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The Psychological Effects of Meditation: A Meta-Analysis

Peter Sedlmeier, Juliane Eberth, Marcus Schwarz, Doreen Zimmermann, Frederik Haarig, Sonia Jaeger, and Sonja Kunze
Chemnitz University of Technology

In this meta-analysis, we give a comprehensive overview of the effects of meditation on psychological variables that can be extracted from empirical studies, concentrating on the effects of meditation on nonclinical groups of adult meditators. Mostly because of methodological problems, almost ¾ of an initially identified 595 studies had to be excluded. Most studies appear to have been conducted without sufficient theoretical background. To put the results into perspective, we briefly summarize the major theoretical approaches from both East and West. The 163 studies that allowed the calculation of effect sizes exhibited medium average effects ($\bar{r} = .28$ for all studies and $\bar{r} = .27$ for the $n = 125$ studies from reviewed journals), which cannot be explained by mere relaxation or cognitive restructuring effects. In general, results were strongest (medium to large) for changes in emotionality and relationship issues, less strong (about medium) for measures of attention, and weakest (small to medium) for more cognitive measures. However, specific findings varied across different approaches to meditation (transcendental meditation, mindfulness meditation, and other meditation techniques). Surprisingly, meditation experience only partially covaried with long-term impact on the variables examined. In general, the dependent variables used cover only some of the content areas about which predictions can be made from already existing theories about meditation; still, such predictions lack precision at present. We conclude that to arrive at a comprehensive understanding of why and how meditation works, emphasis should be placed on the development of more precise theories and measurement devices.

Keywords: meditation, meta-analysis, psychological variables, nonclinical population

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Why do people meditate? There seem to be basically two answers. First, people meditate because they want to overcome psychological or emotional problems: meditation as a means for self-regulation. Second, people meditate to achieve a better understanding of life, enlarge their consciousness, and gain wisdom: meditation as a means to (positive) transformations in consciousness. These two aims often cannot be clearly separated, and most practitioners of meditation probably pursue both to a certain extent (e.g., Coleman, 2001). To date, Western academic psychology has focused on the former: meditation as a therapeutic means. Despite the public's growing interest and an increasing number of studies on the impact of meditation, there is a surprising scarcity of summaries of the empirical evidence, especially for evidence that stems from research outside the therapeutic context. Numerous studies have been conducted to search for effects of meditation, yet there is an even more surprising lack of elaborate psychological theories that make sound predictions about what to expect if one meditates. This atheoretical approach is frequently mirrored in the measures used in the studies, which include all kinds of dependent variables that are not specific to meditation research and have also been used in many other kinds of research. Although, in this article, we place an emphasis on empirical evidence, we are convinced that real progress in understanding the effects of meditation cannot be made if future empirical studies are not guided by better theories. Therefore, after briefly surveying previous attempts to summarize the literature on the effects of meditation, we introduce existing theoretical approaches from both the East and the West. Following our analysis of the empirical evidence, we return to the issue of how we might make progress in understanding meditation and its effects.

There have long been attempts to bring together meditation and psychotherapy (e.g., Coster, 1934), and over time, meditation has become an established psychotherapeutic technique (Walsh & Shapiro, 2006). There are even recently developed approaches to psychotherapy that center around meditation (e.g., Hayes, Strosahl, & Wilson, 1999; Linehan, 2007). In an early literature survey, J. C. Smith (1975) acknowledged therapeutic benefits of meditation but concluded that the evidence available was insufficient to decide whether the cause of the positive outcomes was meditation or whether the effects found were just due to expectation or sitting quietly. A more recent survey by McGee (2008) summarized beneficial effects on both psychological and psychosomatic problems such as anxiety, addiction, aggression, suicidality, depres-

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Peter Sedlmeier, Juliane Eberth, Marcus Schwarz, Doreen Zimmermann, Frederik Haarig, Sonia Jaeger, and Sonja Kunze, Department of Psychology, Chemnitz University of Technology, Chemnitz, Germany.

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Correspondence concerning this article should be addressed to Peter Sedlmeier, Department of Psychology, Chemnitz University of Technology, 09107 Chemnitz, Germany. E-mail: peter.sedlmeier@psychologie.tu-chemnitz.de

sion, chronic pain, insomnia, and hypertension. Positive effects on substance abuse were found in a meta-analysis by Alexander, Robinson, and Rainforth (1994) and on general health in a later meta-analysis by Grossman, Niemann, Schmidt, and Walach (2004). Another recent review by Ospina et al. (2007) lamented the low methodological quality of most studies but concluded that several kinds of meditation significantly reduced blood pressure and helped reduce stress. This series of meta-analyses also found systematic physiological and neuropsychological effects of meditation in healthy practitioners but concluded that overall, "the therapeutic effects of meditation practices cannot be established based on the current literature" (Ospina et al., 2007, p. 6). There is also the risk of adverse effects, especially with meditators prone to psychosis (e.g., Kennedy, 1976; Lazarus, 1976; Otis, 1984). However, notwithstanding the not so positive conclusion of Ospina et al., the claim of therapeutic benefits of meditation is backed up by growing empirical evidence.

In this survey, we are not concerned with therapeutic effects of meditation and therefore have included only studies with groups of adult meditators who were not explicitly classified as belonging to a clinical population. This does not, of course, guarantee that all participants were without major psychological or emotional problems, but the results found in these studies may provide the best available overview of what effects meditation has on generally healthy people. In any case, therapeutic effects were not the intention of the inventors of meditation. In fact, practitioners of meditation using it as a means to attain enlightenment were usually expected to be as free as possible from weaknesses of all sorts (such as mental problems) before they started their practice (e.g., Feuerstein, 2001, p. 14; Harvey, 2004, p. 260).

Moreover, we concentrate on psychological variables and do not consider physiological measures. To date, hundreds of studies have been conducted that have tried to connect physiological and brain measures to the effect of meditation (see Murphy, Donovan, & Taylor, 1997, for a large collection of studies), and there appear to be systematic effects. In a survey on the psychobiology of altered states of consciousness, Vaitl et al. (2005) pointed out several differences between meditators and nonmeditators in electroencephalographic activity and functional magnetic resonance imaging measures and concluded that it "seems promising that the traditional meditation methods are becoming more and more examined scientifically" (p. 109). In a later survey of neuroelectric and imaging studies of meditation, Cahn and Polich (2006) found, for instance, systematic changes in anterior cingulate cortex and dorsolateral prefrontal areas due to meditation as well as state (meditators meditating vs. not meditating) and trait (meditators vs. controls) alpha changes that correlated with meditation experience. Yet they concluded that "a comprehensive empirical and theoretical foundation is still emerging" and that "the specific neural changes and differences among practices are far from clear" (Cahn & Polich, 2006, pp. 202–203). Although physiological effects should not be neglected in a comprehensive theory of meditation, one needs to know more about the psychological effects to make sense of physiological findings. Therefore, we have limited our analysis to psychological dependent variables.

There have already been several reviews of the psychological effects of meditation for nonclinical groups of practitioners (Alexander, Rainforth, & Gelderloos, 1991; Alexander, Robinson, Orme-Johnson, Schneider, & Walton, 1994; Eppley, Abrams, & Shear, 1989). These meta-analyses, mostly conducted by members of the Maharishi International University, found strong effects of meditation on measures of trait anxiety and self-actualization, as well as strong reductions in drug use. Moreover, they all found a superiority of transcendental meditation (TM) compared to other methods of relaxation and meditation. These analyses are, however, limited in matters of both content and methods. First, the meta-analyses examined only a small number of dependent variables (basically, trait anxiety and self-actualization). Second, there are several methodological problems with a substantial number of studies used in the analyses. One rather common problem concerns study design: Many studies did not employ a control group but only a meditation group for which measurements were taken before and after an extended meditation period. Such a design has low internal validity because other potential causal factors (such as the impact of social gatherings, thinking about one's problems, time passing by, etc.) cannot be controlled (see Rosenthal & Rosnow, 1991; Sedlmeier & Renkewitz, 2007). In such designs, within-subject effect sizes might be overestimated. There is, however, another methodological problem that arises if effect sizes from such within-group studies are combined with those from between-group studies. If measures in the within-group studies are positively correlated (as they usually are), effect sizes are larger than in comparable between-group designs (Dunlap, Cortina, Vaslow, & Burke, 1996).[1]

The limitations of the former meta-analyses on the effects of meditation beg a more comprehensive and methodologically stricter summary, which is the current objective. The central question posed pertains to the effects of meditation on psychological variables for healthy (nonclinical) adult practitioners.

We begin by trying to formulate some theoretical assumptions, based on both the early Indian texts that describe the potential effects of meditation and Western approaches. We then report our analysis, including the impact of potential moderator variables. We conclude by pointing out some shortcomings of prior research as well as ways in which research on the effects of meditation could be improved, with an emphasis on working out more precise theories.

Theoretical Considerations About the Effects of Meditation

The vast majority of the studies reviewed below say little or nothing about why and how meditation should work. In short, meditation research has been conducted in a more or less atheoretical manner. Yet some theoretical approaches in the West refer to particular effects of and elaborate concepts from more comprehensive theories in the East, mostly stemming from ancient Indian approaches. So, rather than outlining the theory on which most of the studies surveyed here are based, we focus our theoretical considerations on this question: Why could it have made sense to

[1] An additional problem occasionally encountered when attempting to calculate effect sizes is insufficient information. Eppley et al. (1989, p. 961) reported that in the case of missing information about standard deviations, they made some kind of estimate. We wrote to the authors but were unsuccessful in obtaining the respective information because the person who had done the analysis could not be traced (although one of the coauthors was quite helpful in providing some additional information).

examine the impact of meditation on the psychological variables used? Before we deal with the theoretical background of meditation, we first discuss what meditation is, then introduce some basic Indian theoretical approaches, and finally turn to theoretical approaches developed in Western psychology.

What Is Meditation?

There are many varieties of meditation. According to Shear (2006b), approaches to meditation differ in the mental faculties they use (e.g., attention, feeling, reasoning, visualization, memory, bodily awareness), in how these faculties are used (e.g., actively, passively, effortlessly, forcefully), and the objects to which these faculties are directed (e.g., thoughts, images, concepts, internal energy, aspect of the body, love, God). In practice, however, it is difficult if not impossible to find an approach to meditation that can be reduced to a single mechanism.

Some distinctions are frequently mentioned in the literature, such as the type of attention cultivated (concentration vs. awareness) and the relationship to cognitive processes (e.g., simply observing cognitions vs. deliberately modifying them; see Feuerstein, 2001; Shear, 2006a; Walsh & Shapiro, 2006). A primary distinction is that between concentrative and mindfulness techniques (Goleman, 1988; Kristeller & Rikhye, 2008; Naranjo & Ornstein, 1971), although the two techniques are often used together in actual approaches to meditation such as Zen meditation (e.g., Kapleau, 2000; Samy, 2002). Concentrative techniques use an object of focus or attention, which can be a mantra (mostly a spiritually meaningful word or phrase),[2] one's breathing, or a picture or physical experience. Meditators train their ability to rest their attention on a single object and thereby to disengage their usual mental processes. Take, for instance, breathing as the object of attention. First, trying to stay focused on each breath, meditators experience a heightened awareness of how the mind jumps around (like a monkey, it is often said). They then learn to disengage their responses to thoughts, emotions, actions, or other cognitions, and with much practice, they may be able to effortlessly maintain the awareness of their breathing in the back of the mind, thus producing a calming effect that might even extend to everyday activities.

Whereas concentrative meditation is usually seen to stem from Hinduism (but is also found in many Buddhist approaches), mindfulness meditation is closely connected to Buddhism (Feuerstein, 2001). Mindfulness meditation emphasizes staying present in the moment and maintaining an alert, aware state in a nonjudgmental way (e.g., Kabat-Zinn, 1994). Meditators learn not to let the mind wander into the past or future or into chains of association. Sometimes observing one's breathing, counting breaths, and engaging in labeling (labeling the current thought experience as, for instance, "emotion," "pain," "planning," or "judgment") are used as tools to return to a mindful state of attention. Eventually, meditators are expected to develop a deeper awareness of their thought patterns without experiencing the reactions (e.g., emotions, other thoughts) these patterns usually evoke, leading to nonjudgmental acceptance and emotional equanimity. The mind of a highly experienced meditator should observe just thoughts, just feelings, or just sensations (without letting thoughts create emotions, and these emotions other thoughts, etc.).

A third major type of meditation is meditation with form, often called guided meditation (Kristeller & Johnson, 2005; Kristeller & Rikhye, 2008). In this technique, which has a strong Tibetan Buddhist background, the content of meditation is regarded as very important and is attended to in a mindful rather than analytic or judgmental way. The focus of the guided meditation can be a chant, a mandala (a complex picture, usually of high religious significance), as used in Tibetan meditation practices, or complex universal experiences, such as images of death or suffering or feelings of compassion, as in loving-kindness meditation. Guided meditation is also increasingly used in therapeutic contexts, where the focus has been on treating, for instance, stress, eating disorders, or depressive thoughts (e.g., Kabat-Zinn et al., 1992; Kristeller, Baer, & Quillian-Wolever, 2006; Segal, Williams, & Teasdale, 2002).

At first glance, concentrative, mindfulness, and guided meditation appear quite distinct, but it is difficult to classify meditation as being exclusively of any one class. In practice, there are different emphases on concentration, mindfulness, or guidance, but virtually all meditative practices involve a combination of approaches. For instance, Zen meditation includes focused attention on breathing (concentration), as well as an emphasis on practicing awareness, and sometimes even particular breathing exercises such as deliberately slowing down exhalation (Sekida, 1975). Similarly, it has been argued that TM, which might be primarily regarded as a concentrative technique (focusing attention on a mantra), transcends its own procedure: "You use the mantra to lose it" (Travis & Shear, 2010, p. 1116). Another technique, mindfulness-based stress reduction (MBSR), usually consists of an 8-week training course that teaches a version of Vipassana (Theravada Buddhist) meditation but also includes body scan exercises and selected exercises from hatha yoga (e.g., Kabat-Zinn, 2003). Moreover, there is a practical argument that meditation might not exist in a pure form: Many meditators have tried different methods and might still use earlier practices after switching to a new form of meditation.

Although many approaches to meditation include concentration and mindfulness techniques to some degrees, it is obvious that these approaches are not all the same. Accordingly, one might not expect identical results from practicing different kinds of meditation. Two ways to pay respect to this diversity are (a) to focus on the preponderance of one technique (e.g., an emphasis on concentrative vs. mindfulness techniques) or (b) to focus on the approach to meditation itself (e.g., TM). We later use both kinds of distinctions.

Meditation as a Means to Transformed Consciousness: Indian Theoretical Approaches

The approaches to meditation used in the studies of the meta-analysis can often be traced back directly or indirectly to Hindu or Buddhist traditions. Both Hinduism and Buddhism can be seen as theories of transformation: In both traditions, the sense of self we experience in normal life is considered to be only a preliminary

[2] In many approaches to meditation, such as in TM, mantras are seen as carrying specific powers of their own. The latter view is, however, controversial (for contrasting opinions and data, see Benson, Alexander, & Feldman, 1975; De Mello, 1978; Masuda, Hayes, Sackett, & Twohig, 2004).

view of reality that can be overcome by following the respective path prescribed.[3]

Meditation is a core ingredient in all of these paths. Therefore, one should expect some explanation of why and how meditation works. Indeed, such explanations can be found in the respective literature, but there are two difficulties to overcome to arrive at a psychological theory of meditation. The first is that both Hinduism and Buddhism are vast collections of different approaches (e.g., Harvey, 2004; Klostermaier, 2006; Raju, 1985); the second is that neither is just a psychological theory but is religion, philosophy, and psychology rolled into one. Especially the inclusion of religion can hinder the development of a comprehensive psychological theory of meditation because adherents of a given school might not be willing to put particular religious hypotheses (beliefs) to the test. We deal with the first difficulty by trying to extract the basic teachings of both Hinduism and Buddhism that are relevant to meditation. To achieve this and also to minimize the second problem, we rely on prior work that attempted to extract the psychology part from the two traditions. We lean heavily on the recent Indian psychology movement, which originated in India but includes experts on diverse theoretical approaches to meditation from both East and West (results are largely summarized in Rao, Paranjpe, & Dalal, 2008, and Cornelissen, Misra, & Varma, 2011). We concentrate next on those aspects of the Hindu and Buddhist traditions that we believe are most relevant to a theory of meditation that covers the studies examined here (in the Discussion, we come back to other aspects that should also be treated in a comprehensive theory of meditation).

