Zen and Behavioral Health: A Review of the Evidence

Kenneth P. Kushner

Keywords
Zen · Buddhism · Behavioral health · Science · Meditation

Introduction

Generally speaking, Zen in modern cullture has become associated with greater physical and mental wellness as well as health-related products. These claims originate from more than simple trends in marketing. For example, in 1984, a team of Japanese researchers (Ogata et al. 1984) published a study showing that Zen priests living in Japan had lower mortality rates than age-matched male counterparts living in the general Japanese population. During the years studied (1955–1978), 18% fewer priests died than would have been expected of Japanese men overall, regardless of the cause of death. This decreased mortality was statistically significant for multiple causes of death: heart disease, cerebral vascular disease, hypertension, liver cirrhosis, and some forms of cancer. These results reinforce the popular wisdom that Zen promotes good health. For example, a Google search of the term "Zen and Health" resulted in roughly 54,600 hits. The word "Zen" is now ubiquitous in marketing health-related items from shampoo, to wellness and beauty spas, to exercise programs, to better nutrition.

Given the widespread assumption that Zen is good for health, it is not surprising that Zen has found its way into the medical examination room and psychotherapy office, as interventions based upon Zen principles have been adapted to clinical settings. In this chapter, I will explore the current state of scientific research supporting the efficacy of those interventions. In so doing, I will define "behavioral health" broadly as it applies to both traditional psychotherapy and the application of psychological principles for prevention and treatment of medical illnesses, psychosomatic conditions, and lifestyle modification related to health.

Reviews abound on meditation in general and on specific types of meditation as applied to health and mental health (Canter 2003; Canter and Ernst 2004; Chan and Larson 2015; Chiesa and Serretti 2011; Dear et al. 2008; Fortney and Taylor 2010; Grant 2013; Hofmann et al. 2010; Krisanaprakornkit et al. 2010; Marchand 2013; Ospina et al. 2007; Sedlmeier et al. 2012; Weaver et al. 2008; Zgierska et al. 2009). While some of these reviews show a wide range of positive effects for a variety of forms of meditation, others cite poor design and

K.P. Kushner (✉)
Department of Family Medicine and Community Health, University of Wisconsin, Madison, Wi, USA
e-mail: Kenneth.Kushner@fammed.wisc.edu

A. Masuda and W.T. O'Donohue (eds.), *Handbook of Zen, Mindfulness, and Behavioral Health*, Mindfulness in Behavioral Health, DOI 10.1007/978-3-319-54595-0_14

methodological flaws as reasons for not drawing conclusions about the efficacy of meditation.

The only previous review of research specifically on Zen was conducted by Chiesa (2009), who reviewed the literature through 2008. Limiting himself to stringently controlled studies, he concluded that "…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" (p. 591). More attention to mechanisms of action with better-designed and larger studies was recommended for future examinations on the effectiveness of meditation.

The intent of this chapter is to update Chiesa's review by including literature on *zazen* (usually translated as "Zen meditation") published since 2009. We will also expand upon Chiesa's review by including meditation research that does not involve rigorously controlled methodology. This is, in part, because much of the foundational psychophysiological studies of *zazen* were un- or poorly controlled. Regardless, they provide important insight into the effects of Zen meditation. Further, as Caspi and Burleson (2007) suggest, randomly controlled trials—the gold standard of medical research—may not be practical in meditation research. However, before proceeding, I would like to discuss two major influences that informed this updated review of the literature.

The Traditions of Zen

In a review of methodological issues in meditation research, Caspi and Burleson stressed the point that "different forms of meditation may have different therapeutic effects" (2007, p. 37). The practice of *zazen* is not uniform across the world of Zen practitioners; in fact, two major sects of Japanese Zen, Soto and Rinzai, exist. There are other smaller traditions such as the Obaku sect and Sanbo Kyôdan; the latter combines both Soto and Rinzai practices. Each tradition gives somewhat different instructions for the practice of *zazen*, particularly regarding the role of breathing.

The Rinzai sect emphasizes a type of breathing that is referred to in Japanese as *hara* or *tanden* breathing. *Hara* is a Japanese word that refers to the lower abdomen; the term is replete with physical, psychological, and spiritual connotations in Japanese culture (Von Durckheim 1980). *Tanden* is the Japanese pronunciation of the Chinese word, *dantien*,[1] which refers to a point roughly two inches below the naval. It, too, has significant physical, psychological, and spiritual meanings in both Japanese and Chinese cultures. *Tanden* breathing is a form of deep abdominal breathing in which the lower abdomen is expanded throughout the respiratory cycle. Whereas *tanden* breathing is not absent from Soto and other sects' practices, it may not be stressed to the same degree as it is in the Rinzai tradition (Lehrer et al. 1999). Given that changing breathing patterns can affect both physiological and psychological arousal (Cappo and Holmes 1984), it is conceivable that different methods of breathing employed by various Zen traditions may have different effects on physiological factors impacting health.

I will have more to say about the differences between traditions of Zen in the next section.

Mindfulness and Zen

Anecdotally speaking, considerable confusion exists regarding the relationship between Zen and mindfulness. There appears to be a conflation of Eastern meditative disciplines in general and mindfulness-based disciplines in particular; it is frequently assumed that any Eastern meditative technique involves mindfulness (Wilson 2014). Several prominent researchers and reviewers have described *zazen* as being mindfulness-based (Chiesa 2009; Chiesa and Malinowski 2011; Ospina et al. 2007; Pagnoni et al. 2008).

[1]There are actually three *dantien* in Chinese thought. In common use *dantien* refers to the lowest of the three, the location of which is described above, as does the Japanese word *tanden*.

As I have contended before (Kushner 2012), the blanket assumption that all Zen is mindfulness-based is erroneous. One way of characterizing meditative disciplines is to make a distinction between those that are mindfulness-based and those that are concentration-based (Goleman 1988; Sedlmeier et al. 2012). The practice of mindfulness has been described as "allowing any thoughts, feelings, or sensations to arise while maintaining a specific attentional stance." The same authors described concentration-based meditation as "involving focusing on specific mental or sensory activity; a repeated sound, an imagined image, or specific bodily sensations such as the breath" (Cahn and Polich 2006, p. 180). However, it is generally acknowledged that these differences are not hard and fast dichotomies; rather, they describe a continuum of meditation experiences with varying emphases on mindfulness and concentration. Some traditions of Zen fall more clearly toward mindfulness. In particular, the Soto sect emphasizes a practice called *shikantaza* ("just sitting"), which is closer to mindfulness. Other traditions, notably those of the Rinzai sect, emphasize *samadhi.* Although this term does not have a good equivalent in English, it has been described as a state of "relaxed concentration" (Sayama 1986).

Another schema categorizes meditative disciplines by those that attempt to regulate conscious awareness and those that do not (Chiesa and Malinowski 2011). By this classification, mindfulness-based practices are non-regulatory in nature. On the other hand, some traditions of Zen regulate attention by regulating breathing and posture. The differences between the two can be observed in instructions for mindfulness meditation compared to *zazen* in the Rinzai tradition (which I practice and teach). Kabat-Zinn describes mindfulness as "…observ[ing] the breath as it flows in and out. We give full attention to the feeling of the breath as it comes in and as it goes out… And whenever we find that our attention has moved elsewhere, wherever that might be, we just note it and let it go and gently escort our attention back to the breath" (Kabat-Zinn 1990, p. 64). In contrast, writing from a Rinsai Zen perspective, Sekida writes "it is the correct manipulation of the lower abdomen, as we sit and breathe, that enables us to control the activity of our mind" (Sekida 1985, p. 33).

