconds comparing subjects practicing Zen meditation, Transcendental Meditation, or Yoga to two control groups did not detect any difference in alpha blocking. In this study each group was informed that they would hear a series of clicks presented every 15 seconds during the testing session. The meditators were instructed to continue meditating as normal, whereas the control groups were asked to either strongly attend to each click by counting them or to ignore the clicks. In this study, all groups habituated to the auditory stimulus at the same rate, that is, meditation was not found to have an effect on alpha blocking.

Finally, a more recent study[19] comparing 20 monks (10 with extensive experience, 10 with moderate experience) to 10 controls prior to and during Zen meditation found that slow alpha appeared in all groups but that theta activity only appeared in the experienced group, affecting the frontal region, with the likelihood of it occurring increasing proportionally to the level of experience, hence supporting the previous findings of Kasamatsu and Hirai.[17]

Neuroimaging studies. To date only one study has investigated the effect of long-term Zen meditation in healthy subjects.[20] This study showed that, while control subjects matched for sex, age, and educational level displayed the expected negative correlation of both gray matter volume and attentional performance with age, meditators did not show a significant correlation of either measure with age. The strongest difference between the two groups was found in the putamen volume, a structure strongly implicated in attentional processing. The authors proposed that Zen meditation could have a protective effect against physiological cognitive decline, and could be useful for illnesses such as attention deficit disorders although, given the cross sectional design of the study, further investigations are warranted.

Biological studies. A study investigating a possible difference in the activity of serum nitric oxide, the predominant anti-atherosclerotic principle in the vascular wall, in Zen meditators and matched controls, found a significantly higher level of serum nitrate and nitrite concentration and a significant reduced level of serum malondialdehyde in meditators compared to a control group.[21] The authors reported that, in accord with previous studies that found that oxidative stress could contribute to the pathophysiology of atherosclerosis and chronic heart disease, their results suggested that Zen meditation, by reducing stress, could prevent stress-related disease such as heart attacks, although the absence of pre-test meditation values in both controls and meditators do not allow them to reach definitive conclusions.

Clinical studies

Healthy subjects. A single study comparing 59 long-term Zen meditators to 24 college students spending 60 minutes silently reading popular magazines used as controls found that, after the practice, meditators experienced higher relaxation, mental quietness, and sensation of timeless/boundless/infinity than controls, as well as greater increments in the following relaxation states: mental quiet, love and thankfulness, prayerfulness, and reduced worry.[22] However, the

Table 1. Excluded Studies and Reasons for Exclusion

Study	*Reason for exclusion*
Electroencephalogram studies	
Hardt (1994)[28]	No control group
Murata et al. (2004)[29]	No control group
Kubota et al. (2001)[30]	No control group
Lo et al. (2003)[31]	No statistical analysis
Faber et al. (2004)[32]	No statistical analysis; case report
Coromaldi and Stadler (2004)[33]	No statistical analysis; case report
Takahashi et al. (2005)[34]	No control group
Coromaldi et al. (2006)[35]	No statistical analysis, case report
Neuroimaging studies (fMRI)	
Ritskes et al. (2003)[36]	No control group
Baerensten et al. (2001)[37]	No control group
Biological study	
Moon et al. (2005)[38]	No statistical analysis
Clinical studies	
Lehrer et al. (1999)[39]	No control group
Cysarz and Bussing (2005)[40]	No control group

Table 2. Characteristics of Included Studies

Study (year)	*Subjects*	*Experimental design*	*Main findings*	*Main strengths and limitations*
Neurobiological studies				
Electroencephalogram studies				
Kasamatsu (1966)[17]	70: 48 meditators with different degree of experience, 22 controls in Japan	Cross-sectional study: ZM with different degrees of experience vs. controls: EEG during eyes-open rest or meditation condition	Increased alpha activity, decreased alpha frequency, frontal alpha activity and theta bursts correlated with the level of experience and nonhabituating alpha blocking in meditators	*Strength*: Inclusion of meditators with different degrees of experience *Limitation*: Not all results supported by statistical methodology but largely thorough case illustrations
Becker (1981)[18]	50: 10 for each included category in North America	Cross-sectional study: TM, ZM, Yoga vs. two control groups	No effect of meditation was detected on alpha blocking	*Strenght*: Inclusion of an active control group and two controls *Limitation*: Absence of sufficiently trained meditators
Murata (1994)[19]	30: 20 meditators, 10 controls in Japan	Cross-sectional study: Novice vs. expert ZM vs. controls	Increased frontal alpha coherence in all meditation groups; frontal theta activity correlated with the degree of experience in expert meditators only	*Strength*: Inclusion of meditators with different degrees of experience *Limitation*: Lack of investigation of many psychological conditions which could interfere with the results
Neuroimaging studies				
Pagnoni (2007)[20]	26: 13 expert Zen meditators, 13 matched controls in North America	Cross-sectional study: ZM vs. non-meditators	Control subjects displayed the expected negative correlation of both gray matter volume and attentional performance with age; meditators did not show a significant correlation of either measure with age. The effect was most prominent in the putamen	*Strength*: Controls matched for sex and age; inclusion of only expert meditators in order to detect stronger differences *Limitation*: Possible influence of constant mental activity enhancing putamen and cortical volume in meditators not assessed in the study
Biological study				
Kim (2005)[21]	40: 20 meditators, 20 controls in Korea	Cross-sectional study: ZM vs. controls	Higher level of serum nitrate+nitrite concentration and a significant reduced levelof serum malondial-dehyde in meditators	*Strength*: Control for dietary factors *Limitation*: Absence of pre-test values