Hindu approaches to meditation. Following Klostermaier (2006), we use *Hinduism* as an umbrella term for all traditions that declare allegiance to the Vedas, ancient Indian scriptures that date back to about 3500 B.C.E. (e.g., Frawley, 2001; Hiriyanna, 1932/2000; Klostermaier, 2006; Sharma, 1960/2003). The Vedas (especially the oldest one, the Rig Veda), the Upanishads, the Bhagavad Gita, and the Yoga Sutras are major sources of a Hindu theory of the effects of meditation (see Chang, 1959; Easvaran, 1996; Kalupahana, 1992; Sedlmeier, 2006; Shukla, 2004; Singh, 2004; Sri Aurobindo, 1995; Whiteman, 1993; Woods, 1914/1998). In these scriptures and also in the ensuing practice, meditation does not stand alone as a technique but is always embedded in a religious or spiritual and philosophical context. This context deals, for instance, with views of the world, assumptions about the existence of God, and prescriptions for living (Dasgupta, 1922/1975; Hiriyanna, 1932/2000; Raju, 1985).

The combination of meditation and context is often called *yoga* (for a comprehensive overview of different approaches, see Feuerstein, 2001). Although there are many discrepancies in these texts, a close reading reveals a common theory about what happens if one practices meditation (as the central part of yoga) with dedication: Meditation finally should lead to a state of liberation, enlightenment, or pure consciousness (e.g., Cornelissen, 2003; Feuerstein, 2006; Kulkarni, 1978; Rao, 2004, 2005). What is this pure consciousness? A "super-normal clarity of inward vision or intuition untroubled by either discursive intellection or hedonistic affection" (Sinha, 1958, p. 359). Attaining pure consciousness means—according to most authors—entering a state of totally different consciousness and of knowledge that cannot be compared with normal consciousness. Attaining pure consciousness also means realizing one's true (eternal) Self (with a capital S). However, pure consciousness cannot be recognized by the normal mind, which, according to most accounts, only mirrors it. To achieve pure consciousness, one has to practice specified methods, with meditation as the core. Rao (2010) put it succinctly: "Meditation in the classical tradition has a single acceptable application, which is the transformation of the person to realize herself in a state of total transcendence and freedom from all the existential constraints" (p. 695).

Contact with pure consciousness is generally assumed to be possible only after extended practice of meditation. However, specific approaches to yoga and meditation also make more detailed predictions that refer to earlier phases of practice. To date, it is almost exclusively these early effects that have been subjected to empirical tests. The studies contained in this meta-analysis refer only to such early effects. What can one expect when practicing meditation, even if only for a limited period of time? Within the Hindu tradition, Patañjali's Yoga Sutras are the most authoritative and commonly accepted source for respective predictions.

The Yoga Sutras are the scriptural basis for *Yoga*, one of the so-called six orthodox systems (*darshanas*), and they are widely accepted in most if not all Hindu schools that deal with approaches to meditation.[4] They consist of a collection of often very condensed aphorisms based on ideas from the Vedas and are generally attributed to one Patañjali (for English translations, see Whiteman, 1993; Woods, 1914/1998). Patañjali, however, seems not to have been the inventor of Yoga but rather a collector of practices who systemized already existing thoughts about the issue (e.g., Eliade, 1970; for background on the relationship between Yoga and other Indian philosophical/psychological systems, see Rao & Paranjpe, 2008). It is not clear when, exactly, the Yoga Sutras were written, with estimates ranging from the second century B.C.E. to the fifth century C.E. (Flood, 2004). It is, however, important to notice that almost all varieties of yoga refer in some way to the Yoga Sutras (e.g., Eliade, 1970; Flood, 2004; Joshi & Cornelissen, 2004; Raju, 1983; Shukla, 2004; Sri Aurobindo, 1996).

The basic problem of existence, according to the Yoga Sutras, is that one is in ignorance of and separated from pure consciousness. Patañjali suggests a method that consists of eight steps to reach pure consciousness. The first five steps, including rules of moral conduct, bodily and breathing exercises, and the practice of focusing one's attention inward, are generally seen as preparatory stages; the last three, considered the essential stages, can be seen as

[3] The two approaches actually include many (different!) psychological theories of cognition and personality that are not, however, directly relevant for the studies examined in this article and are also beyond the scope of this article.

[4] The philosophical system of *Yoga* (here written with a capital Y) is not to be confused with the term *yoga* that stands for a collection of different practices. Indian philosophy traditionally differentiates between six orthodox system, that is, systems that are based on Vedic teachings (of which Yoga is one), and several heterodox systems, that is, systems that deny the authority of the Vedas (one of which is Buddhism). Materialism (with Cārvāka as the prominent example) is a third class of philosophical system (for an overview and some illustrative original texts, see Radhakrishnan & Moore, 1957).

varieties of meditation (see Eliade, 1975; Goleman, 1988; Rao & Paranjpe, 2008).[5]

According to the Yoga philosophy, there are five causes of misery, the so-called five *kleshas* (see second book of the Yoga Sutras). Misery, that is, suffering in life, is caused by ignorance about pure consciousness and therefore life becomes driven by sensory inputs and ego cravings. Not surprisingly, the first and fundamental klesha, or hindrance, is spiritual ignorance (*avidyā*), that is, the inability to discriminate between good and evil, truth and falsehood, the permanent and the impermanent, and so forth. The other four hindrances are the feeling of a (mistaken) personal identity (*asmitā*); attachment to or involvement in the thirst, greed, and craving for enjoyment (*rāga*); hate of or aversion to anything considered painful (*dvesha*); and the desire to continue to be what one is and the instinctive fear of death (*abhinivesha*).

With increasing yoga practice, these five hindrances should have increasingly less influence. So, for somebody who practices meditation (the central part of yoga), one would expect positive changes in dealing with emotions, in personality traits, and also in measures of self-actualization. One might also expect practitioners of meditation to change their everyday behavior. Moreover, due to enhanced powers of concentration and awareness (and less susceptibility to stressful events), cognitive processes should also benefit from meditation practice. Similar predictions might be made for TM, which is usually seen as an application of (Advaita) Vedanta (Shear, 2006c, p. 23), another one of the six orthodox systems of Indian philosophy, and not as a direct application of the Yoga system discussed above. However, Vedanta has been heavily influenced by the system of Yoga, and the Yoga Sutras have been incorporated and modified in basically all major Indian systems (see above).

Buddhist approaches to meditation. As in the Hindu approaches, the final aim of Buddhist meditation practices is to achieve liberation or enlightenment, which basically means to experience reality as it really is (e.g., Harvey, 2004). However, whereas in the Hindu systems of Yoga and Advaita Vedanta mentioned above (and also in other orthodox Indian systems) it is assumed that enlightenment means to experience something eternal (variously termed *Purusha, Atman,* or *Brahman,* in the respective systems),[6] a central teaching of Buddhism is that there is nothing that can be identified with an eternal Self (or an eternal soul): The ultimate reality to be recognized in Buddhism is usually regarded as emptiness or void (*sunyata*).[7]

Although the Buddhist approach is quite different at first glance (and, in some respects, also on closer inspection—see De Silva, 2005; Kalupahana, 1992; Mizuno, 1996, for attempts to extract the psychology of early Buddhism), we argue that, as far as the present studies in the meta-analysis are concerned, the effects one can expect by pursuing Buddhist meditation practices are quite similar to those found by following the Yoga Sutras. Please note that Buddhism is not monolithic but has evolved into many quite different approaches. Here, we concentrate on early Buddhism. For our argument, we start with the *four noble truths* that are considered a core element of the basic Buddhist teaching by all Buddhists (see Boccio, 2004; Harvey, 2004; Mikulas, 2007, 2008; Premasiri, 2008; Schwartz & Clark, 2006). The first truth is that life is filled with *dukkha,* that is, unsatisfactoriness.[8] Dukkha arises when perceived reality does not match one's desires or expectations about reality. The ensuing discrepancy causes undesirable emotions, such as anxiety, anger, frustration, or jealousy, and might impair thinking. The second noble truth is that the source of dukkha is craving, that is, a tendency to crave for and cling to beliefs, perceptions, sensations, expectations, opinions, and images of oneself and of reality. Craving in turn leads to clinging. For instance, when one holds a certain hypothesis and it turns out that the hypothesis is wrong, one would suffer dukkha. This might lead one to cling to the (wrong) hypothesis nonetheless to avoid suffering. The third truth is that dukkha ends when craving ceases. Absence of craving does not, however, mean apathy or absence of emotions; rather, it means that a person's behavior is more motivated by appropriateness and compassion than power, sensation, or security. Finally, the fourth truth is that there is a way to free oneself from craving: the *Eightfold Path*. Similar to the eight steps of yoga practice outlined in the Yoga Sutras, the Eightfold Path can be seen as containing a preparatory part, consisting of the first six elements, and a meditation part, comprising the last two. It begins with right understanding, that is, understanding the four noble truths and deciding to do something about it. This is followed by right thought, right speech, right action, right livelihood, and right effort, which all refer to matters of conduct and morality. The meditation part then consists of right mindfulness and right concentration. In actual practice, the eight parts both in the Yoga Sutras and in the Eightfold Path are not followed in a strict order because all the parts are interdependent: Higher morality might, for instance, lead to better meditation, and the reverse could also be true. The process is more aptly represented as a spiral that leads to higher levels, passing through some or all of the eight respective parts (e.g., Harvey, 2004, p. 71).

What can be expected when the pursuit of the Eightfold Path is thoroughly successful? One would see reality as it really is (see

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[5] In particular, the first five steps are *yama* (ethics), *niyama* (inner spiritual discipline), *āsana* (body postures), *prānāyāma* (breath control), and *pratyāhāra* (control of the senses), and the last three steps consist of *dhārāna* (concentration), *dhyāna* (contemplation), and *samādhi* (meditative state of absorption).

[6] In Samkhya and Yoga, Purusha refers to both common as well as individualized forms of pure consciousness, and Atman refers to the substance of the individual Self, whereas the Brahman in Advaita Vedanta is the single principle that accounts for the ultimate reality; the relationship between Atman and Brahman is often regarded as similar to the relationship between waves and the sea (see Paranjpe & Rao, 2008; Rao & Paranjpe, 2008).

[7] Some scholars argue, however, that this difference in views about the ultimate reality to be experienced after successful meditation practice might be due to that ultimate reality being basically indescribable. Indeed, even in Buddhist literature, the ultimate reality is sometimes termed *True Self* (of no-mind and no-form; see Shibayama, 1970), and it has been argued (e.g., Samdhong Rinpoche, 2005) that in the end there is not really a difference between emptiness and fullness (*pūrna*). Also, Ricard (2011, p. 102) spoke of "pure consciousness" in a Buddhist context, and Shear (2006b) argued that the experience of pure consciousness might be the same as that of pure emptiness (pp. xviii–xix). In the same vein, the Brahman in Advaita Vedanta is seen as essentially indescribable and unthinkable, which is captured in the famous *neti, neti* (not this, not that) in the Upanishads (see Indich, 1980, p. 5).

[8] Literal translations include "hard to bear," "off the mark," and "frustrating." The usual translation as "suffering," according to Mikulas (2007, p. 9), does not quite hit the mark (see also Schwartz & Clark, 2006, p. 122).

Premasiri, 2008, p. 97): (a) the transient nature (*anicca*) of everything—material or mental, (b) the tendency of transient objects to produce suffering when there is strong attachment to such objects (*dukkha*), and (c) the lack of any enduring permanent substantial reality in them, which can be identified with some eternal (Self-)existence (*anatta*). With progressing practice in meditation, one would also expect afflictive emotional states such as aggression and craving to occur less frequently and be of briefer duration (see also Wallace, 1999, p. 185). Moreover, one would expect changes in personality and, because of increasing powers of concentration, improvements in cognitive abilities. Only the expectations about what happens on the way are relevant for the studies examined here, and these expectations are quite similar to those of the Hindu approach.

Meditation as a Means to Self-Regulation: Western Theoretical Approaches

To date, a full-fledged theory about the effects of meditation does not exist in Western psychology. An early explanation holds that the main effect of meditation might be a relaxation response that "results in generalized decreased sympathetic nervous system activity, and perhaps also increased parasympathetic activity" (Benson, Beary, & Carol, 1974, p. 37). Benson et al. (1974) claimed that approaches to meditation such as TM or Zen belong in the same category of mental techniques as common relaxation procedures such as progressive relaxation (Jacobson, 1987) or autogenic training (Schultz & Luthe, 1959). According to this explanation, one would expect meditation to yield results similar to those of relaxation techniques.

Recently, however, there have been several attempts to connect ideas from Buddhism to Western psychological theories in an effort to explain the effects of meditation. Most explanations focus on the impact of mindfulness practice on attention control and on shifts in perspective but there have also been attempts to put Buddhist practice into a broader perspective. We first present such an approach that concentrates on cultivating mental balance and well-being and then turn to the more specific approaches.

Cultivating mental balance. In an attempt to connect Buddhist teachings and Western psychology, Wallace and Shapiro (2006) suggested an approach that includes different Buddhist meditation practices. They argued that, although the Buddha did not elaborate on the theme of mental health as such, the Buddha's discourses lay the ground for a model of mental well-being. Their model, which leans heavily on the Tibetan approach to Buddhism, assumes that mental suffering is in large part due to imbalances of the mind and that these imbalances can be overcome by cultivating four kinds of mental balance: conative, attentional, cognitive, and affective. Conative balance (setting right intentions, goals, and priorities) precedes the other three and is cultivated by, among other things, meditating on the realities of impermanence and suffering and the possibility of generating well-being by reflecting on the lives of persons who have achieved this goal. Attentional balance includes the development of sustained voluntary attention and is cultivated by the practice of mindful breathing. Third comes cognitive balance, which involves being calmly and clearly present with experiences as they arise moment by moment. It is cultivated by mindfulness meditation (on the body, the feelings, mental states and processes, and phenomena in general). Finally, affective balance (freedom from excessive emotional vacillation, emotional apathy, and inappropriate emotions) is cultivated by, among other practices, loving-kindness meditation. From this model, one can derive predictions for each stage (although, as the authors argued, the stages might not be followed in a strict linear fashion) and for the general outcome. Similar to the Indian approaches described above, this approach should produce generally positive effects on each of the four components of the model.

Specific effects of mindfulness practice. According to some Western approaches, mindfulness practice can be expected to improve attention control and to lead to a shift in perspective.

Effects via attention control. Lutz, Slagter, Dunne, and Davidson (2008) argued that (as in most Hindu approaches to meditation) Buddhist approaches have meditators focus and sustain their attention on an object. This practice is thought to train skills in sustaining the focus of attention, detecting distractions, disengaging from such distractions, and redirecting the attention to the object one should focus on. These skills have been identified as basic attentional processes, and they are well connected to specific brain regions (for a wealth of references, see Chapter 3 in E. D. Smith & Kosslyn, 2007). According to Lutz et al., continued focused attention practice goes along with improvements in concentration tasks, such as continuous performance tasks, binocular rivalry tasks, and selective attention tasks. Therefore, according to these authors, meditators' concentration should eventually become more and more effortless, thus creating a sense of physical lightness and vigor that reduces the need for sleep and in addition leads to a significant decrease in emotional reactivity.