Thus, because not all Zen involves mindfulness and all mindfulness meditation is not Zen, whether one characterizes a given Zen tradition as mindfulness-based or concentration-based may have implications for the practice of *zazen* and for its physiological effects on a practitioner. It might also affect the amount of time that it takes for a practitioner to learn the techniques. For those reasons, it is unclear what bearing the many studies on mindfulness meditation may have on the question of the effects of *zazen*; therefore, reviews of studies in this chapter are limited to those that are clearly identified as involving Zen or *zazen*.

Methods

In order to search the literature for research studies on Zen, online queries were made in the following databases using "meditation" as a keyword: PubMed, Google Scholar, JSTOR, and Web of Science. This resulted 1655 references between 1995 and June 1, 2015. Given the large number of references, the databases were searched using "Zen" as a title and "meditation" as a keyword. Additional references were gleaned from the articles reviewed. Included for this review was any study that involved quantitative data collection and analysis, clearly involved *zazen* or other aspects of Zen training as a focus, had outcome measures that could pertain to behavioral health (broadly defined as physical or mental health), and was written in English. For reasons described above, studies of mindfulness-based meditation were excluded if they did not explicitly involve Zen or *zazen*. This review is organized by the following categories relevant to behavioral health: relaxation, stress reduction, and anxiety; attention; cardiovascular health; depression; pain; and the training and efficacy of health professionals. In some cases, assignment of a study to one of these categories was somewhat arbitrary. For example, studies involving brain waves may relate to both attention and relaxation. In such instances, they are reviewed

here within the category that seemed the most relevant for each particular study. Where it was available, the specific traditions of Zen described in each study are noted.

The Studies

Relaxation, Stress Reduction, and Anxiety

Perhaps more than anything else in Western culture, Zen is associated with relaxation. Some of the earliest research on the psychophysiology of Zen related *zazen* to decreased physiological parameters associated with relaxation. Both Nagashima et al. (1977) and Hirai (1989) cited a 1964 study conducted by Sugi and Akutsu which found that the respiration rates of experienced Zen priests during *zazen* ranged from two to five breaths per minute, with an average of four breaths per minute. The typical adult breathes at a rate of 16–20 times per minute when resting (Barrett et al. 2010). The priests' oxygen consumption decreased markedly at the beginning of *zazen* and recovered immediately afterward. Oxygen consumption is a good measure of relaxation because relaxed muscles do not require as much oxygen as tensed muscles. Nagashima et al. (1977) observed that the oxygen consumption of an 83-year-old Zen master decreased from his baseline by 50% during meditation. Hirai also reported data indicating that oxygen consumption in two experienced priests decreased by 20–30% during *zazen* (1989).

Research on brain wave changes also pertains to the role of *zazen* in relaxation. Kasamatsu and Hirai (1966) and Hirai (1989) reported on a series of EEG studies, which included recordings of 48 Zen priests of both the Soto and Rinzai sects. They also made recordings of 98 Zen trainees of the same priests. A control sample, including 18 research fellows without prior *zazen* experience, was subjected to the same measurements during *zazen*. A summary of their most salient results, as presented by Hirai (1989), is as follows:

- Alpha wave activity appeared shortly after *zazen* started.
- Over the course of a *zazen* period, the participants showed increasing alpha wave amplitude and decreased alpha frequency.
- In some participants, rhythmical theta trains appeared.
- The more experience with *zazen* a priest had, the more likely he was to show decreased alpha wave frequency and the appearance of rhythmical theta trains.
- They did not find similar changes among control participants with no prior *zazen* experience.
- There were no differences between Rinzai and Soto priests.

Alpha activity is associated with relaxation (Austin 1998); both increased alpha amplitude and decreased alpha frequency are associated with relaxed states. Alpha biofeedback paradigms have traditionally been used to induce relaxation (Yates 1980). Theta activity has been related to relaxation and decreased anxiety (Kubota et al. 2001). From this standpoint, the results of these Japanese studies suggest a relationship between *zazen* and relaxation, also implying this relationship strengthens with increased *zazen* practice.

Subsequent studies generally have corroborated Hirai's findings regarding EEG changes. Hardt (1994) found that the more adept in Zen a student was rated by his or her teacher, the more likely he or she was to show increased alpha amplitude and decreased alpha frequency during *zazen*. Takahashi et al. (2005) trained adults with no meditation experience in *susoku*, a technique of *zazen* involving counting one's breath. They found increased fast theta and slow alpha activity, predominantly frontal, during meditation. Huang and Lo (2009) found increased alpha activity in experienced *zazen* practitioners, but not in controls. Murata et al. (1994) found that theta activity, particularly frontal, was found predominantly in more, as opposed to less, experienced Soto Zen priests.

Fumoto et al. (2004) trained meditation-naïve participants in voluntary abdominal breathing (VAB), a technique clearly derived from *tanden* breathing. As described earlier, *tanden* is deep abdominal breathing in which the lower abdomen remains expanded throughout the respiration cycle. Participants reported increased vigor activity and a tendency for reduced anxiety during VAB, compared to a resting period. These states were correlated with high-frequency alpha activity. Using a similar paradigm, Yu et al. (2011) taught novices without any prior meditation experience how to perform *tanden* breathing. In the subsequent 20-min meditation trial, they were asked to focus their awareness on their breathing. Compared to a resting period, the participants showed increase alpha activity and a decrease in theta.

Three studies investigated the effects of *zazen* on the anxiety levels in nonclinical samples; all three used psychological inventories as dependent measures. Goldman et al. (1979) taught college students *zazen*, which they then practiced daily for five days. They were compared to another group that taught "antimeditation" (e.g., numbers cancellation and symbol-digit tasks while tuning out background music) and a no-treatment control. All groups reported reduced anxiety, and there were no differences between the groups. Gillani and Smith (2001) compared experienced Zen meditators performing *zazen* for 70 min to a control group of college students who were asked to silently read magazines for 60 min. The *zazen* group reported decreased worry compared to the control group. Tloczynski (1994) also taught *zazen* to meditation-naïve college students. The *zazen* instructions involved "following the breath" as adapted from Shapiro and Giber (1978). They were compared to a group given instructions to "just relax" and to a no-treatment control. After six weeks of practice, both meditation and relaxation groups showed statistically significant reductions in anxiety, whereas the control group did not.

Lin et al. (2008) investigated the effects of *zazen* on performance anxiety and musical performance quality in participants recruited from conservatories. Participants were randomly assigned to either a meditation group or a wait list control group. Those in the meditation group were assigned to an 8-week meditation course of Soto-style Zen. There were no differences between the two groups in either self-reports of anxiety or quality of music performance as judged in a recital at the end of the program. However, evidence of a positive correlation between anxiety and musical quality was found in the meditation group alone.