Clinical studies				
Healthy subjects				
Gillani (2001)[22]	83: 59 expert meditators, 24 controls (predominantly North Americans)	Cross-sectional study: ZM vs. controls	After the practice, meditators experienced higher relaxation, mental quietness, and sensation of timeless/boundless/infinity	*Strength*: Comparison of many measures of positive and negative emotions *Limitation*: Possible bias due to the absence of sample characteristics
Physical disorders (cardiovascular system)				
Stone (1976)[23]	19: 15 meditators, 5 controls in North America	Controlled study: patients suffering from hypertension assigned for 6 months to ZM vs. blood pressure checks	Those practicing ZM showed significantly higher decreases in blood pressure	*Limitations*: Small sample, absence of randomization, unclear allocation concealment
Yen (1996)[24]	231: 120 meditators, 111 controls in China	Randomized controlled study: patients suffering from hypertension randomly assigned to 2 months of ZM plus PMR vs. blood pressure checks	Those practicing ZM+PMR showed significantly higher decreases in blood pressure	*Strength*: Randomization between two groups *Limitation*: Unclear allocation concealment
Miscellaneous findings				
Grepmair (2007)[25]	18: 9 therapists practicing ZM vs. 9 non-practitioner therapists in Germany	Randomized controlled study: patients assigned to therapists practicing ZM vs. therapists not practicing ZM	Significantly higher evaluations for individual therapy on clarification and problem-solving perspectives and significantly higher evaluations for the entire therapeutic result for patients followed by therapists practicing ZM	*Strength*: Randomized assignment of patients *Limitation*: Psychotherapists underwent Zen training of only relatively short duration; Zen training here was not tested against a placebo intervention.
Lin (2008)[26]	19, division not specified, in North America	Randomized controlled study: Musicians randomly assigned to ZM or to control condition	No significant improvement on musical performance quality in meditators. A significant decrease in performance quality with increases in performance anxiety in the control group but the meditation group demonstrated a positive linear relation between performance quality and performance anxiety.	*Strength*: Randomized assignment of musicians *Limitations*: Small sample, participants were self-selected and therefore are not necessarily representative of the general population of musicians

ZM, Zen meditation; TM, Transcendental Meditation; PMR, progressive muscle relaxation.

authors did not reported initial sample characteristics, thus introducing a potential bias that underlines the necessity of further investigation in this area.

Physical disorders. Two controlled studies investigated the effects of six months of Zen meditation practice, and two months of Zen meditation plus progressive muscle relaxation, respectively, versus blood pressure checks in patients suffering from hypertension.[23,24] A recent systematic meta-analysis reviewed these studies.[3] The results of the meta-analysis indicated a significant increase in diastolic blood pressure and a non-significant decrease in systolic blood pressure in meditators.

Miscellaneous studies

After an early report[27] emphasized the therapist's well-integrated and mature personality as the crucial element for being a good psychotherapist and suggested the utility of Zen meditation for this purpose, Grepmair et al.[25] investigated whether Zen meditation could be useful for therapists. They randomized 124 inpatients to 9 therapists practicing Zen meditation or to 9 non-meditator therapists. The results showed that patients of meditator therapists compared to patients treated by non-meditators had significantly higher evaluations for individual therapy, clarification, and problem-solving perspectives and showed greater symptom reduction on different scales, including somatization, insecurity in social contact, obsessiveness, anxiety, anger/hostility, phobic anxiety, paranoid thinking and psychoticism, suggesting a significant advance for therapists who practiced Zen meditation.