Effects via a shift in perspective. Shapiro, Carlson, Astin, and Freedman (2006) argued that mindfulness meditation involves intentionally attending with openness and nonjudgmentalness. Continued practice of this kind of meditation eventually leads to a shift in perspective they termed *reperceiving*. Reperceiving is seen as a metamechanism that allows meditators to stand back and witness their own thoughts and experiences instead of being immersed in them. This shift in perspective has also been postulated by other authors but given different names, such as *decentering* (Safran & Segal, 1990), *cognitive defusion* (Hayes et al., 1999), *deautomatization* (Deikman, 1966), and *disidentification* (Martin, 1997). What are the consequences of such a shift in perspective? Shapiro et al. argued that reperceiving helps the meditator recognize what is really important in life. Moreover, by attending to the information contained in each moment instead of reacting automatically to emotions and thoughts, automatic behavior can be relearned. For instance, if anxiety arises, automatic patterns of behavior could be drinking, smoking, or overeating. Instead, reperceiving allows the meditator to step back from the anxiety and see it as simply an emotional state that is arising and will eventually pass away. Mindfully attending to negative emotional states lets the meditator eventually realize that such emotions need not be feared or avoided. In general, cognitive, emotional, and behavioral responses to the environment should become more flexible and less automatic because of this shift in the meditator's perspective (for related arguments and predictions, see K. W. Brown, Ryan, & Creswell, 2007; Garland, Gaylord, & Park, 2009; Kristeller & Rikhye, 2008; Lutz et al., 2008; Mitmansgruber, Beck, Höfer, & Schüßler, 2009).

What Could Have Been Predicted?

The vast majority of the studies included in our analysis did not make theoretically derived predictions, but nonetheless asking "What could have been predicted?" according to the Indian and the Western approaches is quite informative. To answer this question one has to consider the peculiarities of the studies summarized here, that is, the information given about the meditation procedure and the dependent measures used. Both kinds of information are limited in the current sample of studies, which also has an impact on the possible predictions. One limitation is that none of the present studies explicitly dealt with the ultimate aim of meditation as spelled out by the Indian approaches: attaining higher states of consciousness and, eventually, enlightenment. Another restriction is connected to the first: The dependent measures used in the studies dealt with here are more or less conventional measures used in both clinical and nonclinical psychological research (and not measures that are suitable for finding out more about higher states of consciousness).

Predictions of the Indian theoretical approaches. It is evident that the two major Indian approaches to meditation briefly outlined above share many assumptions. This is no wonder, as Buddhism arose in the context of the ideas contained in the Vedas. Early Buddhism, in turn, seems to have had a strong influence on the contents of the Yoga Sutras (Whiteman, 1993). Therefore, one can also expect the predictions of the two major approaches to be quite similar, at least in respect to the topics examined in the present studies. One might, however, expect slight differences in the effects on concentration and awareness. Whereas concentrative meditation, strongly linked to the Yoga Sutras approach, might give its practitioners some advantages in measures of focused attention, practitioners of mindfulness meditation might profit somewhat more on measures that capture mindfulness (although there does not seem to be full agreement among researchers on what mindfulness means—see K. W. Brown et al., 2007; Grossman, 2008).

Despite these differences, the general principles outlined above lead one to expect positive changes in many areas: personality traits, emotional stability, self-actualization, cognition, and behavior. Admittedly, these predictions are quite global (uniformly good things will happen to those who practice meditation), but given the lack of detail about the actual meditation practice followed and the conventional dependent measures used in the studies summarized here, more specific predictions are hardly possible. These predictions might seem trivial, but note that they could be falsified by not finding uniformly positive effects. More precise predictions are possible from the ancient Indian approaches, but these predictions would require us to narrow down the categorization of meditation techniques (which was not possible with the current sample of studies) and also to examine more specific dependent measures that are suitable for measuring altered states of consciousness (for examples of such predictions, see Sedlmeier, 2011; see also the Discussion and Conclusion sections).[9]

Predictions of the Western theoretical approaches. The Western theoretical approaches briefly described above were not developed fully independently but drew heavily on Buddhist thought and/or on techniques used in Buddhist approaches. To simplify somewhat, one might argue that at least the more specific approaches deal with the cultivation of sustained attention, with one approach placing the emphasis on focused attention and the other on an open form of attention. Therefore, one could make quite specific differential predictions for different kinds of attentional tasks for a kind of mindfulness meditation that is more concerned with the cultivation of focused attention versus another kind of mindfulness meditation that is more of the open monitoring variety (see Lutz et al., 2008). However, there is no consensus on these possible predictions, either. For instance, Tanner et al. (2009) argued that TM, which might be classified as a technique that predominantly trains focused attention, also has positive effects on mindfulness. Even if there was agreement on the above differential predictions on respective changes in different aspects of attention, published research on the effects of meditation to date has rarely dealt with such dependent variables, let alone a comparison of effects in such variables.

Common predictions. It seems that meditation research is in some respects comparable to psychotherapy research about 40 years ago, when there was not much differentiation in the predictions of different forms of psychotherapy and where evaluations were quite global (see Barlow, 2010). At least for the research summarized here, predictions cannot be very precise at the moment, mostly because the dependent measures used (see below) do not cover the more specific predictions that can be derived from the theoretical approaches described above.

Both the Indian and Western theoretical approaches emphasize effects on attentional processes: All meditative techniques involve disengagement of attentional processes from our usual scanning, analyzing, cognizing, and reacting (Kristeller & Rikhye, 2008). These changes in attentional processes let one expect changes in cognition and, as a consequence, positive changes in respect to emotional reactions. If practiced for a longer period, one might thus also expect positive changes in measures of behavior and personality. Because the predictions for the dependent measures that have usually been examined in meditation research to date still lack precision, the best strategy seems to be to look at the respective effects in an exploratory way, keeping in mind differences in meditation techniques. This was also our basic approach in the current meta-analysis. So, we kept our research question as open as possible: What can be said about the psychological effects of meditation given the available (and usable) literature?

Studies, Dependent Measures, and Moderator Variables

Selection of Studies

We were interested in the effects of meditation on psychological variables for healthy adults. Therefore, we excluded from our sample studies that dealt only or mainly with physiological measures and those that were therapy studies. We started our search by

[9] As outlined in the introduction, the predictions derived from the Yoga Sutras and the Eightfold Path of Buddhism rest on the assumption that practitioners also heed moral rules and appropriate ways of life. It is unclear from the original writings how substantial the impact of these other ingredients of the respective forms of yoga is in addition to the impact of meditation itself. However, even if we knew, we could not make use of this knowledge because little or nothing was mentioned about the context of meditation in the vast majority of the present studies. One should, however, expect that approaches with a strong connection to either the Yoga Sutras (such as TM) or to the Buddhist Eightfold Path (such as Zen or mindfulness meditation—see Harvey, 2004) would have emphasized this context also in the present studies.

scanning Murphy et al.'s (1997) comprehensive bibliography covering the years 1931–1996. Because data before 1970 were sparse, our meta-analysis covers only studies from 1970 onward. In addition, we consulted major psychological databases (PsycLIT, PsycINFO, and PsycARTICLES) and other related databases (e.g., SSCI, Web of Sciences, The Cochrane Library, and Academic Search Premier). Not to miss any relevant publications, we used the most inclusive descriptor we could think of: meditation. These databases covered all publications through September 2011.

We also used the reference lists of articles, especially those that had been published in major journals. All in all, we found 595 studies (independent samples) reported in articles, book chapters, and unpublished dissertations. However, after closer inspection, it turned out that some of these did not satisfy our two content criteria (psychological measures and nonclinical groups). In addition, many studies had to be excluded because of methodological problems, as described below.

Among the initially selected studies, there was a surprisingly large number that reported data on only a single meditation group that was measured before and after the intervention. We did not include these studies (some of which seem to have been included in earlier analyses) because of the two serious problems mentioned above. The first, that dependent measurements generally lead to larger effect sizes (because the measurements are positively correlated), could in principle be remedied post hoc by applying correction formulas (e.g., Dunlap et al., 1996), although to do so would require information about the correlation between the dependent measurements, which might not be easy to obtain. The second problem is more serious: In such designs without a control group, effect sizes are hard to interpret because they might be biased by other factors not controlled for, and therefore, the internal validity of such studies is generally low (see Rosenthal & Rosnow, 1991). Effect sizes could be highly inflated if the other factors (e.g., social acceptance) work in the same (positive) direction as meditation is expected to work.[10] Therefore, we included only studies that, in addition to a meditation group, also used some kind of control group.

A second methodological constraint concerned the nature of the effects. We were interested in relatively stable effects of meditation, that is, effects that persisted for some time after a meditation session. A number of studies measured only short-term effects right after a specific meditation practice, by comparing measures before and after a meditation session. Such effects, which can often be of a transient nature, are hard to compare to the effects of extended meditation practice. Therefore, we did not include the respective studies in our analysis. For similar reasons, we also excluded the few studies that examined the effects of special meditation retreats on long-term practitioners of meditation because, here, the control group also consisted of long-term meditators and these effects are not comparable to the standard case, that is, with the effects in studies that used no-treatment control groups.

Apart from problems of design, a further major difficulty we encountered quite often was insufficient information to calculate a meaningful effect size. Sometimes, we encountered only test statistics, without information about degrees of freedom or sample size. Sometimes, the only information about statistical analysis was the mentioning of a "significant effect" without recourse to any specific numbers. Another problem consisted of analyses that reported only the overall results of an analysis of variance that compared several groups (e.g., several kinds of meditation and a control group). The corresponding F value did not allow us to calculate effect sizes for the comparison of a given meditation group and a control group. In some studies, results of significance tests were given only for significant results and not for other results that could be seen as measuring the same or a similar dependent variable, and occasionally, means were reported but not measures of variation. If no additional information could be obtained in such cases, the respective measures were not included.

It turned out that almost three quarters of the originally selected 595 studies either did not fulfill our content criteria or (and this was the majority of them) suffered from severe methodological constraints and therefore had to be omitted from further analysis. This left 163 studies for inclusion in the meta-analyses reported below. Of these studies, 125 stemmed from journal articles, 28 were book chapters, and 10 were dissertations that were not published anywhere else.[11] Three of the 163 studies also allowed us to calculate effect sizes for a comparison of meditation and relaxation groups, and an additional seven studies exclusively used relaxation groups as control groups. We found several (mostly recent) studies that compared the effects of meditation to the effects of an active treatment, such as positive thinking, sports, or cognitive training. Of the 163 studies included in the meta-analysis, four contained both no-treatment and active control groups, and there were four additional studies that used only active control groups for comparison.

Categorization of Studies

Because the studies did not test predictions of precise theories, dependent measures and potential moderator variables could not be fully specified in advance but only after an initial examination of the available literature. In the process of analyzing the original reports, it soon became clear that the studies covered a very large number of dependent measures. In addition, they differed in many other respects that could have had an impact on the results and had to be taken into account in the analyses. The classification of the dependent measures and the selection of moderator variables were partly theoretically derived but were also influenced by the information we were able to find in the 163 studies.

Classification of dependent measures. We focused our theoretical considerations made above on effects that were actually examined in the studies of the meta-analysis. This somewhat restricted analysis of existing theories (see the Discussion and Conclusion sections for a broader picture) yielded predictions of positive effects of meditation in measures of attention, mindfulness, cognition, emotion, personality, behavior, and self-actualization. However, as mentioned in the introduction, these theoretical considerations were introduced by us independently of (mostly nonexistent) theoretical considerations in the original studies. To be open to other kinds of dependent measures, we looked at what dependent variables researchers really had used. We even-

[10] Other factors might, of course, also decrease the overall beneficial effects and therefore lead to an underestimate of the effect of meditation. Chances are, however, that the estimated true effect size might be considerably upwardly biased if such studies were part of the analysis.

[11] For eight additional dissertations that were found to be published later as book chapters and articles, we used the published form.

tually arrived at 133 different codes for the dependent measures used in the 163 studies. Although many of these 133 codes already included several comparable dependent measures, it did not seem feasible to analyze such a huge number of codes, so we summarized them into 21 categories, shown in Table 1 (see supplemental Table 1 in the online Supplemental Materials for a detailed list of all the outcome measures used). The main restriction for choosing appropriate categories was that a sufficient number of studies could be found. As a lower bound for the number of studies that should fall into one category, we chose $n = 4$ studies. If a given dependent measure was used in four or more studies and if it concerned more than just a specific aspect of an established psychological category, we treated it as a category of its own, such as state and trait anxiety and stress.

Almost all of the dependent measures could be brought into a positive–negative dimension that allowed us to determine not only whether changes occurred but also whether these changes (brought forward by meditation) were improvements. For some variables, however, such a clear positive–negative dimension could not be postulated. This was the case for neutral personality traits such as adaptability, agreeableness, conscientiousness, conservativeness, openness, extraversion, sociability, and shyness. It is not really clear in which direction meditation should yield changes in these variables although one might expect changes in a more liberal direction (e.g., higher amounts of extroversion, openness, and sociability). Therefore, we analyzed these neutral variables by using the differences between the more liberal and the more conservative end of the respective dimensions as the effect. However, we expected no pronounced effect of meditation for these measures.

Potential moderating variables. The effects of meditation can be influenced by many variables. Because there does not yet exist a comprehensive theory about the differential effects of meditation, we began our analysis by including as many potential moderating variables as we could find information for in the research reports. It turned out, however, that some of these variables, such as specific information about the instructor, specific demographic and personality information about participants (e.g., racial/ethnic background), attrition rate, and mode of recruitment, were only rarely reported and thus did not allow for meta-analytic treatment. In addition to information about sample sizes, which we used as weights in the calculation of average effect sizes, we found information about a few other potential moderator variables in the majority of studies: participants' age and gender, year of publication, publication outlet, kind of treatment, kind of control group, kind of design, duration of treatment, experience of meditators, and randomization. We did not have specific expectations about age and gender but looked at their potential impact nonetheless. For the other variables, we specify the potential impact on the results below.

Kind of control group. If Benson et al. (1974) are right, the effects of meditation should not differ from those of relaxation procedures because, according to these authors, both should produce the same relaxation response, which in turn should influence

Table 1
Categories for the Dependent Measures Used in the 163 Studies, With the Variables (Codes) Grouped Into These Categories

Category	Corresponding codes
Anxiety state	Anxiety state
Anxiety trait	Anxiety trait
Attention	Concentration/attention, sustained attention, orienting, alerting, conflict monitoring, executive processing, behavioral inhibition
Behavior	Motor performance, behavior error, behavior time, reaction time
Cognition	Cognitive distortion, reflection, suppression, thought control
Emotion regulation	Emotion regulation, emotion perception/awareness, emotion clarity, emotion modulation, emotion reactivity, coping, positive coping strategies, approach coping, positive religious coping, negative coping strategies, avoidance coping, negative religious coping, relaxation ability
Empathy	Empathy, perspective taking
Intelligence	Intelligence, mental rotation, verbal fluency, arithmetic task, academic achievement
Interpersonal	Relationship satisfaction, relationship distress, relatedness, closeness, social skills, social dysfunction, defective integration, attachment style
Learning and memory	Long-term memory, working memory, learning, memory
Mindfulness	Mindfulness, state mindfulness, trait mindfulness, dissociation, nonreactivity to inner experience, observing, noticing, attending to sensations, perceptions, thoughts, feelings, acting with awareness, automatic pilot, concentration, nondistraction, describing, labeling with words, nonjudging of experience, decentering, curiosity, acceptance
Negative emotions	Negative affect, Profile of Moods, anger, tension, worry, confusion, nervosity, inadequacy (felt), distrust, guilt, suspiciousness, frustration
Neuroticism	Neuroticism, emotional stability, irritability
Perception	Perception, field independence, change blindness, perspective changing, autokinesis
Personality (negative)	Egoism, dominance, capacity for status, psychoticism, rigidity, mixed negative personality traits
Personality (neutral)	Adaptability, agreeableness, conservativeness, conscientiousness, openness, extraversion, sociability, shyness
Positive emotions	Positive affect, calm, love, hope, savoring forgiveness
Self-concept	Self-concept, locus of control, self-efficacy, self-esteem, self-compassion, group dependent
Self-realization	Self-actualization, artistic ability, inner-directed, time-competence (POI), POI subscales, spirituality/spiritual experiences, religiosity, moral reasoning
Stress	Stress
Well-being	Well-being, life satisfaction, psychological well-being, depression, rumination, vigor/activity, energy level, fatigue, optimism, sense of coherence

Note. The POI (Personal Orientation Inventory) is an instrument for measuring self-actualization (Shostrom, 1966).

all other dependent measures in a similar way. Therefore, relaxation control groups should not differ from meditation groups. A similar argument holds for other active control groups that have recently been used in meditation research, such as control groups that practice positive thinking, sports, or cognitive training. Because this moderator variable has special importance as an alternative explanation for the effects of meditation, it is treated separately below.