Attention

Whether it is called mindfulness or *samadhi*, the development of concentration is central to Zen training. It is not surprising, therefore, that some of the earliest research on the psychophysiology of Zen pertained to attention. The EEG studies described above are relevant in that regard. The development of theta activity has been related to states of relaxed concentration (Kubota et al. 2001).

Another line of research, also going back to the early days of research on Zen, pertains to attention: alpha blocking. Typically, alpha activity is interrupted when a participant is initially exposed to a novel stimulus, such as a clicking noise. Over repeated presentations of the same stimulus in short sequence, the amount of alpha disruption is diminished (i.e., alpha blocking), as the participant habituates to the stimulus. This habituation can be seen as the participant's ceasing to pay attention to the new stimulus.

Kasamatsu and Hirai (1966) compared three Zen masters performing *zazen* to three control participants, sitting with their eyes closed, in their degrees of alpha blocking subsequent to the presentation of the regular presentation of a clicking noise. They found that the control participants, who were research fellows with no Zen experience, showed steadily decreasing durations of alpha blocking over the course of stimuli presentation. On the other hand, the Zen masters' duration of alpha blocking stayed the same throughout. In other words, the Zen masters

remained keenly attentive to their environment, regardless of repetition; that is, their concentration did not tire. They remained in the "here and now" as they treated every repetition of the stimulus as a unique occurrence. This indicates increased ability to sustain attention on the part of the Zen masters.

Hirai (1989) later described a series of studies in which he found that control participants sitting with their eyes closed showed greater alpha blocking than Zen priests performing *zazen*. This was true regardless of the alpha-blocking stimulus (hand clapping, calling out names). He concluded that *zazen* "produces a condition that may be called relaxed awareness accompanied by steady responsiveness" (p. 74). One priest in the experiment described this state as "noticing every person on a street without looking back at them in emotional curiosity" (p. 63).

Becker and Shapiro (1981) were unable to replicate Kasamatsu and Hirai's (1984) and Hirai's (1989) earlier results. They found that 10 experienced Zen students recruited from an American Zen center did not show inhibition of alpha blocking after repeated exposure to clicks while performing *zazen*. Nor did they find trends indicating that those with more *zazen* experience show less habituation to the stimulus than those with less experience.

Kozasa et al. (2008) reported on a preliminary study in which one Zen nun and four "regular meditators" were tested before and after an eight-day *sesshin* (i.e., Zen retreat). In these tests, they were administered the Stroop Color Word Test, a test with high demand on attention, while undergoing functional magnetic resonance imagery (fMRI). The authors noted "enhanced activation" of the anterior cingulate, right dorsolateral prefrontal, insular, occipital, and parietal cortices after meditation practice. According to the literature, these areas represent functional activation related to attentional circuitry and reinforce the idea that meditation can further develop attentional abilities that have lasting effects (p. 366).

Pagnoni and Cekic (2007) studied the effects of *zazen* on gray matter volume and attention in aging participants. Typically, both gray matter volume and attention decline with increased age. The participants were 13 experienced Zen trainees. Control participants were matched for age, sex, and education level. Both groups were administered a continuous performance test (i.e., a measure of sustained attention) while undergoing fMRI. They found less age-related decline in the volume of the putamen, a cerebral structure strongly linked to attentional processing, in the meditators than in the controls. They also found that gray matter volume and performance on the attention task both correlated negatively for control participants; the meditators did not show a correlation between the two variables. Their findings suggest that regular meditation may reduce cognitive decline associated with normal aging due to relative preservation of gray matter volume.

Cardiovascular Health

In Ogata et al.'s (1984) study of mortality among Japanese priests, death by heart disease accounted for approximately half of the comparison cohort. The authors suggested that diet may have been a factor of the priests' greater longevity; in fact, Japanese Zen priests who ate a strict vegetarian diet were found to have more favorable lipid levels than matched meat-eating controls (Kita et al. 1988). Ogata et al. did mention, almost in passing, that the monks' practice of "self-control" might also have contributed to their longevity. Presumably, they were referring to the monks' meditative practice, and it is reasonable to suspect that intensive practice of *zazen* may have influenced their longevity.

Kim et al. (2005) studied the effect of Zen meditation on serum nitric oxide and on oxidative stress. Nitric oxide is known to improve vasodilation (i.e., widening of the blood vessels) and to decrease atherogenesis (i.e., plaque builds up in the arteries linked to heart disease). Oxidative stress has been implicated as a cause of atherogenesis and chronic heart disease; it was measured by serum malondialdehyde (MDA). Twenty experienced members of a Zen center in Korea were compared to age- and sex-matched

control participants with no previous stress management or meditation training. Blood samples drawn before and after a 70-min meditation period showed that the meditators had significantly higher levels of nitric oxide and lower levels of MDA compared to the controls. Kormanovski et al. (2009) found unfavorable changes in serum lipid levels after six weeks of practice among Transcendental Meditation instructors who were taught *zazen*.

Heart rate variability (HRV) refers to variation in the intervals between heartbeats. A related phenomenon, respiratory sinus arrhythmia (RSA), occurs when HRV is synchronized with respiration (Yasuma and Hayano 2004), more specifically when heart rate increases during inhalation and decreases during exhalation. By reducing unnecessary heartbeats during exhalation, RSA provides rest for the heart. Thus, high cardiac variability is related to aerobic fitness and general physical activity. It declines with age, is a risk factor for hypertension, and predicts mortality among patients with cardiac disease. Cardiac variability is also related to vagus nerve tone (Thayer and Lane 2007) which is associated with positive cardiovascular health, and greater amplitude of RSA has been related to increased vagal tone (Lehrer 2001). Therefore, it is logical to deduce that practices that increase HRV and RSA, particularly the amplitude of respiratory and heart rate waves, may improve cardiovascular health.

Lehrer (2001) and Lehrer et al. (1999) studied cardiac variability in six Rinzai and five Soto Japanese priests over the course of a 20-min period of *tanden* breathing. They found that heart rate amplitudes increased during *zazen* in low-frequency wave ranges but decreased in the high-frequency range. Rinzai priests breathed slower and had high amplitudes of low-frequency heart rate waves than Soto priests. The authors concluded that "the elevations in HR low-frequency waves among Zen monks may explain the apparently salutary effects of Zen on heart disease" (p. 819).

Cysarz and Büssing (2005) studied nine participants; one had "long experience" with zazen, and one was "experienced" with Vipassana meditation, which is mindfulness-based. The remaining participants had no previous experience with any meditative discipline. Researchers found that the participants exhibited RSA during both *zazen* (i.e., concentrate on "just sitting" and "just breathing") and *kinhin* (i.e., walking meditation). They did not, however, compare those who were experienced in meditation to those who were meditation-naïve. Peressutti et al. (2010) found greater resonance between respiration and cardiac variability in more experienced Soto *zazen* practitioners compared to less experienced ones. Fiorentini et al. (2013) found that higher cardiac variability during a Zen retreat persisted into the next day.