A randomized investigation focusing on the impact of Zen meditation on musical performance anxiety and quality found that, while the control group demonstrated a significant decrease in performance quality with increases in performance anxiety over time, the meditation group demonstrated a positive linear relationship between performance quality and performance anxiety, suggesting that enhanced concentration and mindfulness, cultivated by Zen practice, might enable the subjects to channel performance anxiety to improve musical performance.[26] Although these study surely need replication, it is important to underline that they open a new field of research and further confirmation as well as extension of these preliminary results to further categories of workers are needed in order to better establish for whom and how Zen meditation could be useful.

Discussion

The aim of the present work was to review current evidence on electroencephalographic, neuroimaging, and biological data as well as clinical application or miscellaneous findings on Zen meditation. EEG studies on Zen meditation detected α-wave activity across the frontal lobe. Although some authors interpreted these findings as the neural correlate of psychological harmony, in which consciousness is characterized by an heightened sense of awareness but without content, according to others, it simply represents baseline cortical activity or metabolic depression.[5,41] Findings in other mindfulness meditations or concentrative and yogic meditations found consistent α-activity as well,[5] suggesting that it may not be a distinguishing feature of Zen meditation, but rather a feature more generally associated with meditation. Moreover, meditation experience could be related to greater frontal theta activation, leading to the hypothesis that greater experience could be related to higher ability of self-inducing deep relaxation. Interestingly, case reports focusing on advanced Zen masters consistently found theta activity during their meditative practice.[32,33,35] although the absence of statistical analysis suggests considering these findings with caution. Similar findings were obtained for further meditations as well,[5] suggesting that it could be a general marker of proficiency in practice but highlighting the necessity for further investigations to better establish whether the appearance of theta waves in different areas could represent a specific marker for different meditative practices or not. Finally, available evidence on the effects of Zen meditation on alpha-blocking is contradictory and needs further investigation.

The only long term fMRI study showed that Zen meditation was positively associated with gray brain matter volume, in accord with findings on Vipassana meditation, another Buddhist mindfulness meditation, which showed that cerebral cortex was thicker in meditators compared to controls.[42] Future research should investigate larger samples in order to investigate possible efficacy of these meditative practices for the prevention of physiological cognitive decline associated with age or for their potential usefulness in illnesses such as attention deficit disorders.

Few studies focused on potentially clinical uses of Zen meditation. Sparse evidence showed possible utility for the reduction of stress and blood pressure and for helping professionals such as psychotherapists and musicians. More research is needed in order to replicate these findings and to better establish the potential clinical uses of Zen meditation. This is particularly true if we consider the growing evidence of the benefits for health related to other mindfulness meditation practices, including mindfulness-based stress reduction and mindfulness-based cognitive therapy.[6–8,13]

The scarcity of findings do not allow us to reach a complete understanding of Zen meditation and its potential, especially given the absence of a validated scientific model of this practice. An initial problem is represented by the scarcity of proposed mechanisms of action through which Zen meditation might improve health. Recently, many hypotheses, including both psychological and biological mechanisms, have been proposed to explain how mindfulness meditations in general improve health, and future studies should test these specifically for Zen meditation as well. Paying attention in a particular way, paying attention to the present moment, and paying attention nonjudgmentally, are all factors the may contribute to reperceiving reality in a more flexible and adaptive way through a reduction of ruminative and dichotomous thinking.[43] On the other hand, biological mechanisms include activation of cerebral areas related to positive emotions,[44] reduction in cortisol levels,[45] release of beta endorphins,[45] and enhancement of parasympathetic activity.[34] Recent studies investigating the relationship between the construct of "mindfulness" and clinical outcomes[46–49] found that mindfulness-based stress reduction interventions increased levels of mindfulness and that these increases were related to improvements in clinical outcomes.

A second important field for future investigation is the relationship between "doses" of meditation—between time of daily practice and years of practice—and outcome. As EEG studies suggest possible changes in EEG patterns from novel to expert meditators, clinical outcomes could be related to the length of practice, as well. Future research should also investigate the differences between early Zen meditation practice such as *Su-soku* and advanced practice such as as *Shikantaza* by directly comparing expert practitioners able to meditate in both situations, through EEG and fMRI, and compare Zen meditation directly with other types of meditation. Finally, future investigation through more rigorous controlled studies on larger samples is needed to better clarify some contrasting findings regarding the presence or absence of alpha blocking during Zen meditation.