Design of studies. We encountered two kinds of study design, one-shot studies that compared a group of meditators and a matched group of nonmeditators at a given point in time, and pre–post designs that compared the changes between two measurements for a group that received meditation training with one that did not. On average, one should expect a higher amount of meditation experience for the (often accomplished) meditators in the one-shot studies than for those learning to meditate in pre–post studies. Therefore, the effects of meditation might be stronger in the one-shot studies. Such a comparison should, however, be complemented by a more precise analysis of the impact of the amount of meditation practice (see below).

Randomization. One major methodological concern when studying treatment effects is that there might be a priori differences between the treatment and control groups. The best way to control for such differences is to divide participants randomly into the two groups. Randomization might be especially important in meditation research because meditators may differ a priori in some respects from nonmeditators. If some personality characteristics of meditators are responsible for the positive effect of meditation, then one should find smaller effects in randomized studies where those personality factors (as well as other potential moderator variables) are controlled for.

Publication outlet. Another important potential moderator variable can be the methodological quality of a given study. That quality is not easily determined, but a good indicator should be the publication outlet. It might, on average, make a difference in respect to the methodological rigor of a study if it had to pass a journal's review process or if it (only) had to fulfill the criteria set up by a book editor (who might be interested in particular results). We also looked at the effect sizes in unpublished dissertations that might yield a lower bound for effect size estimates because published research, that is, dissertations that were eventually published, might contain a selection of (more positive) results.

Year of publication. A first inspection of the studies included gave us the impression that methodological rigor might have increased over the years. If this is indeed the case, one could expect more exact effect size estimates in more recent publications. Therefore, we included the year of publication as another moderator variable to see whether effect sizes changed over the years in a systematic way.

Kind of meditation. One obvious candidate explanation for variance in effects is the kind of meditation. That different kinds of meditation should differ in their effectiveness has already been repeatedly suggested. For instance, it has been argued that TM has stronger effects than other approaches to meditation (e.g., Eppley et al., 1989). In the introduction, we made a distinction between approaches that put different amounts of emphasis on concentrative meditation, mindfulness meditation, and guided meditation. As discussed there, this distinction is not clear-cut but is based on the predominance of a meditative procedure. Given the relatively scarce information in the studies examined about the meditation methods and given the existing data, such a distinction proved difficult. Another way to look for different kinds of meditation would be to look for different labels. We found two such consistent groups: TM and mindfulness meditation. Whether TM can be considered a predominantly concentrative meditation is open to discussion, but there seems to be at least a general agreement that it is not a mindfulness meditation technique. We found only a few studies that used guided meditation (meditation with form) but quite a few that followed idiosyncratic approaches or did not specify the approach used. Therefore, we created a third group of meditation practices, which we termed *other meditation practices.*

Amount of meditation practice. Finally, one would expect that the amount of meditation practice matters: More experienced meditators should have benefited more. It might, however, be important whether this experience was there long before the meditator even thought about participating in a study or was acquired in the course of a controlled study. Therefore, we looked separately at the relationship between meditators' prior experience and effects of meditation in these two kinds of studies. In the one-shot studies, experienced meditators were compared with nonmeditators, using only one point of measurement. Because, in this case, the period in question could be quite large (up to more than 16 years of meditation experience), we used months as units. In the studies with two points of measurement, treatment and control groups were compared before and after the meditation training. Here, we recorded the duration of the study in days.

Method

Coding Procedure

All authors served as coders and followed a very fine-grained coding system (available from the authors on request), detailing the criteria for inclusion of a study, for coding dependent measures into the specified categories and for extracting the information to calculate effect sizes. We began with a theoretically derived coding system that was augmented in the course of the analysis when unanticipated dependent measures were encountered. All extensions of the coding system were performed by the first author and at least one additional coder. In the rare cases in which there was disagreement, the issue was discussed in a group of coders until a common solution was found and included in the coding system. In the later stages of analysis, this procedure was used if new dependent variables were encountered or if there was ambiguity about the coding. If the coding system was changed, all previously analyzed studies for which the changes were relevant were reexamined. All coders were trained by the first author until there was full agreement about the coding results for several studies.

Calculation of Effect Sizes

We used correlations (between group membership and the dependent variables) for the final analysis but took whatever information was available for the calculation of intermediate steps. This could be results of significance tests or means and sample standard deviations (e.g., Rosnow & Rosenthal, 2009). Note that the effect size of interest always referred to the difference between treatment (meditation) and control groups. In most of the cases, the control

group was a no-treatment group, but in some studies, the effects of meditation were compared with the effects of relaxation training or an active control group. We report results for both kinds of comparisons below. If there is only one point of measurement, then the effect size is the difference between the effects in meditation and (matched) control groups. If the psychological variables in question were measured twice (usually before and after a meditation course), the effect size refers to the difference in the change scores of treatment and control groups. These two standard cases are dealt with first. We explain how we calculated effect sizes from means and standard deviations as well as from the results of significance tests. Then, we describe how we dealt with the (remarkably numerous) studies that looked at changes only in single groups without adequately comparing these changes between groups, where we calculated *post hoc effect sizes.*

Effect sizes from means and standard deviations. If means and standard deviations of scores (one point of measurement) or change scores (two points of measurement) were given, we first calculated standardized differences (*d* or *g*) and then transformed them into correlations. For instance, if means and sample standard deviations (for Groups a and b) were available, *d* was calculated as follows:

$$d = \frac{\bar{x}_a - \bar{x}_b}{s_{ab}} \quad \text{with} \quad s_{ab} = \sqrt{\frac{n_a s_a^2 + n_b s_b^2}{n_a + n_b}}. \tag{1}$$

The standardized effect size was then transformed into *r* using

$$r = \frac{d}{\sqrt{d^2 + \frac{1}{pq}}}, \tag{2}$$

where *p* and *q* are the proportional sizes of the samples in Groups a and b compared to the total sample size. For instance, if $n_a = 20$ and $n_b = 30$, then we would obtain values of $p = .4$ and $q = 0.6$. If, instead of sample standard deviations (*s*), estimated population standard deviations were given, the same kind of calculation was performed, but using the effect size *g* instead of *d* (e.g., Rosenthal, 1994; Sedlmeier & Renkewitz, 2007).

Effect sizes from significance tests. Suitable significance tests could be *t* or *F* tests that compared treatment and control groups after the treatment had taken place, *F* tests of interaction (Pre–Post × Treatment–Control),[12] and *F* tests from analyses of covariance (pretest as a covariate). In these cases, the correlational effect size was calculated as follows:

$$r = \sqrt{\frac{t^2}{t^2 + df}} \quad \text{and} \quad r = \sqrt{\frac{F}{F + df_{error}}}. \tag{3}$$

If the results of nonparametric tests had been reported, we tried to determine the appropriate (one-sided) *p* value, and if an exact *p* value was either reported or could be calculated from the information about test statistics and sample size, we determined the respective *t* statistic and calculated $r_{equivalent}$ (Rosenthal & Rubin, 2003):

$$r_{equivalent} = \sqrt{\frac{t^2}{t^2 + (n-2)}}. \tag{4}$$

Post hoc effect sizes. There were also quite a number of studies that allowed the calculation of effect sizes only for the meditation and the control groups separately (and not for the difference between the two groups). However, in these cases, it is possible to calculate meaningful effect sizes. If significance tests had been conducted separately for treatment and control groups, we applied a method suggested by Rosenthal and Rubin (1979) that can be used to calculate a significance test of the difference in change scores of Groups a and b post hoc from two *z* statistics:

$$z_{diff} = \frac{z_a - z_b}{\sqrt{2}}. \tag{5}$$

Usually, however, test statistics are not reported as *z* values but mostly as *t* values (*t* tests for dependent means, e.g., for posttest scores minus pretest scores of the meditation group). To arrive at *z* scores, the (one-sided) *p* values of the *t* statistics were determined, and these *p* values were the basis for determining the *z* statistics. Finally, correlative effect sizes were calculated from the result (Sedlmeier & Renkewitz, 2007):

$$r = \frac{z_{diff}}{\sqrt{N}}, \tag{6}$$

where *N* is the total sample size. If only means and standard deviations for pre- and posttest results were given (separately for each group), we first calculated a *t* test for dependent means for each group and then followed the procedure outlined above. If the correlation between pre- and posttest scores (which is needed to calculate the standard deviation of the difference scores) was not given, we assumed a correlation of $r = .5$ as the default value.[13]

Basic Meta-Analytic Procedure and Checks for Potential Biases

One potential problem that exists in all kinds of meta-analyses is whether the studies included stem from the same population, that is, whether they are really comparable. If not, the conclusions of a meta-analysis cannot be generalized beyond the studies included, and even for them, a conclusion might not make much sense. In our case, we could almost expect the studies not to come from the same population, due to the different approaches to meditation and the huge variety of dependent measures used. Thus a fixed-effects model of meta-analysis that assumes that all studies stem from the same population (or at least do not differ in their population values) did not make much sense. Therefore we used the random-effects model proposed by Hunter and Schmidt (1990, 2004; see also Schmidt, Oh, & Hayes, 2009). To examine the question of whether our studies were comparable, we used two kinds of checks in our meta-analyses reported below, funnel plots and psychometric meta-analysis, the latter following naturally from the approach of Hunter and Schmidt (2004). As an indicator of robustness

[12] In this simple case, an interaction measures nothing but the difference in the change scores. The calculation of the post hoc effect sizes follows the same logic.

[13] In contrast to Grossman et al. (2004), who used an $r = .7$, but consistent with the suggestion Faul, Erdfelder, Lang, and Buchner (2007) gave for performing power analyses for repeated measurements, we decided on a relatively low value of $r = .5$. This decision ensures that our effect size estimates are not inflated but are rather on the conservative side.

against publication bias, we used the fail-safe *N,* and finally, to have a measure of precision for our mean weighted effect sizes, we calculated confidence intervals (CIs) for these effects whenever we considered it appropriate. These four techniques are now explained in more detail.

Funnel plots. A funnel plot (e.g., Egger, Smith, Schneider, & Minder, 1997; Light & Pillemer, 1984) is a scattergram for the variables effect size on the *x*-axis and sample size on the *y*-axis. If all studies come from the same population and if there are no systematic selection processes, one should see a funnel turned upside down. Such an inverted funnel shape is expected because the largest samples should give the best estimates of the population effect, whereas effect sizes calculated from small samples can vary widely due to sampling error. If the effect sizes stem from different populations or if only a subsample was selected (e.g., only the studies with significant outcomes), the scattergram should deviate markedly from a funnel shape.

Psychometric meta-analysis. Another way to analyze the comparability of studies is psychometric meta-analysis (Hunter & Schmidt, 1990). The *psychometric* comes from the analogy to traditional test theory where the test score (e.g., in a personality test or an IQ test) is assumed to be the sum of the true score and an error component (Lord & Novick, 1968). Accordingly, the empirical variance, that is, the variance of the effect sizes in a meta-analysis (expressed in *r*), is the sum of the variance of the population effect sizes (ρ) plus the variance due to sampling error (*e*):

$$s_r^2 = \sigma_\rho^2 + \sigma_e^2, \tag{7}$$

where

$$s_r^2 = \frac{\Sigma[N_i(r_i - \bar{r})^2]}{\Sigma N_i}, \quad \sigma_e^2 = \frac{(1 - \bar{r}^2)^2}{\overline{N} - 1}, \quad \text{and} \quad \bar{r} = \frac{\sum_{i=1}^{n} N_i r_i}{\sum_{i=1}^{n} N_i}. \tag{8}$$

If the effect sizes from all studies (with effect sizes r_i and sample sizes N_i) stem from one population, there should be no variance of the population effect sizes ($\sigma_\rho^2 = 0$), and the variance of the effect sizes found should be totally attributable to sampling error alone. If, however, the empirical variance is substantially larger than the error variance, this indicates that the effect sizes stem from several different populations and, therefore, might express different population effects, that is, several sampling distributions mixed into one.

In the event the above analyses indicate that the effect sizes stem from different populations, the next step is to search for those populations, that is, to search for moderator variables. Once plausible candidates for such variables are found, the psychometric meta-analysis can be repeated for the subgroups built by the categories of the moderator variables. If, for the subgroups, the empirical variances are substantially smaller or even can be explained by error variances alone, this might indicate that true population effects have been identified.

Fail-safe *N*. In addition to the visual inspection of funnel plots, we used Rosenthal's (1979) fail-safe *N* as a (rough) measure of the robustness of our results against publication bias. The fail-safe *N* gives the number of studies averaging null results (unpublished studies remaining in the file drawer) that would be required to bring the overall *p* level to a value of just $p = .05$. The fail-safe *N* is calculated by first determining for each of the *k* studies the standard normal deviates (*Z*) corresponding to the exact *p* values associated with the respective statistic and then using the following formula (Rosenthal, 1979, p. 639):

$$\textit{fail-safe } N = \frac{k}{2.706}(k\overline{Z}_k^2 - 2.706). \tag{9}$$

If the fail-safe *N* is large in comparison to the number of studies included in the meta-analysis, this can be regarded as an argument for the robustness against publication bias of the mean effect found. Rosenthal (1979) suggested as a lower bound that the fail-safe *N* should be larger than $5k + 10$.

Confidence intervals for combined effect sizes. Especially for detailed analyses, one might look for information on how exact the effect size estimates are. This information can be found in (the length of) CIs. CIs for combined effects have increasingly been used in recent meta-analyses, and we also calculated 95% CIs for our results whenever applicable (see Schmidt et al., 2009):

$$\begin{aligned} \mathrm{CI}_{\mathrm{Upper\_End}} &= \bar{r} + 1.96\frac{s_r^2}{\sqrt{k}} \\ \mathrm{CI}_{\mathrm{Lower\_End}} &= \bar{r} - 1.96\frac{s_r^2}{\sqrt{k}}, \end{aligned} \tag{10}$$

where s_r^2 is the variance of effect sizes from the psychometric meta-analysis (see above) and *k* is the number of studies. Note that CIs can also be used for (approximate) significance testing. Cumming and Finch (2005) showed that if 95% CIs for independent means do not overlap, this is equivalent to a significant difference between the two respective means at $\alpha = .01$ (see also Cumming, 2011). However, conducting significance tests is a problematic procedure in meta-analyses (e.g., Hunter & Schmidt, 2004). To a lesser extent this also holds for CIs, although they give information on the size of the effect itself and some information on the variability of the effect. In the following, we use the overlap or nonoverlap of the respective CIs in a more informal way. Following the basic intention of meta-analysis to give sound estimates of population effects, that is, to lay the emphasis on the effect, we also focus on the absolute sizes or differences in absolute sizes of effects.

Calculations for obtaining effect sizes were performed by programming all formulas in both Microsoft Excel and the statistical programming package R. The remaining analyses were performed with Microsoft Excel, R, and the statistical programming package SPSS.

Results

We begin the report of our findings with a global view of the results, including all studies and effect sizes averaged over all dependent measures. We then proceed with more detailed analyses of the 21 different categories of dependent variables shown in Table 1. In both analyses, we deal with the three kinds of control groups (no-treatment control groups vs. relaxation and active control groups) and consider the impact of other potential moderator variables.

To obtain a measure of the reliability of raters' codings, we took a random sample of $n = 30$ studies (of the 163 used in our

analysis) and had a new independent rater make judgments about (a) the categorization of dependent variables and (b) the values of the moderator variables, according to the detailed coding scheme all raters had used. Then, we determined the mean agreement (*MA*) across the $n = 30$ studies by

$$MA = \frac{1}{n}\Sigma\frac{\#\text{agreements}}{\#\text{total}}. \quad (11)$$

In the case of moderator variables, #total was always 11 (participants' age and gender, year of publication, publication source, kind of treatment, kind of control group, duration of treatment, experience of meditators, randomization, kind of design, and sample size). In the case of the categorization of dependent variables, #total was determined as the sum of the disjunctive categories the two raters had found. Here, the maximum #total could reach was 21 (the number of categories shown in Table 1).[14] We found $MA_{\text{moderator variables}} = 0.93$ and $MA_{\text{categories}} = 0.92$, which indicates high reliability.