Stone and DeLeo (1976) taught what they referred to as "psychologic-relaxation training" to mild-to-moderate hypertensive patients. This training, which was clearly modeled after *zazen*, involved sitting in a chair and counting breaths, as in *susoku*. The 19 patients were newly diagnosed, having previously had untreated hypertension, and were receiving care at a Veterans' Administration Hospital. Fifteen patients were arbitrarily assigned to the medication group on the basis of the researchers' perceptions of their abilities to understand the instructions, their motivation, and their willingness to participate in an experimental protocol. They were asked to practice the relaxation exercise for 10–15 min, twice daily, for six months. The remaining five patients were assigned to a control group and received only monthly blood pressure measurements. The blood pressure of the meditation group was significantly lower after six months of meditation, but there was no significant change of blood pressure in the control group. The average reduction in combined systolic and diastolic blood pressure in the former group was 12 mm Hg. Fifty-seven percent of the meditation group participants experienced at least a 14 mm Hg reduction with a range up to 30 mm Hg.

Pain Management

The traditional practice of Zen involves performing *zazen* in a seated cross-legged posture

for long periods of time; moving is not permitted. This can become uncomfortable, if not painful, but Zen practitioners learn to cope with the pain through distraction, breathing, and relaxing tense muscles (Kushner 2000). It is conceivable, then, that the practice of *zazen* may have a role in pain management.

The analgesic effects of *zazen* have been studied in a series of reports by Grant and colleagues. Grant and Rainville (2009) compared 13 experienced Zen meditators, recruited from local centers, with matched controls. Participants in both groups were individually administered a painful thermal stimulus while they were in a supine position. The meditators required higher temperatures to elicit moderate pain. When instructed to attend to the pain "mindfully," the meditators reported decreased pain intensity, whereas the controls reported greater pain intensity when asked to concentrate on the pain. In the meditators, pain modulation was correlated with the slowing of respiration; no such association was found for the controls. The researchers concluded that Zen meditators have lower pain sensitivity and experience analgesic effects during mindful states. Using similar methodology, Grant's group (Grant et al. 2010) found that experienced *zazen* practitioners had greater cortical thickness (i.e., indicating more gray matter) than non-meditating controls in pain-related brain regions. Previous research (Teutsch et al. 2008) had shown that increased gray matter in pain-processing regions of the brain is associated with decreased pain sensitivity. Thus, the results of Grant et al. (2010) suggest that decreased pain sensitivity among Zen meditators may be related to morphological changes in the brain.

In yet another study, Grant et al. (2011) found that experienced Zen students, compared to non-meditating controls, had reduced activity in executive, evaluative, and emotional areas of the brain when exposed to a painful stimulus; additionally, the most experienced meditators showed the greatest reductions. They interpreted this to show that lower pain sensitivity in meditators was predictive of "a functional decoupling of the cognitive-evaluative component of pain, possibly allowing the practitioners to view painful stimuli more neutrally" (p. 151).

Depression

There are theoretical reasons why *zazen* may be beneficial for people with depression. The cognitive-behavioral model of psychotherapy for depression is predicated on the idea that fixation on dysfunctional automatic thoughts is implicated in the development and perpetuation of depression. Cognitive-behavioral therapists have developed techniques to "distance" patients from those negative cognitions (Teasdale et al. 1995). These techniques, in Beck's words, allow people to "examine thoughts as psychological phenomena rather than as identical to reality" (1976). I have previously written how the practice of *zazen* creates distance from unnecessary thought through the development of *samadhi* (Kushner 2012). By implication, *zazen* should enable an individual to create distance from negative automatic thoughts.

Yu et al. (2011) found that oxygenated hemoglobin (i.e., an index of activation of brain areas) in the anterior prefrontal cortex increased significantly during focused attention on *tanden* breathing in meditation-naïve participants. These changes were related to reductions in self-reported negative mood administered before and after the meditation task. Because previous research had implicated the anterior prefrontal cortex in emotion regulation, they hypothesized that the reduction in negative mood may have been mediated by activation of the anterior prefrontal cortex. Yu et al. and Fumoto et al. (2004) both found that serotonin (5-HT) levels increased during *tanden* breathing, compared to baseline measurements. Serotonin is a commonly known neurotransmitter implicated in the treatment of depression. Thus, on a theoretical level, zazen may improve mood through its actions on the serotonin system.

The Training and Effectiveness of Behavioral Health Practitioners

There are many theoretical reasons why the practice of *zazen* may enhance therapeutic effectiveness. In this section, we will focus our attention on the effects of behavioral health practitioners practicing *zazen*.

The development of empathy, intuition, and the ability to pay full and extended attention are key by-products of Zen training. This can result in enhanced therapeutic presence (Bruce and Davies 2005; Brenner 2009) or what my colleague, Gordon Greene Roshi (who authored Chapter "Zen, Pain, Suffering and Death" in this book) and I refer to as "Therapeutic Stance" (Kushner and Greene 2005). It has also been suggested that Zen training improves therapeutic intuition (Sayama 1986).

Lesh (1984) taught *zazen* to students enrolled in a master's degree program in counseling psychology. The specific *zazen* instructions included regulation of posture and counting one's breath while breathing diaphragmatically. The meditators were compared to two other groups: (1) master's degree students in other areas of study who were taking counseling psychology classes and volunteered to participate in the meditation program but who did not actually do so; and (2) another group of master's degree students in also other areas who were taking counseling psychology classes but who did not volunteer to participate in the meditation program. The *zazen* group practiced daily for 1 month. Lesh found that the meditation group improved on measures of empathy over the course of the study, whereas the others groups did not. However, level of concentration achieved in *zazen*, as determined by the ratings after each practice session, was not related to individual empathic abilities. They also found that participants who started out low in empathic ability were more likely to improve than participants high in this ability after 1 month of *zazen*.

Grepmair et al. (2006) compared the outcomes of patients who were in inpatient treatment with either psychotherapists in training who practiced Zen meditation before psychotherapy sessions or psychotherapists in training who did not practice Zen meditation. The setting was a "psychosomatic" hospital in Germany. The same psychotherapists participated in both nine-week phases of the study. In the first phase, no modifications were made to the therapists' training program. At the beginning of the second phase, the therapists all received instruction in *zazen* from a Zen master, who then led daily morning sittings for the group for the duration of the phase. Whereas the Zen master's tradition of Zen was not specified, his meditation technique involved focused attention on breathing while sitting on a cushion or chair. Data were collected on 196 patients throughout the study. The authors did not describe the diagnoses of the patients. Different patients were treated in each of the two phases of the study. Patients in both phases were blind as to whether their therapists were or were not engaging in *zazen*. The therapists and the Zen master were blind to the fact data had been collected on their patients. The results were that patients' symptom improvement was greater and ratings of their psychotherapy experiences were more favorable for the meditation phase than in the control phase.

Summary

What, then, have we learned from the studies reviewed above?

Relaxation, stress management, and anxiety. Early psychophysiological studies indicate that physiological parameters associated with relaxation (i.e., decreased respiration and decreased metabolism) are also associated with *zazen*, at least in experienced practitioners. The cumulative results of the various EEG studies described above strongly suggest that brain wave activity with relaxation (i.e., slow wave alpha and theta activity) is associated with *zazen*. The latter appears to be more prominent in more experienced Zen trainees; thus, it requires a considerable amount more experience and skill in the meditative discipline. It should be noted that the associations between *zazen* and increased alpha and theta activity has not been born out in

all studies. Notably, Fumoto et al. (2004) found that *tanden* breathing was associated with high-frequency alpha. In a study using a similar methodology, Yu et al. (2011) found that *tanden* breathing was associated with decreased theta activity. However, both the studies used meditation-naïve participants who received minimal training in the breathing technique. This led Yu et al. to speculate that the increase of theta during zazen might be a function of experience with *zazen*. The literature to date on physiological parameters and *zazen* has focused almost exclusively on the changes during meditation or immediately after its termination. The lasting effects of *zazen* on brain waves have not been studied.