The limitations of this review include the decision to restrict the search to articles published in English: a number of Asian journals that could contain important results about Zen meditation practices have not been indexed. A second limitation is that the literature review was conducted by a single author, thus introducing a potential selection bias. A third limitation is the absence of a quality assessment of the included studies, which reduces the significance of the review findings. Finally, the inclusion of different study designs may introduce possible confounding factors, such as the absence of randomization, or cross-sectional studies carried out at one time point and giving no indication of the sequence of events.

In conclusion, actual evidence on Zen meditation is scarce and does not allow us to reach definitive conclusions. There is some evidence that Zen meditation practice is related to EEG alpha activity and theta activity (especially in more expert practitioners); that long-term Zen meditation might protect against cognitive decline; and that Zen meditation could be useful for reducing stress and blood pressure. What is needed is a model, a better understanding of mechanisms of action, and better designed and larger studies.

Disclosure Statement

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References

1. Park CL. Religiousness/spirituality and health: A meaning systems perspective. J Behav Med 2007;30:319–328.
2. Moreira-Almeida A, Neto FL, Koenig HG. Religiousness and mental health: A review. Rev Bras Psiquiatr 2006;28:242–250.
3. Ospina MB, Bond K, Karkhaneh M, et al. Meditation practices for health: State of the research. Evid Rep Technol Assess (Full Rep) 2007;155:1–263.
4. Arias AJ, Steinberg K, Banga A, et al. Systematic review of the efficacy of meditation techniques as treatments for medical illness. J Altern Complement Med 2006;12:817–832.
5. Cahn BR, Polich J. Meditation states and traits: EEG, ERP, and neuroimaging studies. Psychol Bull 2006;132:180–211.
6. Bishop SR. What do we really know about mindfulness-based stress reduction? Psychosom Med 2002;64:71–83.
7. Proulx K. Integrating mindfulness-based stress reduction. Holist Nurs Pract 2003;17:201–208.
8. Allen NB, Chambers R, Knight W. Mindfulness-based psychotherapies: A review of conceptual foundations, empirical evidence and practical considerations. Aust N Z J Psychiatry 2006;40:285–294.
9. Kabat-Zinn J. Wherever You Go, There You Are: Mindfulness Meditation in Everyday Life. New York: Hyperion, 1994.
10. Goleman DJ, Schwartz GE. Meditation as an intervention in stress reactivity. J Consult Clin Psychol 1976;44:456–466.
11. Kapleau P. The Three Pillars of Zen: Teaching, Practice and Enlightenment. Boston: Bacon Press, 1965.
12. Lutz A, Dunne JP, Davidson RJ. Meditation and the neuroscience of consciousness: An introduction. In: Zelazo M, Moscovitch M, Thompson EE, eds. Cambridge Handbook of Consciousness. New York: Cambridge University Press, 2007.
13. Coelho HF, Canter PH, Ernst E. Mindfulness-based cognitive therapy: Evaluating current evidence and informing future research. J Consult Clin Psychol 2007;75:1000–1005.
14. Mizuno K. Essentials of Buddhism. Tokyo: Kosei Publishing, 1972.
15. Omori S. An Introduction to Zen Training: A Translation of Sazen Nyumon. Boston: Tuttle Publishing, 2001.
16. Kit WK. The complete Book of Zen. Boston: Tuttle Publishing, 2001.
17. Kasamatsu A, Hirai T. An electroencephalographic study on the zen meditation (Zazen). Folia Psychiatr Neurol Jpn 1966; 20:315–336.
18. Becker DE, Shapiro D. Physiological responses to clicks during Zen, Yoga, and TM meditation. Psychophysiology 1981;18:694–699.
19. Murata T, Koshino Y, Omori M. Quantitative EEG study on Zen meditation (zaZen). Jpn J Psychiatr Neur 1994;48:881–890.
20. Pagnoni G, Cekic M. Age effects on gray matter volume and attentional performance in Zen meditation. Neurobiol Aging 2007;28:1623–1627.
21. Kim DH, Moon YS, Kim HS, et al. Effect of Zen meditation on serum nitric oxide activity and lipid peroxidation. Prog Neuropsychopharmacol Biol Psychiatry 2005;29:327–331.
22. Gillani NB, Smith JC. Zen meditation and ABC relaxation theory: An exploration of relaxation states, beliefs, dispositions, and motivations. J Clin Psychol 2001;57:839–846.
23. Stone RA, DeLeo J. Psychotherapeutic control of hypertension. N Engl J Med 1976;294:80–84.
24. Yen LL, Patrick WC, Chie WC. Comparison of relaxation techniques, routine blood pressure measurements and self learning packages in hypertension control. Prevent Med 1996;25:339–345.
25. Grepmair L, Mitterlehner F, Loew T, et al. Promoting mindfulness in psychotherapists in training influences the treatment results of their patients: A randomized, double-blind, controlled study. Psychother Psychosom 2007;76:332–338.
26. Lin P, Chang J, Zemon V, et al. Silent illumination: A study on Chan (Zen) meditation, anxiety, and musical performance quality. Psychol Music 2008;36:139–155.
27. Chung CY. Psychotherapist and expansion of awareness. Psychother Psychosom 1990;53:28–32.
28. Hardt JV. Proficiency in Zen meditation: Correspondence with multi-channel EEG coherence spectrum. Int J Psychophysiol 1994;18:112–113.
29. Murata T, Takahashi T, Hamada T, et al. Individual trait anxiety levels characterizing the properties of zen meditation. Neuropsychobiology 2004;50:189–194.
30. Kubota Y, Sato W, Toichi M, et al. Frontal midline theta rhythm is correlated with cardiac autonomic activities during the performance of an attention demanding meditation procedure. Brain Res Cogn Brain Res 2001;11:281–287.