Global Analysis

To obtain a first impression of the overall impact of meditation, we conducted a meta-analysis including all measures that could be interpreted on a negative–positive dimension, that is, all measures that allowed us to determine whether meditation had a positive (or negative) effect. This was indeed possible for almost all the measures used except some personality traits that might instead be regarded as neutral, such as introverted–extroverted and conservative–experimenting.

Overall effect. Excluding these neutral variables, we obtained a weighted (by sample size) mean $\bar{r} = .28$ ($n = 163$). Using Cohen's (1992) conventions for correlational effect sizes (small: $r = .1$, medium: $r = .3$, and large: $r = .5$), this effect can be considered medium sized.[15] The weighted mean effect size for the neutral variables that were examined in $n = 12$ studies was only $\bar{r} = .05$. Figure 1 shows a funnel plot of the respective 163 effect sizes (no study examined neutral variables exclusively) with the weighted mean effect size marked as a vertical bar. It does not, however, show total symmetry. What does the psychometric meta-analysis say? With $s_r^2 = 0.0249$ and $\sigma_e^2 = 0.0134$, we obtain $\sigma_\rho^2 = 0.0115$, which might be interpreted as a substantial variation of population effect sizes (see Hunter & Schmidt, 2004), indicating that although the first impression is of a rather homogeneous positive effect of meditation, there might be different effects behind the picture seen in Figure 1. The fail-safe *N* for these results is 43,266, which clearly exceeds the lower bound of $5k + 10 = 825$ studies, therefore indicating that our results are unlikely to be susceptible to the file drawer problem.

Meditation versus relaxation and active control. We found three studies that compared a meditation group to both a group practicing some relaxation technique and a no-treatment control group and seven studies that compared the effects of meditation only against those of relaxation (and not against a no-treatment control group). If the effect of meditation can be explained by the relaxation response (Benson et al., 1974), one should find basically no difference between the two conditions in these 10 studies. However, averaged over all available dependent measures, the effect of meditation compared with that of relaxation was still comparatively strong: $\bar{r} = .21$. This effect is somewhat smaller than that found for the comparison of meditation and no-treatment control groups ($\bar{r} = .28$), but it clearly indicates that meditation has an effect on the psychological variables analyzed that extends far beyond the relaxation response elicited by relaxation procedures.

More recently, effects of meditation have been increasingly compared with effects of an active treatment such as positive thinking, sports, or cognitive training, to see whether meditation has an effect beyond that induced by these kinds of treatments. We located eight studies that made such a comparison. Four of these also included a no-treatment control group (included in the 163 studies in the main analysis), and four additional studies compared a meditation group exclusively with an active control group. Also in this case, there was an overall advantage of meditation compared with those treatments, but the effect was smaller: $\bar{r} = .16$. Considering the diversity and small number of studies, results for both kinds of comparisons have to be regarded with some caution. However, the pronounced difference found in mean effects for meditation versus relaxation indicates a reliable effect.

Impact of other moderator variables. We first turn to the results for moderator variables for which we did not have specific expectations. For the $n = 138$ studies that provided information on participants' age, we found no systematic relationship between age and the impact of meditation ($r = -.07$), but in the $n = 122$ studies that allowed us to determine meditators' gender ratio (proportion of females), we found a somewhat larger correlation with effect size ($r = -.20$), indicating, at a first glance, a tendency for females to profit less from meditation. However, a closer inspection of the relationship showed that this negative correlation was mainly due to one outlier in the unpublished dissertations (all-male group, effect of $r = .8$) and some all-male groups with relatively large effects in the $n = 16$ book chapters for which the gender ratio could be determined. Considering only the $n = 96$ studies from journal articles with information on gender ratio, the effect was much smaller ($r = -.09$).

Kind of design. Inconsistent with our expectations, it did not make a difference whether studies were performed using one-shot or pre–post designs. The weighted mean effect size for the former was $r = .27$ ($n = 82$ studies), and for the latter, it was $r = .28$ ($n = 81$ studies). That the two kinds of designs yielded comparable outcomes is also illustrated by the overlapping CIs in Figure 2.

Randomization. For several studies, we could not find information about whether groups had been divided randomly into a meditation and a control group. We took all the studies that allowed categorization and found, somewhat surprisingly, that the effects for randomized and nonrandomized studies were roughly

[14] An example: If Rater A thought that the study had used five categories of dependent variables, Rater B thought that there had been six, and both raters agreed on four of these categories, #total = 4 + (6 − 4) + (5 − 4) = 7, and $MA = 4/7$. Note that the *MA* coefficient, which can reach a maximum of 1, may be regarded as a measure of common variance.

[15] Please note that the conventions for correlational effect sizes are more conservative for medium and large effects than those for standardized differences. If one assumes equal sample sizes in experimental and control groups, correlations of $r = .1$, $r = .3$, and $r = .5$ correspond to standardized differences of $d = 0.20$, $d = 0.63$, and $d = 1.15$ (see Rosenthal & Rosnow, 1991, for the respective formula), whereas Cohen's conventions for small, medium, and large standardized differences are $d = 0.2$, $d = 0.5$, and $d = 0.8$, respectively.

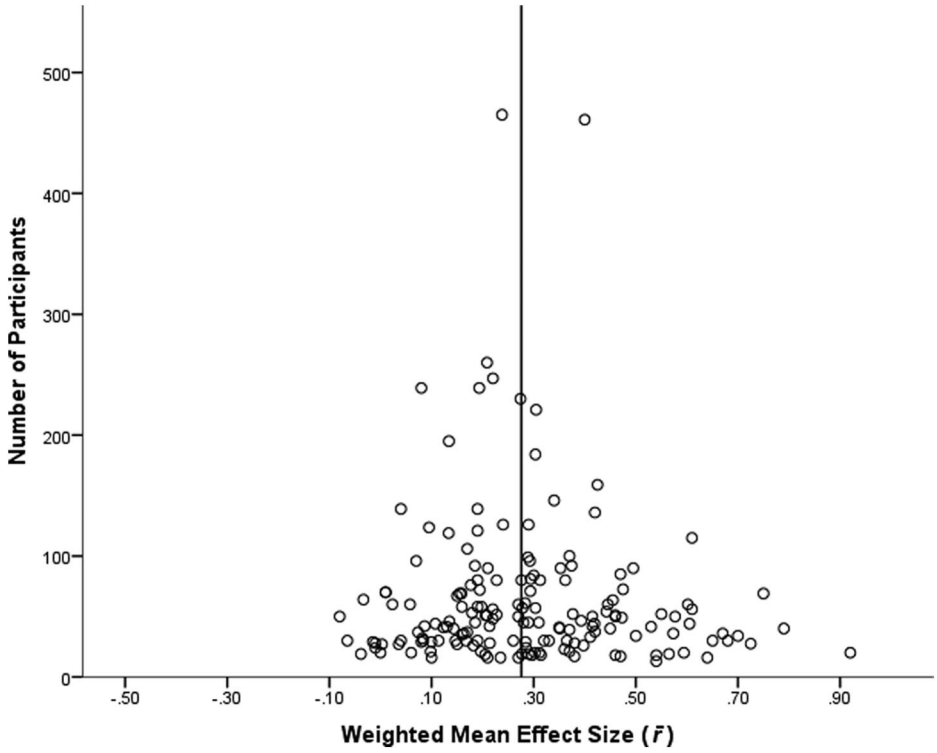

Figure 1. Funnel plot of all (nonneutral) effect sizes ($n = 163$). The vertical bar represents the weighted (by sample size) mean effect size.

the same. If participants had been randomly divided into two groups, one meditating and the other not, the weighted average effect size was $\bar{r} = .29$ ($n = 51$), and if groups of meditators were compared to groups of nonmeditators, it was $\bar{r} = .28$ ($n = 110$). This can probably be interpreted as a negligible difference, even if the respective ends of the two CIs in Figure 2 coincide.

Unpublished versus published research. A major concern in meta-analysis is whether the results included might represent a positive selection, that is, yield an upwardly biased estimate of the respective population effect. One way to examine this question is to inspect funnel plots (see below), and another is to compare results of published and unpublished studies. If there is a publication bias that favors positive results, effect sizes in unpublished research should be markedly smaller than corresponding effect sizes in published research. We were able to locate 10 unpublished dissertations that had been submitted between 2003 and 2009. Five of these studies fell into the category of mindfulness meditation, and the other five dealt with the category of other meditation

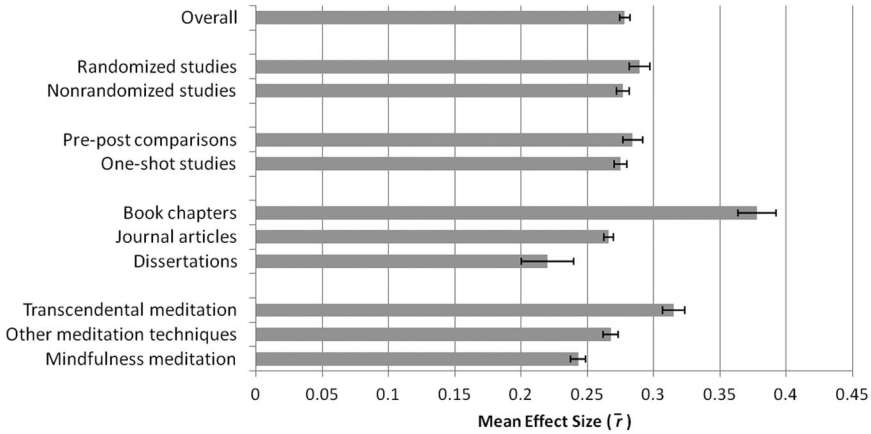

Figure 2. Global effects (averaged over all available dependent measures) of meditation separated by whether studies used randomized groups or not, by kind of design, publication outlet, and kind of meditation. Shown are weighted mean effect sizes (correlations) and 95% confidence intervals.

practices. The overall weighted mean effect size was $\bar{r} = .22$. These results now need to be compared with results in the studies that were published in the same time period and examined the effects of mindfulness meditation and other meditation practices. The weighted mean overall effect size for these $n = 38$ studies was $\bar{r} = .25$. Thus, considering this sample, the difference between the effect sizes in published and unpublished research is rather small overall.

Publication outlet. We used the publication outlet as an indicator variable for methodological rigor, comparing articles with book chapters. Figure 2 shows that there are indeed differences in effect sizes across different types of outlets. The effects were $\bar{r} = .38$ ($n = 28$) for book chapters and $\bar{r} = .27$ ($n = 125$) for studies stemming from articles. For the sake of completeness, Figure 2 also shows the mean effect for the 10 unpublished dissertations discussed above, $\bar{r} = .22$, and reveals a rather small difference between articles and unpublished dissertations but a more pronounced difference between articles and book chapters. Psychometric meta-analyses for articles and book chapters indicated a decrease in the variance of population effects (compared to the overall $\sigma^2_\rho = 0.0115$) only for the articles ($\sigma^2_\rho = 0.0078$) and not for book chapters ($\sigma^2_\rho = 0.0245$), indicating that the latter might contain rather heterogeneous population effects, similar to the state of affairs for the unpublished dissertations. Therefore, to obtain a less confounded and biased picture of the other moderator variables' impact, we performed the following analyses only for the journal articles, unless otherwise indicated.

Year of publication. If the quality of the methods applied has improved over time, one should find some systematic trend in the effect size estimates as the years go by. Figure 3 indicates that there might be such a trend: Effect sizes systematically diminished over time ($r = -.23$, $n = 125$). However, a closer inspection of the data reveals that this negative correlation was mostly due to early changes: For the $n = 22$ articles that were published before 1980, the average effect of meditation was $\bar{r} = .35$, which, for the next 2 decades, went down to $\bar{r} = .19$ ($n = 8$ articles before 1990) and then rose again to $\bar{r} = .27$ ($n = 17$ articles before 2000). For the $n = 78$ articles that were published from 2000 onward, the average effect barely differed from that for the preceding decade: $\bar{r} = .26$, thus indicating no systematic downward trend.

Kind of meditation. Does it make a difference whether meditators practice TM, mindfulness meditation, or some other kind of meditation? A first glance at the results in all 163 studies might indicate that it does. Whereas the mean weighted effect size for TM is $\bar{r} = .32$ ($n = 63$), that for mindfulness meditation is only $\bar{r} = .24$ ($n = 52$), and that for the other (often idiosyncratic) approaches is $\bar{r} = .27$ ($n = 48$). So does TM show superior effects, as suggested in earlier analyses? A second look reveals that most book chapters contained studies on the impact of TM, and the weighted mean effect size of these $n = 28$ chapters was quite high: $\bar{r} = .38$. Again, to avoid confounding the impact of the kind of meditation with publication outlet, we analyzed only articles. Doing this makes the effects of different kinds of meditation more equal: The mean weighted effect size for TM is now $\bar{r} = .27$ ($n = 36$), that for mindfulness meditation is $\bar{r} = .26$ ($n = 46$), and that for the other (mostly idiosyncratic) approaches is $\bar{r} = .26$ ($n = 43$).

To find an indicator of how reliable these estimates are, we also checked the three corresponding funnel plots. Whereas the plots for mindfulness meditation and the other approaches (not shown) do not systematically deviate from symmetry, the plot for the TM

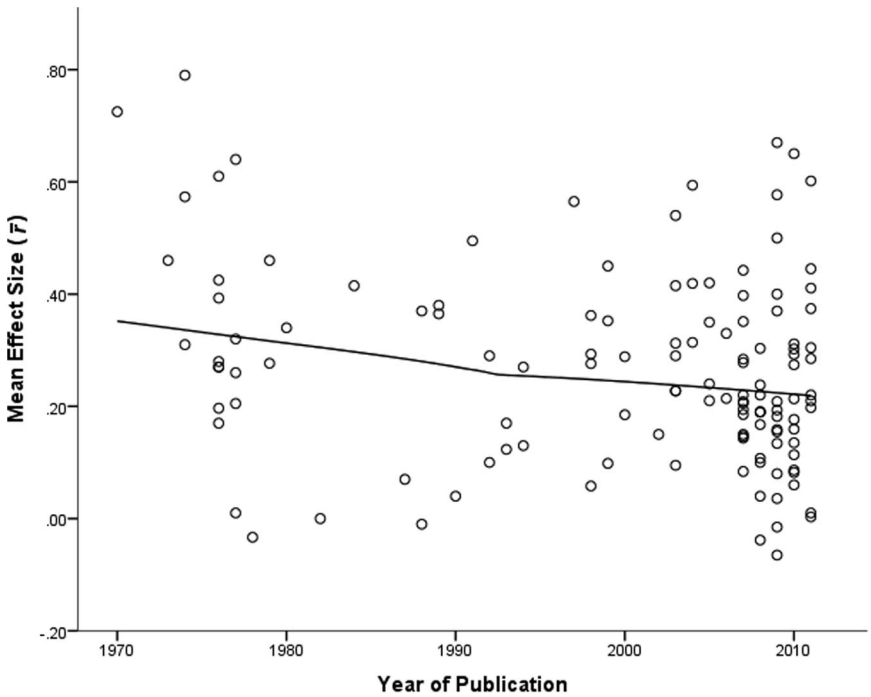

Figure 3. Relationship between year of publication and effect sizes. Shown is a LOWESS curve (see Cleveland, 1985) for the $n = 125$ studies.

studies seems to be somewhat upwardly biased. Figure 4 shows a funnel plot that might be expected if some publication bias has occurred: Studies with small effects and small sample sizes are tendentially missing. Thus, it seems that the $\bar{r} = .27$ found for TM articles is a slight overestimation of the true population effect. This conclusion is backed up by a look at the psychometric meta-analyses. Compared to the population variance for all 125 articles ($\sigma^2_\rho = 0.0078$), the population variance for mindfulness meditation ($\sigma^2_\rho = 0.0029$) decreased considerably, and that for the other approaches category ($\sigma^2_\rho = 0.0071$) remained about the same, but it increased for TM ($\sigma^2_\rho = 0.0135$). However, also in this special case with $k = 36$ TM studies, we still find unlikely susceptibility (similar to the results for mindfulness meditation and the other meditation techniques) to the file drawer problem (fail-safe $N = 2{,}246$ compared to a lower bound of $5k + 10 = 190$).