Despite the promise shown by the psychophysiological studies indicating that *zazen* induces relaxation, there is an almost total absence of studies that have examined the efficacy of *zazen* in stress management programs or clinically anxious populations. Lin et al.'s (2008) investigation of the effects of *zazen* on a self-identified anxious population of musicians is the exception. They demonstrated that *zazen* was beneficial to musicians with higher levels of performance anxiety.

Attention. There is physiological evidence that the practice of *zazen* may increase attention. In particular, theta activity, associated with *zazen*, at least in experienced meditators, promotes a state of relaxed alertness. Similarly, alpha-blocking studies provide evidence that experience with Zen training leads to sustained attention. The results of Kozasa et al. (2008) indicate that the benefits of *zazen* on attention may extend past periods of meditation. Results from Pagnoni and Cekic's (2007) work suggest that attentional improvements brought about by *zazen* may be due to morphological changes in the brain and that these changes may inhibit the decline in attention seen in the normal aging process. In spite of the psychophysiological evidence suggesting that *zazen* may improve attention, to date no studies have examined *zazen* as way of enhancing attention in nonclinical populations or as a treatment for Attention Deficit/Hyperactivity Disorder.

Cardiovascular health. There is evidence that HRV and RSA, which have been related to cardiac health, are strengthened with *zazen*. The results of Cysarz and Büssing (2005) indicate that this might be true for novice Zen practitioners, not just advanced practitioners. There is evidence that the practice of *zazen* may decrease oxidative stress and increase serum nitric oxide; both outcomes have been related to cardiovascular health. There is also evidence that *zazen* may reduce blood pressure among mild-to-moderate hypertensive patients.

Pain. There is evidence that experienced Zen practitioners may have lower pain sensitivity compared to non-meditators. To date, there have been no studies of the use of *zazen* as an analgesic measure in clinical populations.

Depression. There is evidence suggesting that *zazen* may increase positive mood, even in novice meditators, and that such improvement may be mediated by changes in blood serotonin levels. To date, there have been no studies of the use of *zazen* in the treatment of clinically depressed populations.

The Training and Effectiveness of Behavioral Health Practitioners. There is evidence that *zazen* may improve empathy of counselors in training. More impressive is evidence from a randomized double-blind study that the outcomes of psychotherapist trainees who participate in *zazen* are better than those of trainees who do not meditate.

Type of Zazen. There is little evidence of differences among the traditions of *zazen*. Whereas there are accounts of experienced Rinzai practitioners breathing more slowly than experienced Soto practitioners (Lehrer et al. 1999; Hirai 1989), these were based on observations of small samples and are almost anecdotal. Hirai (1989) found no differences in EEGs of experienced Soto and Rinzai practitioners. Similarly, there are no studies that have investigated whether modifications to *zazen* [e.g., performing it while supine (Grant et al. 2011) or sitting in chairs (Stone and DeLeo 1976)] affect its underlying physiological effects.

Experience with Zazen. The *zazen* training experience of the participants in the studies

reviewed ranged from several hours to decades. The little data available on the effects of training are found in the EEG studies. These data suggest that slow alpha and theta activity increases with training. Few studies utilized internal measures to determine whether the participants had properly learned how to practice *zazen*. Lesh (1984) used logs of participants' subjective experiences with *zazen*. Both Fumoto et al. (2004) and Yu et al. reported that by using biofeedback, they were able to teach *tanden* breathing in one session to participants unfamiliar with meditation. This was confirmed by physiological monitoring of their breathing.

As noted above, both Fumoto et al. (2004) and Yu et al. (2011) obtained results that contradicted previous research on more experienced Zen practitioners (notably Hirai 1989). This prompted Yu et al. to suggest that their results may have reflected their use of novice practitioners. This raises the important but unanswered question of how long it takes to learn the techniques of *zazen* in order to experience health benefits. Based upon my experience as both a Zen student and Zen instructor, the learning curve for *zazen* can be steep. This can explain the somewhat surprising results of Kormanovski et al. (2009) who found that cholesterol levels changed in unfavorable directions after six weeks of *zazen*. Further, the fact that their participants were teachers of another meditative discipline (Transcendental Meditation) may not have predisposed them to attain proficiency in *zazen* more quickly than other people. One could argue that it might have taken them longer because they may have had difficulty abandoning their habitual way of meditating. On the other hand, other studies found positive benefits after minimal zazen training. Cysarz and Büssing (2005) found positive effects on HRV in their participants, most of whom had no prior *zazen* experience. Lin et al. (2008) found positive benefits on the music quality of performance-anxious musicians (albeit it only among the most anxious musicians) after eight weeks of *zazen* training. These studies suggest that it may be possible for people to experience health benefits after relatively little *zazen* training.

Discussion

In his 2009 review of research on Zen, Chiesa wrote, "In conclusion, actual evidence on Zen meditation is scarce and does not allow us to reach definitive conclusions" (2009, p. 591). The same can be said today. Chiesa did provide some evidence that zazen is related to increased (slow) alpha and theta activity, especially among more experienced practitioners, that it could be useful for reducing stress and high blood pressure, and that it might prevent age-associated cognitive decline. The current review provides additional evidence suggesting that *zazen* might have applicability in the promotion of cardiac health, to the treatment of anxiety, depression, and attention problems, and to the control of pain. There is also evidence that *zazen* might improve the therapeutic effectiveness of behavioral health practitioners, at least in trainees. Ultimately, there is an almost total absence of research on the effectiveness of *zazen* in clinical populations. In short, we are left more with a road map for future research than with a firm base of evidence supporting the clinical efficacy of *zazen*.

Of all the studies reviewed in this chapter, only two of them involved actual clinical samples: Stone and DeLeo's (1976) study of the treatment of mild-to-moderate hypertensive patients and Grepmair et al.'s study of the effects on patients of therapists in training practicing *zazen*. Both studies found *zazen* to be effective. In the case of Stone and DeLeo, patients who engaged in *zazen* experienced significant reductions in blood pressure. Grepmair et al. (2006) found that psychiatric inpatients in treatment with trainees who did *zazen* had greater symptom reduction and better evaluations of their therapy experiences. Both studies had design flaws. Stone et al. had a small sample size (19 in the treatment groups, 5 in the control group), and the selection and assignment of the participants were, in the words of the researchers, "arbitrary." Grepmair et al. had a fairly large sample size (119 patients), and they kept patients and therapists blind to their conditions, but the control participants were treated earlier in the year than the participants whose therapists were sitting

zazen. Thus, the better outcomes of the patients in the second phase of the study may have been due to the fact their therapists were more skilled in general at that time. A third study, Lin et al. (2008), while failing to use an actual clinical sample, recruited musicians with self-described performance anxiety. They found that *zazen* was effective only for more anxious participants.