31. Lo PC, Huang ML, Chang KM. EEG alpha blocking correlated with perception of inner light during Zen meditation. Am J Chin Med 2003;31:629–642.
32. Faber PL, Lehman D, Gianotti LR. Scalp and intracerebral (LORETA) theta and gamma EEG coherence in meditation. Paper presented at the meeting of the International Society for Neuronal Regulation, Winterthur, Switzerland, 2004.
33. Coromaldi E, Stadler MA. Long-sustained theta activity during deep meditation: A single case study with a Zen master. Int Clin Psychophysiol 2004;54:175–176.
34. Takahashi T, Murata T, Hamada T, et al. Changes in EEG and autonomic nervous activity during meditation and their association with personality traits. Int J Psychophysiol 2005; 55:199–207.
35. Coromaldi E, Stadler MA, Basar-Eroglu C. Correlation between EEG oscillations during deep meditation: A study with a Zen master. Int J Psychophysiol 2006;61:367.
36. Ritskes R, Ritskes-Hoitinga M, Stodkilde-Jorgensen H, et al. MRI scanning during Zen meditation: The picture of enlightenment? Construct Hum Science 2003;8:89–90.
37. Baerentsen KB, Hartvig NV, Stodkilde-Jorgensen H, et al. Onset of meditation explored with fMRI. Neuroimage 2001;26(Suppl 1):297.
38. Moon YS, Kim DH, Song DK. Effect of Zen meditation on serum growth factors/cytokines. Eur Neuropsychopharm 2005;15:S621.
39. Lehrer P, Sasaki Y, Saito Y. Zazen and cardiac variability. Psychosom Med 1999;61:812–821.
40. Cysarz D, Bussing A. Cardiorespiratory synchronization during Zen meditation. Eur J Appl Physiol 2005;95:88–95.
41. Dietrich A. Functional neuroanatomy of altered states of consciousness: The transient hypofrontality hypothesis. Conscious Cogn 2003;12:231–256.
42. Lazar SW, Kerr CE, Wasserman RH, et al. Meditation experience is associated with increased cortical thickness. Neuroreport 2005;16:1893–1897.
43. Shapiro SL, Carlson LE, Astin JA, et al. Mechanisms of mindfulness. J Clin Psychol 2006;62:373–386.
44. Davidson RJ, Kabat-Zinn J, Schumacher J, et al. Alterations in brain and immune function produced by mindfulness meditation. Psychosom Med 2003;65:564–570.
45. Newberg AB, Iversen J. The neural basis of the complex mental task of meditation: Neurotransmitter and neurochemical considerations. Med Hypotheses 2003;61:282–291.
46. Cohen-Katz J, Wiley S, Capuano T. The effects of mindfulness based stress reduction on nurse stress and burnout: A qualitative and quantitative study. Hol Nurs Pract 2005;2:26–35.
47. Lau MA, Bishop SR, Segal ZV, et al. The Toronto Mindfulness Scale: Development and validation. J Clin Psychol 2006;62:1445–1467.
48. Shapiro S, Oman D, Thoresen CE, et al. Cultivating mindfulness: Effect on well being. J Clin Psychol 2007;64:840–862.
49. Carmody J, Baer RA. Relationships between mindfulness practice and levels of mindfulness, medical and psychological symptoms and well-being in a mindfulness-based stress reduction program. J Behav Med 2007;31:23–33.

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