Amount of meditation practice. Does longer meditation practice lead to more pronounced effects? Again, because of the heterogeneity introduced by the different publication outlets, we considered only journal articles in examining the impact of meditation practice on the impact of meditation. Let us first look at the one-shot studies taken from articles that used only one measurement comparing meditators and nonmeditators. Here, the correlation between amount of meditators' experience (in months) and the effect of meditation (for all variables combined) was $r = -.11$ ($n = 46$ studies). The LOWESS curve in Figure 5 indicates that this relationship was not linear. In fact, if only those studies in which meditators had meditated for up to 10 years (120 months) are considered, the relationship is positive ($r = .13$, $n = 35$). If only the effects for meditators with up to 2 years (24 months) of meditation experience are analyzed, the positive correlation even increases to $r = .68$ ($n = 11$ studies, $p = .02$). It seems that the positive effects of meditation increased only up to about 10 years of practice, whereas for the few studies that tested more experienced meditators against a no-treatment control group, effects tended to become smaller again.

Let us now turn to the studies that used both pre- and posttests. These studies compared the improvement in the meditation group against the changes in a no-treatment control group. The picture is similar to the one-shot studies: Overall, the relationship between duration of study and effects of meditation was $r = .05$ in the respective $n = 69$ studies. However, again, the relationship is not linear (see Figure 6). An initial improvement can only be found up to about 1 month (30 days—not shown in the LOWESS curve), and the correlation for the respective $n = 13$ studies is $r = .12$. If one looks at the correlation between duration and effect sizes for the interval from 30 to 180 days, one obtains $r = .002$, indicating that training regimens that lasted longer than 1 month do not seem to have led to more improvement.

Differential Effects of Meditation

Although the predictions derived from the Yoga Sutras and the Eightfold Path are in principle consistent with a global positive effect of meditation, one might more plausibly expect some variation in the population effect sizes for the different categories of dependent measures a priori. Therefore, the heterogeneity found in the results of the global psychometric meta-analysis is not so surprising. Drawing on theoretical deliberations and what was actually reported in the studies, we derived 21 categories of dependent measures (see Table 1). For each category, we identified four or more independent studies that had been published in journal articles. The analysis of the influence of potential moderator variables on the effects of meditation was partly limited by the usually quite small fre-

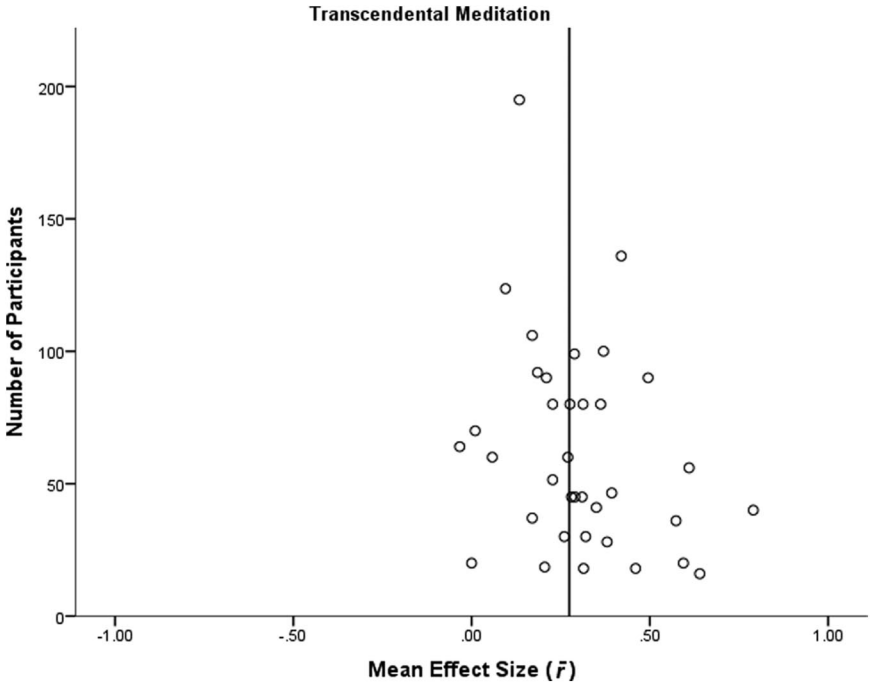

Figure 4. Funnel plot for the $n = 36$ articles that report results for Transcendental Meditation studies.

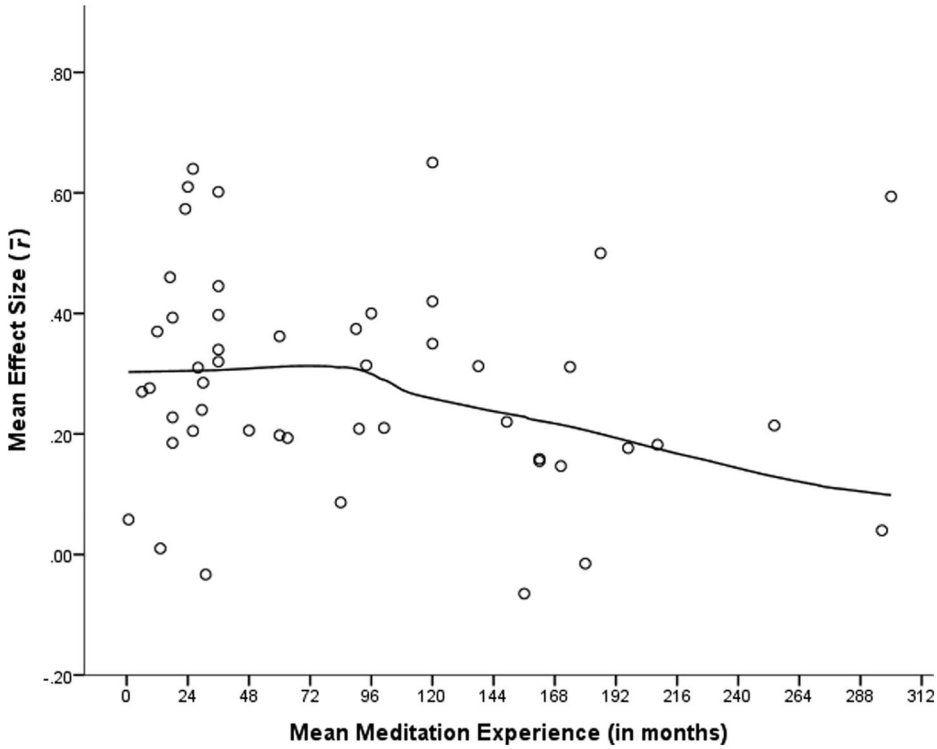

Figure 5. Relationship between the amount of meditation practice in months and the effect sizes that express the differences between meditators and nonmeditators in the one-shot studies.

quency of studies that fell into a given category. We first report the effect sizes for the different categories, then compare the results of studies that used relaxation groups or some kind of active treatment groups as control groups with those that used no-treatment controls, and finally examine differential effects of the three kinds of meditation identified above.

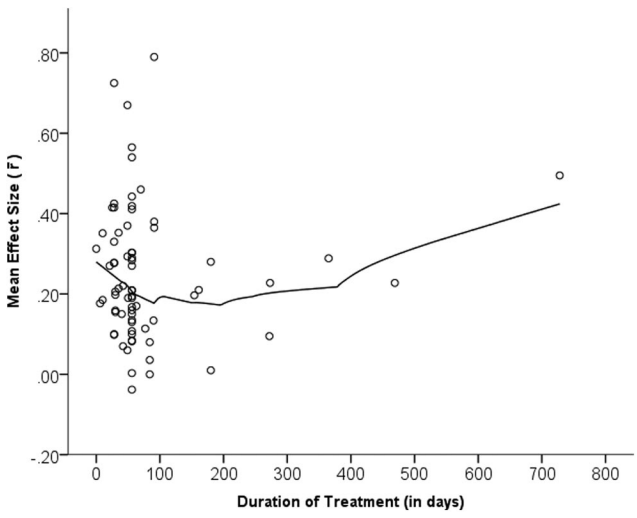

Figure 6. Relationship between the duration of studies in days and the effect sizes that express the differences in gains for treatment (meditators) and no-treatment groups.

Different effects for different categories? Figure 7 shows the weighted mean effect sizes, combined for all $n = 125$ articles (top bar of Figure 7) and separately for all 21 categories of dependent measures, along with the number of articles included for calculating the respective effect sizes and 95% CIs. The results shown in Figure 7 indicate that overall, meditation does not exert uniform effects on the categories of dependent measures we looked at. Compared to the small effect for neutral personality variables, for which no systematic impact of meditation was expected ($\bar{r} = .03$), all other categories of dependent measures exhibited a systematically higher impact (no overlap in CIs). The largest effects of meditation were obtained for variables that referred to positive changes in relationships (interpersonal: $\bar{r} = .44$), state anxiety ($\bar{r} = .37$), negative emotions ($\bar{r} = .34$), and trait anxiety ($\bar{r} = .32$), and the lowest for measures of learning and memory ($\bar{r} = .21$), negative personality traits ($\bar{r} = .18$), and emotion regulation ($\bar{r} = .17$). Overall, it seems that the more cognitive measures (emotion regulation, as operationalized in the respective studies, can be seen at least in part as measuring a kind of cognitive control strategy—see Ochsner & Gross, 2005) were less influenced by meditation than were emotional measures, especially negative ones. Measures that refer to focused and open attention yielded medium effects (attention: $\bar{r} = .28$, mindfulness: $\bar{r} = .28$), close to the average effect for all articles ($\bar{r} = .27$).

Table 2 shows the effect sizes for all measures as well as the number of studies (k) that went into the respective analyses and the total sample size (N), summed up over all studies included for calculating the effect for a given dependent measure (see supple-

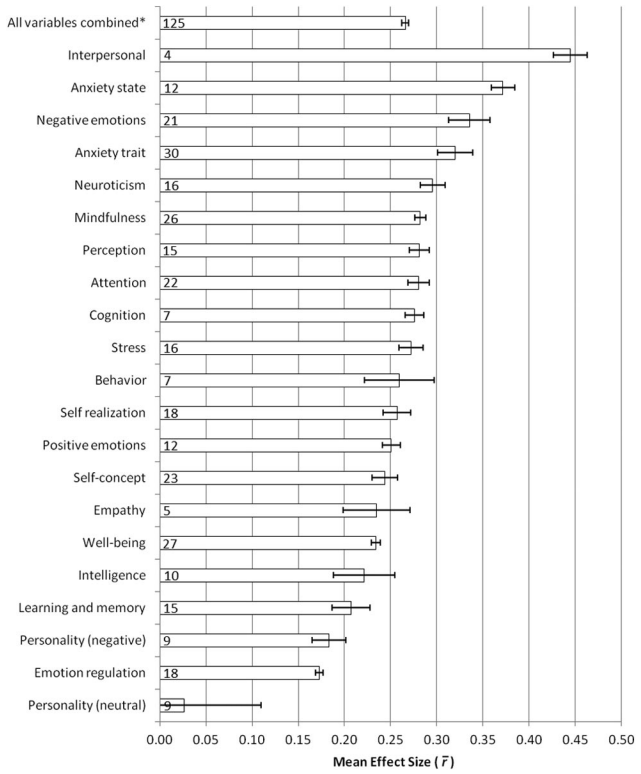

Figure 7. Effect sizes, number of studies (articles only) used to calculate them, and 95% confidence intervals for all categories listed in Table 1, as well as for the overall effect size ("All variables combined*"). The specific categories include results for $k \geq 4$ studies. The category "All variables combined*" also includes data for variables that were examined in $k < 4$ studies.

mental Table 2 in the online Supplemental Materials for a detailed list of all effect sizes). In addition, the table gives the figures for the corresponding psychometric meta-analyses. If one takes the population variance (σ^2_ρ) for all variables combined as a standard of comparison ($\sigma^2_\rho = 0.0078$ for the $n = 125$ articles), then a substantially lower population variance for a given dependent measure would indicate that the respective effect size is a good estimate of the corresponding population effect. Note that negative population variances that can arise due to the unreliability of the rather few effect sizes can be treated as $\sigma^2_\rho = 0$ (see Hunter & Schmidt, 1990, p. 109). Markedly lower population variances in Table 2 (last column) are indicated by numbers in boldface. It seems that for state anxiety, cognition, positive emotions, well-being, and emotion regulation, the effect sizes are good estimates of the respective population effects. Especially remarkable is the low population variance for the category of interpersonal that contains results from only four studies, which indicates that the large effect found there might not be a chance finding.

Meditation versus relaxation and active control. Globally, the effects of meditation on the dependent measures were clearly larger than the effects of relaxation training: Did this also show for specific categories? The 10 studies that examined the differences in effects of meditation as opposed to those of relaxation used a variety of dependent measures. To guarantee some stability, we included only those dependent measures that had been examined in three or more of the articles. Figure 8 shows the results. Please note that the interpretation of the bar lengths in Figure 8 is somewhat counterintuitive: If, for instance, the bar length for the relaxation control group (effects of a meditation group compared to that of a relaxation group) is equal to the respective bar for the no-treatment control group (effects of a meditation group compared to that of a no-treatment control group), this means that the effect of meditation was probably not at all attributable to relaxation. If, however, the effect for the relaxation control group was small in comparison to the effect for the no-treatment control group, this would indicate that part of the effect of meditation might be due to relaxation.

For reference, the bars at the bottom of Figure 8 report the results for all variables combined (including those that were examined in fewer than three of the 10 studies). The respective effect sizes are $\bar{r} = .21$ ($n = 10$ studies) for the effects of meditation compared to a relaxation training control group and $\bar{r} = .27$ ($n = 125$ articles) for the effects of meditation compared to a no-treatment control group. So, overall, it seems that relaxation training had only a very small effect (amounting to a difference of $r = .06$) over and above what could be expected in no-treatment control groups. The largest effect of relaxation in comparison to no treatment (the larger the difference between the two colors of bars, the stronger the relative effects of relaxation) was found for

Table 2
Rank-Ordered Mean Weighted Effect Sizes ($\bar{r}$), Number of Studies (k), Total Sample Size (N), and the Three Components of Psychometric Meta-Analysis (s^2_r, σ^2_e, and σ^2_ρ) for All Categories of Dependent Variables Used in the Meta-Analysis

Category	$\bar{r}$	k	N	s^2_r	σ^2_e	σ^2_ρ
All variables combined*	.26	125	8,161	0.0212	0.0134	0.0078
Interpersonal	.44	4	184	0.0186	0.0143	**0.0043**
Anxiety state	.37	12	504	0.0228	0.0181	**0.0046**
Negative emotions	.34	21	1,134	0.0521	0.0147	0.0372
Anxiety trait	.32	30	1,896	0.0525	0.0130	0.0395
Neuroticism	.30	16	1,218	0.0271	0.0111	0.0160
Mindfulness	.28	26	3,074	0.0161	0.0073	0.0088
Perception	.28	15	953	0.0213	0.0136	0.0078
Attention	.28	22	1,307	0.0273	0.0145	0.0128
Cognition	.28	7	470	0.0135	0.0129	**0.0006**
Stress	.27	16	855	0.0269	0.0164	0.0105
Behavior	.26	7	645	0.0506	0.0095	0.0411
Self-realization	.26	18	772	0.0321	0.0208	0.0113
Positive emotions	.25	12	612	0.0173	0.0176	**<0**
Self-concept	.24	23	1,215	0.0338	0.0171	0.0167
Empathy	.23	5	263	0.0415	0.0173	0.0241
Well-being	.23	27	2,070	0.0125	0.0122	**0.0003**
Intelligence	.22	10	577	0.0534	0.0160	0.0375
Learning and memory	.21	15	647	0.0400	0.0217	0.0183
Personality (negative)	.18	9	426	0.0279	0.0202	0.0077
Emotion regulation	.17	18	948	0.0089	0.0182	**<0**
Personality (neutral)	.03	9	730	0.1267	0.0121	0.1146

Note. Estimated population variances for particular categories that are substantially smaller than those for all effects combined (indicating higher homogeneity of results) are printed in bold. Negative population variances are probably due to the unreliability of the rather few effect sizes and can be treated as $\sigma^2_\rho = 0$ (see Hunter & Schmidt, 1990, p. 109). The category "All variables combined*" also includes data for variables that were examined in $k < 4$ studies.