The American Psychological Association has established criteria for empirically supported treatments[2] (Task Force on Promotion and Dissemination of Psychological Procedures 1995). In them, a distinction is made between *well-established* and *probably efficacious* empirically supported treatments. Although these criteria have been controversial (Church et al. 2014; Norcross et al. 2006), and the designation "empirically supported" does not necessarily imply that it is more efficacious than others, the American Psychological Association criteria provide a good reference point of how many in the field evaluate the evidence base of treatments. On the basis of those criteria, *zazen* cannot be designated either a *well-established* or *probably efficacious* treatment for any specific behavioral or medical disorder.

Regardless, lack of evidence is not evidence of lack of effectiveness. The lack of empirical evidence of the efficacy of *zazen* is based largely on a paucity of empirical investigation of its utility and should not stifle innovation in the application of *zazen* in clinical contexts. Despite its prominence in the early days of meditation research, *zazen* has languished in a research backwater. This is unfortunate because *zazen* has much to offer, as should be evident from the other chapters of this book. Perhaps this chapter will serve as encouragement to include *zazen* in the research agenda of behavioral health researchers. Basic questions remain that should be addressed in the future:

- For what conditions is *zazen* appropriate as a treatment? The obvious first choices, based on the literature, are anxiety disorders, attention problems, depression, and hypertension.
- How can zazen be used in coordination with other treatments?
- How long does it take to attain adequate proficiency with *zazen* for a patient to receive benefit from it? Whereas the fact that an octogenarian Zen master can reduce his oxygen consumption by 50% may have scientific interest, it may not be relevant to the question of how quickly an anxious patient can expect to benefit from *zazen*.
- Are some techniques of *zazen* (e.g., following the breath versus regulating the breath, or *tanden* breathing) easier to learn or more efficacious than others? Which techniques are most effective for what problems?
- What modifications to *zazen* may be made for it to be more applicable in a behavioral health setting? Of particular concern is posture; many Westerners have difficulty with the traditional postures for *zazen*: the full and half lotus positions. Can the benefits of *zazen* be preserved if other postures are used?
- What is the role of zazen in the prevention of physical, psychological, or comorbid problems?

Limitations

This review has several limitations. First, it is not systematic in that I selected the articles; there was no independent vetting process. Second, I only reviewed publications written in English. Third, by limiting the search to publications specifically involving Zen *or zazen*, I did not

[2]**Criteria for Empirically Supported Treatments** (Paraphrased from Chamblis and Task Force on Promotion and Dissemination of Psychological Procedures 1995) *Well-established*: Manualized treatments researched by at least two different investigators, using well-specified client samples with either (A) two or more between-group studies showing superiority to placebo or another treatment, and/or equivalence to an established treatment in an adequately powered study or (B) a large series of well-designed single-case studies demonstrating efficacy compared to another intervention as in "A" above. *Probably Effective*: Two studies showing superiority to waiting-list control or one or more studies meeting criteria for A above but only one investigator or two or more positive studies but heterogeneous samples or a small series of well-designed single-case studies.

discuss contributions of research on other forms of meditation that may still relate to the efficacy of *zazen* in behavioral health.

Coda

Whenever a prospective Zen student contacts me, I first have a face-to-face meeting with them. I ask them why they want to study Zen. Almost without exception, they describe a utilitarian reason, such as wanting to feel less stressed, wanting to be more effective at work, or wanting to get over a breakup. Others hope to control long-standing depression or anxiety. One person told me he wanted to live longer. He believed that we are all born with an upper limit of the number of breaths we can take in a lifetime and he thought that he could extend his life by learning to slow down his breathing.

All of these motivations for starting Zen training are important and meaningful. They reflect a larger trend in our society as meditative disciplines become equated with health and mental health (Wilson 2014). However, it is misleading to view Zen or any Buddhist meditative tradition, if not any religion for that matter, solely in utilitarian terms.

In the foundational story of Buddhism, Shakyamuni Buddha left the comfort of his palace to find the answers to burning existential doubt. He did not leave to become less stressed or a more effective heir apparent to the throne of his kingdom. The religion that grew out of this experience was fundamentally designed to help people come to grips with basic questions of existence. States of relaxation or attention are perquisites for this; they are not ends in and of themselves. Benefits to health or mental health that arise from *zazen*, while certainly desirable, are essentially by-products of the search for one's true nature. To paraphrase my colleague, Stephen Kow Roshi, "the question of whether Zen training benefits your health is misguided. The question should be whether Zen can help you fearlessly face ill health and death."

In this review, I took a decidedly dualistic approach to Zen by focusing narrowly on scientifically based evidence for the applicability of *zazen* to behavioral health. But, from a different, hopefully less dualistic perspective, the research on Zen should have no effect on the practice or significance of Zen. It will remain a vital way for dedicated people to answer critical existential questions.

On the other hand, if aspects of Zen training can reduce the suffering of a larger group of people, this would be in keeping with a basic Buddhist tenet. Gordon Greene Roshi has articulated a distinction between training *in* Zen and training *by* Zen. Training in Zen refers to people who commit themselves to intensive Zen training. Training *by* Zen refers to the application of Zen principles to help people in their daily lives. The use of *zazen* in the context of behavioral health clearly fits into the rubric of training *by* Zen, and Zen has much to offer the world in that context.

References

Austin, J. H. (1998). *Zen and the brain*. Cambridge, MA: MIT Press.

Barrett, K., Barman, S., Boitano, S., & Brooks, H. (2010). *Ganong's review of medical physiology*. New Delhi: McGraw Hill.

Beck, A. T. (1976). *Cognitive therapy and the emotional disorders*. New York: International Universities Press.

Becker, D. E., & Shapiro, D. (1981). Physiological responses to clicks during Zen, Yoga, and TM meditation. *Psychophysiology, 18*(6), 694–699.

Brenner, M. J. (2009). Zen practice: A training method to enhance the skills of clinical social workers. *Social Work in Health Care, 48*(4), 462–470. doi:10.1080/00981380802589860

Bruce, A., & Davies, B. (2005). Mindfulness in hospice care: Practicing meditation-in-action. *Qualitative Health Research, 15*(10), 1329–1344. doi:10.1177/1049732305281657

Cahn, B. R., & Polich, J. (2006). Meditation states and traits: EEG, ERP, and neuroimaging studies. *Psychological Bulletin, 132*(2), 180–211. doi:10.1037/0033-2909.132.2.180

Canter, P. H. (2003). The therapeutic effects of meditation. *British Medical Journal, 326*(7398), 1049–1050.

Canter, P. H., & Ernst, E. (2004). Insufficient evidence to conclude whether or not transcendental meditation decreases blood pressure: Results of a systematic review of randomized clinical trials. *Journal of Hypertension*.

Cappo, B. M., & Holmes, D. S. (1984). The utility of prolonged respiratory exhalation for reducing physiological and psychological arousal in non-threatening and threatening situations. *Journal of Psychosomatic Research, 28*(4), 265–273.

Caspi, O., & Burleson, K. O. (2007). Methodological challenges in meditation research. *Advances in Mind-Body Medicine, 22*(3–4), 36–43.