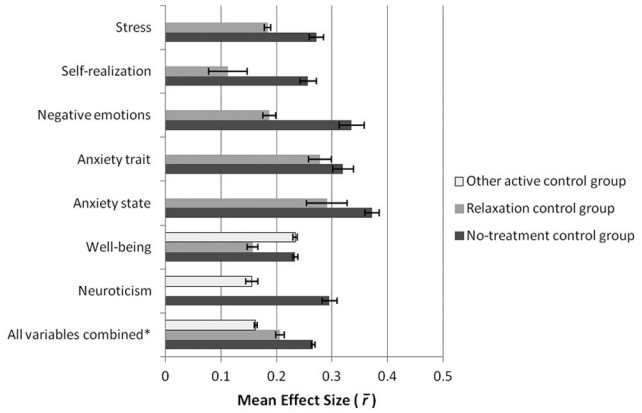

Figure 8. Effects of meditation compared to relaxation control groups (medium gray bars), active control groups (light bars) and no-treatment control groups (dark bars), for all dependent measures combined and for seven specific measures (results for $k \geq 3$ studies). Shown are effect sizes ($\bar{r}$) and 95% confidence intervals. The category "All variables combined" also includes data for variables that were examined in $k < 3$ studies.

self-realization and for reducing negative emotions, amounting to a difference of $r = .15$ for both categories (self-realization: $\bar{r} = .11$ vs. $\bar{r} = .26$, and negative emotions: $\bar{r} = .19$ vs. $\bar{r} = .34$, for relaxation groups and no-treatment control groups, respectively). Still, a quite substantial advantage of meditation over relaxation can also be seen in the detailed analysis.

For the comparison with active control groups, only two specific categories with $k = 3$ studies could be used. For the category of well-being, there was no difference when the effects of meditation were compared to a no-treatment and an active control group ($\bar{r} = .23$ in both cases); only in respect to the category neuroticism did the training regimens employed in the respective active control groups have any effect (meditation vs. active control: $\bar{r} = .16$, compared to meditation vs. no-treatment control: $\bar{r} = .30$). Although, overall, the advantage of meditation over active control groups is somewhat smaller than that over relaxation groups, to date, not much can be said about the commonalities of the respective programs and procedures for meditation, due to the scarcity of studies and the diversity of training regimens.

Kind of meditation. The global analysis yielded quite comparable effects for TM, mindfulness meditation, and the other meditation procedures. Does this uniformity of results also hold for the more detailed analyses of single categories? A thorough comparison of the three kinds of meditation was difficult, due in part to the small number of studies that used a given category of dependent measure. Again, we only included results that could be calculated from at least three studies. On the basis of these data, Figure 9 indicates that there might indeed be differential effects.

Comparatively strong effects for TM (compared to the two other approaches) were found in reducing negative emotions, trait anxiety, and neuroticism and being helpful in learning and memory and in self-realization (see also Table 3). This finding is consistent with prior meta-analyses that found superior effects of TM in trait anxiety and measures of self-realization (see the introduction). For mindfulness meditation, such comparatively strong effects were identified in reducing negative personality traits, reducing stress, and improving attention and mindfulness (see also Table 4). The more idiosyncratic approaches to meditation (other meditation techniques) yielded a comparatively large effect in the category of cognition (see also Table 5). It might also be informative to compare the two specific approaches outlined above, TM and mindfulness meditation, whenever this is possible. TM yielded noticeably larger effects than mindfulness meditation for the categories negative emotions, neuroticism, trait anxiety, learning and memory, and self-realization. The opposite results were found for negative personality traits and self-concept, where the effects of mindfulness meditation were larger.

It seems that the overall heterogeneity of the results for the TM articles ($\sigma^2_\rho = 0.0135$, compared to $\sigma^2_\rho = 0.0077$ for all articles) is largely due to the categories of intelligence, behavior, negative emotions, and trait anxiety that apparently included quite diverse population effects (all $\sigma^2_\rho > 0.03$). In the case of mindfulness meditation, the categories of intelligence and self-concept appear to have been quite heterogeneous ($\sigma^2_\rho = 0.0801$ and $\sigma^2_\rho = 0.0383$, respectively), and for the other meditation techniques, heightened variability was found in the categories of trait anxiety and negative emotions ($\sigma^2_\rho = 0.0641$ and $\sigma^2_\rho = 0.0245$, respectively). However,

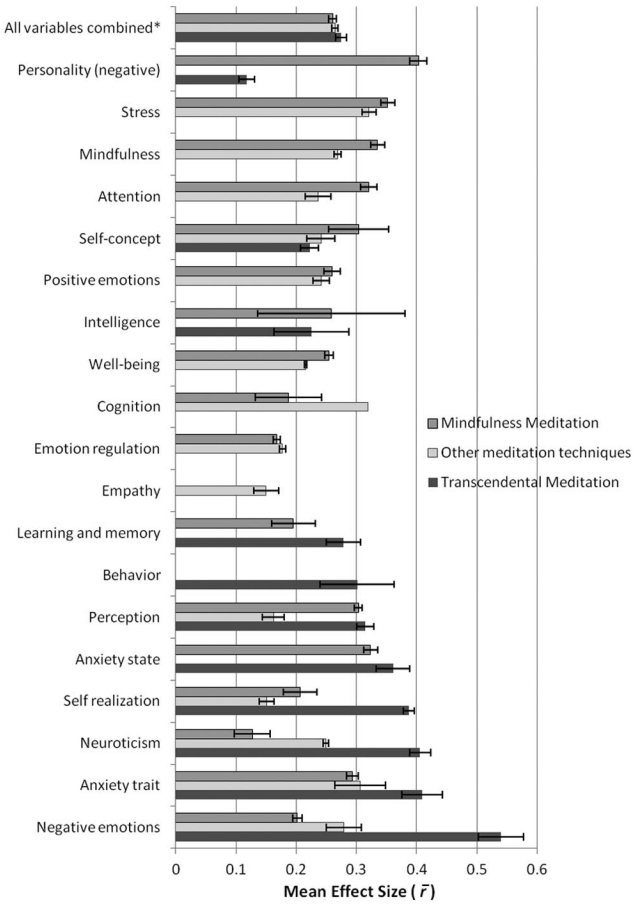

Figure 9. Differential effects of the kind of meditation for specific categories of dependent measures. Shown are effect sizes ($\bar{r}$) and 95% confidence intervals for all dependent measures that were used in three or more studies. The category "All variables combined" also includes data for variables that were examined in $k < 3$ studies.

Table 3
Rank-Ordered Mean Weighted Effect Sizes ($\bar{r}$), Number of Studies (k), Total Sample Size (N), and the Three Components of Psychometric Meta-Analysis (s_r^2, σ_e^2, and σ_ρ^2) for All Categories of Dependent Variables Used in the Meta-Analysis for Transcendental Meditation

Category	$\bar{r}$	k	N	s_r^2	σ_e^2	σ_ρ^2
Negative emotions	.54	5	357	0.0424	0.0071	0.0352
Anxiety trait	.41	7	328	0.0454	0.0151	0.0303
Neuroticism	.41	9	498	0.0271	0.0129	0.0142
Self-realization	.39	6	279	0.0110	0.0159	**<0**
Anxiety state	.36	4	193	0.0282	0.0160	0.0122
Perception	.31	8	583	0.0209	0.0113	**0.0096**
Behavior	.30	6	398	0.0775	0.0127	0.0648
Learning and memory	.28	5	167	0.0328	0.0263	**0.0065**
Intelligence	.23	6	450	0.0775	0.0122	0.0653
Self-concept	.22	11	548	0.0253	0.0185	**0.0068**
Personality (negative)	.12	5	313	0.0147	0.0158	**<0**
All variables combined*	.27	36	2,247	0.0274	0.0139	0.0135

Note. Included are all results for $k \geq 3$. Estimated population variances for particular categories that are substantially smaller than those for all effects combined (indicating higher homogeneity of results) are printed in bold. The category "All variables combined*" also includes data for variables that were examined in $k < 3$ studies.

due to the small number of studies, these results have to be interpreted with caution.

Discussion

Does meditation work in principle, that is, does it have positive effects? The evidence accumulated in the present meta-analysis yields a clear answer: yes. As for the overall size of the effect, is it practically meaningful? This question is hard to answer, but a comparison with other fields of study might be of some help here. The overall mean effect size Lipsey and Wilson (1993) found in 302 meta-analyses of psychological, educational, and behavioral treatments, including psychotherapy, was $d = 0.50$, and estimates for the population effect of psychotherapy go up to $d = 0.80$ (Wampold, 2001). We reported our results as correlative effect sizes, but if one recalculates them (assuming equal sample sizes for meditation and control groups) in terms of standard deviation units, one obtains $d = 0.58$ for the overall effect ($r = .28$) and $d = 0.56$ for the effect found only in the journal articles ($r = .27$). Even if one takes the results in the dissertations as a lower bound, it still results in $d = 0.45$ ($r = .22$). Thus, the impact of meditation on (healthy) practitioners is quite comparable to the impact of behavioral treatments and psychotherapy on patients.

Unfortunately, as elaborated in the introduction of this article, the current state of theories on meditation does not allow us to derive very specific hypotheses, at least not for most of the dependent measures that have been studied in meditation research so far. However, one can derive the quite global hypothesis that positive effects should be expected on almost all psychological variables used in the current studies. Our results are consistent with such a global prediction.

Even if there are no clear hypotheses about differential effects for different dependent measures, the studies performed to date contain a huge variety of dependent measures, and therefore, we also explored the effects obtained for those variables. The effect size estimates for the 21 categories identified by us revealed a substantial variation across these dependent measures. A first

Table 4
Rank-Ordered Mean Weighted Effect Sizes ($\bar{r}$), Number of Studies (k), Total Sample Size (N), and the Three Components of Psychometric Meta-Analysis (s_r^2, σ_e^2, and σ_ρ^2) for All Categories of Dependent Variables Used in the Meta-Analysis for Mindfulness Meditation

Category	$\bar{r}$	k	N	s_r^2	σ_e^2	σ_ρ^2
Negative personality traits	.40	3	97	0.0127	0.0224	**<0**
Stress	.35	10	419	0.0185	0.0188	**<0**
Mindfulness	.34	16	1,005	0.0249	0.0127	0.0120
Anxiety state	.32	6	200	0.0149	0.0248	**<0**
Attention	.32	14	742	0.0253	0.0155	0.0098
Self-concept	.30	7	208	0.0671	0.0287	0.0383
Perception	.30	3	170	0.0056	0.0148	**<0**
Anxiety trait	.29	11	610	0.0164	0.0153	**0.0010**
Positive emotions	.26	6	299	0.0176	0.0178	**<0**
Intelligence	.26	3	97	0.1079	0.0278	0.0801
Well-being	.25	17	1,067	0.0154	0.0142	**0.0012**
Self-realization	.21	8	285	0.0398	0.0265	0.0133
Negative emotions	.20	8	380	0.0113	0.0198	**<0**
Learning and memory	.20	8	291	0.0521	0.0262	0.0260
Cognition	.19	3	93	0.0488	0.0311	0.0177
Emotion regulation	.17	9	492	0.0095	0.0176	**<0**
Neuroticism	.13	4	175	0.0300	0.0227	0.0074
All variables combined*	.26	46	2,131	0.0219	0.0191	0.0029

Note. Included are all results for $k \geq 3$. Estimated population variances for particular categories that are substantially smaller than those for all effects combined (indicating higher homogeneity of results) are printed in bold. The category "All variables combined*" also includes data for variables that were examined in $k < 3$ studies.

Table 5
Rank-Ordered Mean Weighted Effect Sizes ($\bar{r}$), Number of Studies (k), Total Sample Size (N), and the Three Components of Psychometric Meta-Analysis (s_r^2, σ_e^2, and σ_ρ^2) for All Categories of Dependent Variables Used in the Meta-Analysis for Other Meditation Techniques

Category	$\bar{r}$	k	N	s_r^2	σ_e^2	σ_ρ^2
Anxiety state	.48	2	111	0.0120	0.0109	**0.0011**
Stress	.32	4	197	0.0114	0.0167	**<0**
Cognition	.32	3	305	0.0003	0.0080	**<0**
Anxiety trait	.31	12	958	0.0745	0.0104	0.0641
Negative emotions	.28	8	397	0.0420	0.0175	0.0245
Mindfulness	.27	9	1,874	0.0089	0.0042	**0.0048**
Neuroticism	.27	3	545	0.0038	0.0049	**<0**
Positive emotions	.24	6	313	0.0170	0.0174	**<0**
Self-concept	.24	5	459	0.0268	0.0098	0.0170
Attention	.24	7	473	0.0292	0.0134	0.0157
Well-being	.22	8	807	0.0025	0.0091	**<0**
Emotion regulation	.18	9	456	0.0082	0.0189	**<0**
Perception	.16	4	200	0.0181	0.0194	**<0**
Self-realization	.15	4	208	0.0126	0.0188	**<0**
Empathy	.15	3	164	0.0183	0.0178	**0.0005**
All variables combined*	.26	43	3,784	0.0171	0.0100	0.0071

Note. Included are all results for $k \geq 3$. Estimated population variances for particular categories that are substantially smaller than those for all effects combined (indicating higher homogeneity of results) are printed in bold. The category "All variables combined*" also includes data for variables that were examined in $k < 3$ studies.

tentative interpretation of the results might be that meditation has its largest effects in reducing negative emotions and neuroticism, which might be connected to the surprisingly large effect in the category of interpersonal that relates to relationship issues.

Smaller effects were obtained in measures that express different aspects of cognition. The effects for measures of attention (the two broad categories of attention and mindfulness) were medium sized. This does not provide clear evidence for the hypothesis derived above from some Western theoretical approaches that increases in attentional abilities should have an effect on cognitive processes and this, in turn, should have a beneficial effect on emotions, assuming that effects that come first yield larger effect sizes. Rather, these results might indicate that meditation affects cognitive variables by reducing counterproductive emotions and feelings. Note, however, that differences in effect sizes should not be overinterpreted—small causes sometimes can have huge effects; that is, small changes in cognition might yield huge changes in emotional variables. A further problem connected with such an interpretation is the still rather loose categorization of cognition and emotion, and also attention or mindfulness, that was possible with the present studies. Moreover, for some central concepts, such as mindfulness, the contemporary literature exhibits considerable variance in descriptions and definitions (K. W. Brown et al., 2007).

In sum, two of our main findings are that (a) meditation has a substantial impact on psychological variables, indicated by a medium-sized (e.g., Cohen, 1988) global effect, and (b) its effects might be somewhat stronger for negative emotional than for cognitive variables. Due to the lack of a comprehensive theoretical approach (and results from studies derived therefrom), it is still unclear how meditation works. Might it elicit a relaxation response and therefore be considered another variety of relaxation training, or might it just be cognitive training? Moreover, a closer look at the studies included in the meta-analysis revealed that they differed in many respects that might have affected the results. We first deal with the relaxation explanation and the cognitive-training explanation of meditation and then discuss the effects of all moderator variables that allowed a systematic analysis. This is followed by a discussion of the difficulties meditation research might be especially prone to, and we end the Discussion with theoretical and methodological deliberations in respect to future research.

Is Meditation (Just) a Relaxation Technique or a Cognitive Training?

One suggested hypothesis about how meditation might work is that it yields a relaxation response (e.g., Benson et al., 1974). If this is the case, the effects of meditation should not differ from those of (other) relaxation techniques. Our results contradict such an expectation: When meditation groups were compared to no-treatment groups, the effects of meditation were only slightly larger than when they were compared to relaxation groups. This means that no-treatment controls and relaxation control groups barely differed. Our findings clearly indicate that meditation is not just a relaxation technique, although there might be common elements in the two kinds of techniques. A similar argument holds for the potential commonalities between meditation and the training regimens used in the active control groups in our sample: These training regimens might have more in common with meditation than (pure) relaxation techniques, although also here, meditation yielded more pronounced effects. To find out what the differences are, one needs to compare the effects of meditation on the one side and relaxation or specific cognitive training regimens on the other in a more systematic way.