Chan, R. R., & Larson, J. L. (2015). Meditation interventions for chronic disease populations: A systematic review. *Journal of Holistic Nursing: Official Journal of the American Holistic Nurses' Association*, 1–15. doi:10.1177/0898010115570363

Chiesa, A. (2009). Zen meditation: An integration of current evidence. *The Journal of Alternative and Complementary Medicine, 15*(5), 585–592. doi:10.1089/acm.2008.0416

Chiesa, A., & Malinowski, P. (2011). Mindfulness-based approaches: Are they all the same? *Journal of Clinical Psychology, 67*(4), 404–424. doi:10.1002/jclp.20776

Chiesa, A., & Serretti, A. (2011). Mindfulness-based interventions for chronic pain: A systematic review of the evidence. *The Journal of Alternative and Complementary Medicine, 17*(1), 83–93. doi:10.1089/acm.2009.0546

Church, D., Feinstein, D., Palmer-Hoffman, J., Stein, P. K., & Tranguch, A. (2014). Empirically supported psychological treatments: The challenge of evaluating clinical innovations. *The Journal of Nervous and Mental Disease, 202*(10), 699–709. doi:10.1097/NMD.0000000000000188

Cysarz, D., & Büssing, A. (2005). Cardiorespiratory synchronization during Zen meditation. *European Journal of Applied Physiology, 95*(1), 88–95. doi:10.1007/s00421-005-1379-3

Dear, J. W., Gough, K., & Webb, D. J. (2008). Transcendental meditation and hypertension. *Postgraduate Medical Journal, 84*(994), 417.

Fiorentini, A., Ora, J., & Tubani, L. (2013). Autonomic system modification in Zen practitioners. *Indian Journal of Medical Science, 67*(7), 161. doi:10.4103/0019-5359.125877

Fortney, L., & Taylor, M. (2010). Meditation in medical practice: A review of the evidence and practice. *Primary Care, 37*(1), 81–90. doi:10.1016/j.pop.2009.09.004

Fumoto, M., Sato-Suzuki, I., Seki, Y., Mohri, Y., & Arita, H. (2004). Appearance of high-frequency alpha band with disappearance of low-frequency alpha band in EEG is produced during voluntary abdominal breathing in an eyes-closed condition. *Neuroscience Research, 50*(3), 307–317. doi:10.1016/j.neures.2004.08.005

Gillani, N. B., & Smith, J. C. (2001). Zen meditation and ABC relaxation theory: An exploration of relaxation states, beliefs, dispositions, and motivations. *Journal of Clinical Psychology, 57*(6), 839–846.

Goldman, B. L., Domitor, P. J., & Murray, E. J. (1979). Effects of Zen meditation on anxiety reduction and perceptual functioning. *Journal of Consulting and Clinical Psychology, 47*(3), 551–556.

Goleman, D. (1988). *The meditative mind: The varieties of meditative experience*. New York: Putnam.

Grant, J. A. (2013). Meditative analgesia: The current state of the field. *Annals of the New York Academy of Science, 1307*(1), 55–63. doi:10.1111/nyas.12282

Grant, J. A., Courtemanche, J., Duerden, E. G., Duncan, G. H., & Rainville, P. (2010). Cortical thickness and pain sensitivity in Zen meditators. *Emotion, 10*(1), 43–53. doi:10.1037/a0018334

Grant, J. A., Courtemanche, J., & Rainville, P. (2011). A non-elaborative mental stance and decoupling of executive and pain-related cortices predicts low pain sensitivity in Zen meditators. *Pain, 152*(1), 150–156. doi:10.1016/j.pain.2010.10.006

Grant, J. A., & Rainville, P. (2009). Pain sensitivity and analgesic effects of mindful states in Zen meditators: A cross-sectional study. *Psychosomatic Medicine, 71*(1), 106–114. doi:10.1097/PSY.0b013e31818f52ee

Grepmair, L., Mitterlehner, F., Rother, W., & Nickel, M. (2006). Promotion of mindfulness in psychotherapists in training and treatment results of their patients. *Journal of Psychosomatic Research, 60*(6), 649–650. doi:10.1016/j.jpsychores.2006.04.003

Hardt, J. V. (1994). Proficiency in Zen meditation-correspondence with multichannel EEG coherence spectrum. *International Journal of Psychophysiology, 18*(2), 112–113.

Hirai, T. (1989). *Zen meditation and psychotherapy*. Tokyo; New York: Japan Publications.

Hofmann, S. G., Sawyer, A. T., Witt, A. A., & Oh, D. (2010). The effect of mindfulness-based therapy on anxiety and depression: A meta-analytic review. *Journal of Consulting and Clinical Psychology, 78*(2), 169–183. doi:10.1037/a0018555

Huang, H. Y., & Lo, P. C. (2009). EEG dynamics of experienced Zen meditation practitioners probed by complexity index and spectral measure. *Journal of Medical Engineering Technology, 33*(4), 314–321. doi:10.1080/03091900802602677

Kabat-Zinn, J. (1990). *Full catastrophe living: Using the wisdom of your body and mind to face stress, pain and illness*. New York, NY: Delta Publishing.

Kasamatsu, A., & Hirai, T. (1966). An electroencephalographic study on the Zen meditation (Zazen). *Psychiatry and Clinical Neurosciences, 20*(4), 315–336. doi:10.1111/j.1440-1819.1966.tb02646.x

Kasamatsu, A., & Hirai, T. (1984). An electroencephalographic study of the Zen meditation (Zazen). In *Meditation, classic and contemporary perspectives*. New York: Aldine Publishing Company.

Kim, D. H., Moon, Y. S., Kim, H. S., Jung, J. S., Park, H. M., Suh, H. W., et al. (2005). Effect of Zen meditation on serum nitric oxide activity and lipid peroxidation. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 29*(2), 327–331.

Kita, T., Yokode, M., Kume, N., Ishii, K., Nagano, Y., Mikami, A., et al. (1988). The concentration of serum

lipids in Zen monks and control males in Japan. *Japanese Circulation Journal, 52*(2), 99–104.

Kormanovski, A., Padilla, E. L., Rodriguez, R. C., & Harasymowicz, J. (2009). Metabolic effects of a Zen meditation and qigong training program on sedentary people. *Archives of Budo, 5*, 15–19.

Kozasa, E. H., Radvany, J., Barreiros, M. A. M., Leite, J. R., & Amaro, E. (2008). Preliminary functional magnetic resonance imaging Stroop task results before and after a Zen meditation retreat. *Psychiatry and Clinical Neurosciences, 62*(3), 366. doi:10.1111/j.1440-1819.2008.01809.x

Krisanaprakornkit, T., Ngamjarus, C., Witoonchart, C., & Piyavhatkul, N. (2010). Meditation therapies for attention-deficit/hyperactivity disorder (ADHD). *Cochrane Database Systematic Reviews*, (6), CD006507. doi:10.1002/14651858.CD006507.pub2

Kubota, Y., Sato, W., Toichi, M., Murai, T., Okada, T., Hayashi, A., et al. (2001). Frontal midline theta rhythm is correlated with cardiac autonomic activities during the performance of an attention demanding meditation procedure. *Cognitive Brain Research, 11*(2), 281–287.

Kushner, K. (2000). *One arrow, one life: Zen, archery and enlightenment*. Boston: Tuttle.

Kushner, K. (2012). You cannot wash off blood with blood: Entering the mind through the body. *Explore (NY), 8*(4), 243–248. doi:10.1016/j.explore.2012.04.002

Kushner, K., & Greene, G. (2005). Seeing 180 degrees: A Zen perspective on the medical encounter. *Medical Encounter*, 3–5.

Lehrer, P. (2001). Biofeedback for respiratory sinus arrhythmia and tanden breathing among zen monks: Studies in cardiovascular resonance. In Y. Haruki, A. Umezawa, I. Homma, & Y. Masaoka (Eds.), *Respiration and emotion* (pp. 113–120). Tokyo: Respiration and Emotion. doi:10.1007/978-4-431-67901-1_11

Lehrer, P., Sasaki, Y., & Saito, Y. (1999). Zazen and cardiac variability. *Psychosomatic Medicine, 61*(6), 812–821.

Lesh, T. V. (1984). Zen meditation and the development of empathy in counselors. In *Meditation, classic and contemporary perspectives*. New York: Aldine Publishing Company.

Lin, P., Chang, J., Zemon, V., & Midlarsky, E. (2008). Silent illumination: A study on Chan (Zen) meditation, anxiety, and musical performance quality. *Psychology of Music, 36*(2), 139–155. doi:10.1177/0305735607080840

Marchand, W. R. (2013). Mindfulness meditation practices as adjunctive treatments for psychiatric disorders. *Psychiatric Clinics of North America, 36*(1), 141–152. doi:10.1016/j.psc.2013.01.002

Murata, T., Omori, M., Murata, I., Nishio, M., Koshino, Y., Sakamoto, K., et al. (1994). Quantitative EEG study on Zen meditation (Zazen). *Japanese Journal of Psychiatry and Neurology, 48*(4), 881–890.

Nagashima, C., Ikawa, Y., & Akishige, Y. (1977). Studies of "Josoku". In Y. Akishige (Ed.), *Psychology of Zen*. Tokyo: Komazawa University.

Norcross, J. C., Beutler, L. E., & Levant, R. F. (2006). *Evidence-based practices in mental health: Debate and dialogue on the fundamental questions*. Washington, DC: American Psychological Association.

Ogata, M., Ikeda, M., & Kuratsune, M. (1984). Mortality among Japanese Zen priests. *Journal of Epidemiology and Community Health, 38*(2), 161–166.

Ospina, M. B., Bond, K., Karkhaneh, M., Tjosvold, L., Vandermeer, B., Liang, Y., et al. (2007). Meditation practices for health: State of the research. *Evidence Report/Technology Assessment, 155,* 1–263.

Pagnoni, G., & Cekic, M. (2007). Age effects on gray matter volume and attentional performance in Zen meditation. *Neurobiology of Aging, 28*(10), 1623–1627. doi:10.1016/j.neurobiolaging.2007.06.008

Pagnoni, G., Cekic, M., & Guo, Y. (2008). "Thinking about not-thinking": Neural correlates of conceptual processing during Zen meditation. *PLoS One, 3*(9), e3083. doi:10.1371/journal.pone.0003083

Peressutti, C., Martín-González, J. M., García-Manso, J. M., & Mesa, D. (2010). Heart rate dynamics in different levels of Zen meditation. *International Journal of Cardiology, 145*(1), 142–146. doi:10.1016/j.ijcard.2009.06.058

Sayama, M. (1986). *Samadhi: Self development in Zen, swordsmanship, and psychotherapy*. Albany, New York: SUNY.

Sedlmeier, P., Eberth, J., Schwarz, M., Zimmermann, D., Haarig, F., Jaeger, S., et al. (2012). The psychological effects of meditation: A meta-analysis. *Psychological Bulletin, 138*(6), 1139–1171. doi:10.1037/a0028168

Sekida, K. (1985). *Zen training: Methods and philosophy*. New York: Weatherhill.

Shapiro, D. H. J., & Giber, D. (1978). Meditation and psychotherapeutic effects. Self-regulation strategy and altered state of consciousness. [Review] [132 refs]. *Archives of General Psychiatry, 35*(3), 294–302.

Stone, R. A., & DeLeo, J. (1976). Psychotherapeutic control of hypertension. *New England Journal of Medicine, 294*(2), 80–84. doi:10.1056/NEJM197601082940204

Takahashi, T., Murata, T., Hamada, T., Omori, M., Kosaka, H., Kikuchi, M., et al. (2005). Changes in EEG and autonomic nervous activity during meditation and their association with personality traits. *International Journal of Psychophysiology, 55*(2), 199–207. doi:10.1016/j.ijpsycho.2004.07.004

Task Force on Promotion and Dissemination of Psychological Procedures. (1995). Training in and dissemination of empirically-validated psychological treatments. *The Clinical Psychologist, 48*(1), 2–23. doi:10.1037/e554972011-003

Teasdale, J. D., Segal, Z., & Williams, J. M. (1995). How does cognitive therapy prevent depressive relapse and why should attentional control (mindfulness) training help?. [Review] [30 refs]. *Behaviour Research & Therapy, 33*(1), 25–39.

Teutsch, S., Herken, W., Bingel, U., Schoell, E., & May, A. (2008). Changes in brain gray matter due to repetitive painful stimulation. *Neuroimage, 42*(2), 845–849.

Thayer, J. F., & Lane, R. D. (2007). The role of vagal function in the risk for cardiovascular disease and mortality. *Biological Psychology, 74*(2), 224–242. doi:10.1016/j.biopsycho.2005.11.013

Tloczynski, J. (1994). A preliminary study of opening-up meTeutsch, S., Herken, W.,Bingel, U., Schoell, E. May, A. (2008). Changes in brain gray matter due to repetitive painful stimulation. Neuroimage, 42(2), 845-849.ditation college adjustment, and self-actualization. *Psychological Reports, 75*(1 Pt 2), 449–450.

Von Durckheim, K. G. (1980). *Hara: The vital centre of man*. London: Allen and Unwin.

Weaver, A. J., Vane, A., & Flannelly, K. J. (2008). A Review of Research on Buddhism and Health: 1980–2003. *Journal of Health Care Chaplaincy, 14*(2), 118–132. doi:10.1080/08854720802129075

Wilson, J. T. (2014). *Mindful America: The mutual transformation of Buddhist meditation and American culture*. New York, NY: Oxford University.

Yasuma, F., & Hayano, J.-I. (2004). Respiratory sinus arrhythmia: Why does the heartbeat synchronize with respiratory rhythm? *Chest, 125*(2), 683–690. doi:10.1378/chest.125.2.683

Yates, A. (1980). *Biofeedback and the modification of behavior*. New York, NY: Plenum.

Yu, X., Fumoto, M., Nakatani, Y., Sekiyama, T., Kikuchi, H., Seki, Y., et al. (2011). Activation of the anterior prefrontal cortex and serotonergic system is associated with improvements in mood and EEG changes induced by Zen meditation practice in novices. *International Journal of Psychophysiology, 80*(2), 103–111. doi:10.1016/j.ijpsycho.2011.02.004

Zgierska, A., Rabago, D., Chawla, N., Kushner, K., Koehler, R., & Marlatt, A. (2009). Mindfulness meditation for substance use disorders: A systematic review. *Substance Abuse, 30*(4), 266–294. doi:10.1080/08897070903250019