Other Moderating Influences

To put our results into perspective, we analyzed the impact of all moderator variables that allowed such an analysis. We found that age did not have a systematic impact on the effects of meditation, and it seems that the effects of gender are also negligible if some atypical studies reported in unpublished dissertations and book chapters are excluded from the analysis. In addition, contrary to our expectations, the kind of design also did not seem to make much difference, which might be connected with the noncorrespondence between meditation experience and effect sizes (see below). However, the impact of the other moderator variables warrants more discussion.

Effect of randomization. The lack of difference between the effects obtained in randomized studies and those in nonrandomized ones is somewhat counterintuitive, as one might expect that less control would tend to inflate the effects found (because other factors not controlled for might also have a positive impact on the dependent measures). However, the nonimpact of this aspect of study design is quite common in other fields of research (Matt & Navarro, 1997; Staines & Cleland, 2007). Lipsey and Wilson (1993), for instance, found slightly larger effects for randomized studies, and also in the Grossman et al. (2004) meta-analysis, no difference could be detected. It appears that randomization might be less important than it is usually thought to be, but this might be dependent on how carefully the control group is sampled. It could also be that if the number of quasi experiments is sufficiently high, moderating factors that work in both directions (e.g., increasing vs. decreasing levels of anxiety) might cancel each other out.

Source of data. We looked at the publication outlet (book chapters, journal articles, or unpublished dissertations) as a potential proxy for the quality of the study and for the completeness of the data reported. One might argue that the review process in established journals prevents methodologically less sound studies from being published, whereas there might be a higher chance of getting such a study published in a book chapter. In unpublished dissertations, the methodological quality might also vary to a higher degree than in journal articles, but in dissertations, one usually finds the complete data set, whereas, in journals, the data reported might be partly selected. If such differences did not exist, there would be no differences in effect sizes for these three kinds of publication outlet. We did, however, find such a difference: Effects were largest in book chapters, followed by those in journal articles, and the effects in the unpublished dissertations were the lowest. However, when the effects found in the latter are compared to the effects found in studies in the same time period that used comparable approaches to meditation, the difference ($r_{diff} = .03$) seems to be negligible.

In addition, we also found a difference in the variance of effect sizes: Effect sizes were much more consistent in the journal articles than in the other two publication outlets. Therefore, and also because the number of dissertations was too small to examine effects of potential moderators, we relied exclusively on the articles for all the moderator analyses that are discussed in the following.

Year of publication. We used the year of publication as a potential indicator of changes in methodological quality. If the quality of the methods applied increases over time, one should find increasingly better estimates of population effect sizes. There was indeed some change, but it affected mostly the early period of meditation research in the 1970s. Over the past 2 decades, changes in effect size were marginal. Therefore, it seems that the overall effect found is quite a good estimate of the average population effects produced by meditation.

Kind of meditation. We have already mentioned that it is quite difficult to make clear distinctions between different approaches to meditation.[16] Most approaches include more than one basic technique, but it is possible that some approaches are more effective than others. Indeed, prior research (see the introduction) suggested that, for instance, the effects obtained with TM might be larger than those obtained with other approaches. We looked at this difference in our analysis and at first glance replicated the earlier findings. This can be taken as evidence of the superior effects of TM, but we also pointed out an alternative explanation: We found substantially larger effects for results published in books than for those published in peer-reviewed journals. So if it was the case that the review process in the edited books was less rigorous than that in the journals, the larger effects in the books might be regarded as less reliable than those reported in the journals. If only the journal results are compared, TM does no better than the other approaches. In addition, the funnel plots for the TM studies (for both chapters and articles together—not shown—and for articles alone—see Figure 4) indicate that even these results for TM might be slightly overestimated. So, it seems that the three categories we identified for the sake of comparison, TM, mindfulness meditation, and the heterogeneous category we termed *other meditation techniques,* do not differ in their overall effects.

For most of the specific categories that could be analyzed, we found quite a variation in effects. These results indicate that different approaches to meditation might have differential effects. To date, it is difficult, however, to deduce any consistent differences therefrom.

Meditation experience. We were quite unprepared to find that the length of meditation experience seemingly did not have a monotonously increasing long-term effect. This was true for both the one-shot studies where more or less experienced meditators were compared to a no-treatment control group and for the better controlled studies that looked at differential gains of meditation and control groups. However, in the former group of studies, there was an increasing effect up to 10 years, with the largest gains in the first 4 years, that decreased again after 10 years. A similar pattern, albeit during a much shorter period, was found for the studies in which the changes in a meditation and a control group were compared. Also here, effects increased for the first month and later tended to decrease again.

There are several potential explanations for our findings. First, they might be due to the relatively sparse data for extensive meditation practice and extended meditation training regimens (about 180 months in Figure 5 and about 100 days in Figure 6) that allow outliers to exert strong effects. Second, there might be some upper bound for the positive effects of meditation, as measured by the variables used in the studies, and further practice only keeps practitioners at the levels they achieved early on. It would be interesting, then, to know what happens if meditation practice is diminished or terminated. Do the beneficial effects decrease over time, or will they remain stable? Third, and connected to the last point, total time since the beginning of meditation might be less predictive of effects than the amount of recent meditation (see Chan & Woollacott, 2007), which is usually not reported in studies. Fourth, one might ask what the test results really say about everyday behavior (e.g., Blanton & Jaccard, 2006). Thus, one might want to augment the test results by judgments of meditators themselves and significant others on changes that took place after the practice of meditation. Fifth, our assumption that the context (e.g., the nonmeditative parts of the Eightfold Path) was heeded by the meditators might not hold. If it was not and if context plays an important role, there might be limits to what one can achieve without following moral principles and a certain conduct. Finally, important changes might go totally unnoticed by relying on standard psychometric devices. As meditation practice increases, practitioners are expected to progress more and more in their spirituality and achieve changes in their consciousness. Such changes are not the subject of standard questionnaires on personality traits or emotions. These deliberations are expanded upon below.

Alternative Explanations of Our Findings

In all kinds of empirical research, there usually linger potential alternative explanations for the results obtained. In meditation research, this problem might be seen as especially pronounced. Results may be heavily influenced by factors other than whether participants meditate or not. In the following, we discuss the most important concerns regarding the conclusion that the changes found in our analysis are due to the practice of meditation (and not to alternative explanations).

Experimenter bias. In meditation research, the experimenter might be a member of a particular group and therefore be especially interested in showing that the meditation approach practiced in this group works. This might be true, but there was not enough information given in the current studies to allow us to judge if this had occurred.

Participants' expectations. One will probably not find many participants in meditation research who do not expect to have at least some benefit from practicing meditation. People who are associated with a meditation tradition or a certain teacher or group might be especially prone to want to prove that the approach they have chosen works well. Such an effect should be especially pronounced in measures of a more subjective type (such as measures of felt emotions or measures of well-being), and they should be minimized in more objective measures (such as behavioral measures or measures of attention). However, our results do not show such a pattern. Although some of the highest overall effects were obtained in measures of emotions, more objective measures of perception and attention also scored relatively high in comparison to other subjective measures, such as well-being and negative personality traits (see Figure 7). If the different kinds of meditation are compared, differences between more subjective and more

[16] Some studies (e.g., those using MBSR and a few others) also included bodily exercises that might have influenced the outcomes. Some differences between MBSR studies and other studies grouped into the category Mindfulness Meditation are described in Eberth and Sedlmeier (in press).

objective measures are even less pronounced (see Figure 9). Thus, it appears that participants' expectations might not have played a prominent role in the studies included in our meta-analysis.

Cognitive dissonance effects. If meditators have spent a good deal of their life practicing a certain kind of meditation and if they are confronted with (self-perceived) evidence that they did not make progress, the resulting cognitive dissonance might be very likely solved by noticing positive effects all the same. Here, the same argument holds as in the case of participants' expectations. One should find clear differences between measures that can be manipulated easily (e.g., ratings of anxiety) and those that cannot (e.g., reaction times). We did not find such systematic pronounced differences.

Placebo effects. What if meditation is a placebo? Often placebos have strong immediate effects that come down to baseline after some time. Could the time course found for the effects in our studies be interpreted in such a way? We do not think so, for two reasons. First, there was still improvement after the initial few sessions, and second, on average, effects never went down to baseline. One cannot, however, exclude some placebo effects in meditation (just as such effects cannot be excluded in research on medication and psychotherapy—see Wampold, Minami, Tierney, Baskin, & Bhati, 2005).

Personal relationship effects. In meditation courses, participants might have an especially positive relationship with their instructor, and this might influence their ratings. Again, one would probably expect systematically stronger effects in more subjective measures than in more objective ones, which we did not find. We cannot, however, on the basis of the information given, exclude the possibility of such an effect.

Theories of Meditation: How Far Are We?

In the introduction, we presented Indian and Western theoretical approaches to explaining the effect of meditation. There, we confined our discussion of the Indian approaches to those that fit the kinds of studies included in our meta-analysis. Basically, we derived a relatively unspecific prediction, saying that with more-or-less healthy (nonclinical) practitioners of meditation, one might (on average) expect generally positive effects of meditation on measures that have a clear positive–negative dimension. Our results are consistent with this general prediction. They are not particularly spectacular, but as they stand, they could be used as support for both Hindu and Buddhist approaches. We also mentioned that these approaches contain other predictions that were not applicable to the studies at hand, which in any case had largely been conducted in a rather atheoretical manner. Below, we add one more prediction that can be derived from the Indian approaches. The Western approaches, both the more comprehensive one on mental balance by Wallace and Shapiro (2006) and the more specific ones that center around the concepts of attention and shift of perspectives, were not really tested in the current studies, but the results (especially those obtained in the studies labeled *mindfulness meditation*) can be considered consistent with the predictions of the mental balance approach. We first expand on the Indian approaches and then discuss implications of the Western theoretical approaches.

Indian approaches. Hindu and Buddhist approaches have many similarities, but they also differ in many respects. We first outline one more rather general prediction that the two approaches largely share and then discuss the issue of specific predictions.

General predictions. In the introduction, we derived one general prediction for beginning and intermediate practitioners of meditation from both the Hindu and Buddhist approaches (meditation yields generally positive psychological effects), but we did not deal with predictions that refer to advanced or final stages in the meditation practice. Here is such a prediction. Both Hindu and Buddhist approaches hold that practitioners of meditation might develop a kind of supercognition, special abilities (*siddhis*) that exceed our normal abilities. Buddhist theory predicts that six kinds of siddhis might arise (e.g., De Silva, 2005, p. 29). Notably, the least spectacular one, destruction of the defiling impulses, is seen as the most significant. The others are psychokinesis, clairaudience, telepathic knowledge, retrocognitive knowledge (memory of previous lives—no direct perception of the past, only recollection of memories), and clairvoyance. The Yoga Sutras report more of these siddhis as a result of extended yoga practice. In both the Hindu and Buddhist approaches, siddhis are not regarded as very important, and the Buddha, as well as famous yogis, has warned of the dangers inherent in the siddhis (Braud, 2008; De Silva, 2005). Nonetheless, a theory about the effects of meditation would not be complete without consideration of these altered states of consciousness. There is some evidence that such states can occur spontaneously (Barušs, 2003; Cardena, Lynn, & Krippner, 2000), but the effects found in meta-analyses are usually quite small (Storm, Tressoldi, & Di Risio, 2010; Utts, 1996). To the best of our knowledge, nobody has yet examined whether the respective effects are more pronounced for experienced practitioners of meditation, as both the Hindu and Buddhist approaches would predict.

Specific predictions. As already mentioned in the introduction, there are many different Hindu as well as Buddhist approaches, and we concentrated on the commonalities because there would have been no data to support more specific hypotheses. To date, most psychological theories for the more specific approaches are far from precise, but some predictions are possible (see Sedlmeier, 2011), such as the predictions about lawful progression in the stages of meditation (*dhyāna* states) of Theravada Buddhism (e.g., Harvey, 2004, p. 251). Similarly, predictions can be derived for other Buddhist and Hindu approaches. A recent example of an even more specific prediction comparing two kinds of Buddhist meditation approaches can be found in Kozhevnikov, Louchakova, Josipovic, and Motes (2009). Such predictions are mostly confined to highly selected groups of practitioners. Because many of the original texts are quite cryptic, additional interpretations may be necessary, and different (maybe even contradictory) testable predictions may be the outcome. However, making the more specific approaches, both Hindu and Buddhist, more precise and testing the predictions derived with the respective practitioners are a most promising research strategy.

Western approaches. The Western theoretical approaches to meditation are generally less concerned with enlightenment than with well-being. We discussed two such approaches in the introduction. For the more comprehensive approach of Wallace and Shapiro (2006), there already exists empirical evidence regarding their four components (mental balances), but the authors also pointed out many open questions and concluded that "precise working definitions of hypotheses and constructs must be established" and "reliable and valid methods of measurement need to be

developed" (p. 699). The mental balances model could be a good starting point for achieving this aim.

A different way to think about more specific theories could be to take a more technical approach that identifies the components of the main meditative approaches and derives predictions from different combinations of these components. A promising starting point in this endeavor could be to isolate different kinds of attentional training and to examine their impact by suitable measures (see MacLean et al., 2010, for a recent example of such an approach). Our results hint at contingencies among attentional, emotional, and cognitive variables. To understand such possible contingencies better, it is necessary to first construct testable models of these contingences and then to test them against each other. Do the effects of meditation differ dependent on whether the context (e.g., the moral rules and the way to lead one's life) is heeded? Do the effects of some kinds of meditation differ dependent on whether they are combined or not combined with breathing exercises? One might also want to find out whether a given approach suits a given person and whether the exercises meditators practice are adapted to the meditators' expertise and needs. Such an approach, which might involve phases of trial and error, could be especially relevant in a clinical context, where there is more interest in specific (and quick) effects than in self-actualization. To test such specific hypotheses, single-case experimental designs (e.g., Barlow, Nock, & Hersen, 2009) appear to be more promising than conventional group comparisons.

How might we proceed? We believe that the highest barrier for true advancement in meditation research has been the lack of precise theories (see also Shear, 2006a). To overcome the problem, it is probably a good idea to first screen all available theoretical bases for such a theory. Because the practice of meditation has been closely connected with Indian theoretical approaches for millennia, we believe every effort should be made to extract precise psychological theories that are relevant for meditation from both the Hindu and Buddhist approaches. This should be possible despite the amalgamation of these theories with religious issues. In addition, researchers should be developing theories that make connections between Western and Eastern psychological approaches as the basis for deriving precise predictions instead of continuing the prevalent practice of trying to determine if meditation works. A central issue in testing these more precise theories is that of measurement.

Measurement of Meditation Effects

The methodological quality of the studies we examined was, to say the least, quite varied. Recall that we had to eliminate the majority of the initially identified studies because their designs did not conform to minimal standards of internal validity and/or the information given did not allow us to calculate effect sizes. Apparently, as also can be seen from the variety of publication outlets, there is (as yet) no unified community for meditation research; rather, contributions come from all kinds of interested researchers with quite different backgrounds. Yet, apart from general methodological deficiencies, one central methodological problem in meditation research concerns measurement.

Almost all the studies that went into the meta-analysis used conventional questionnaires and tests that were not specifically developed for meditation research. Even the self-actualizing person figuring prominently in Shostrom's (1966) Personal Orientation Inventory, which was used as the main measure of self-actualization (as seen in Western context), might not fully fit with the predictions contained in theories about meditation. The final aim of meditation seems to be quite comparable across the Indian approaches (see the introduction), but predictions for what should happen over an intermediate period of practice seem to diverge (Sedlmeier, 2011; Shear, 2006a). Many of those predictions concern transformed states of consciousness, including extrasensory perception phenomena (see above), which obviously are way out of reach of standard questionnaires. Thus, the missing effect of meditation experience discussed above might be due to not having measured progress in the areas where progress should be found. However, although some of the approaches make some precise predictions, the theories are in general rather weakly specified. More specific predictions are absolutely necessary for making more precise measurements. Even if the predictions were more precise, methods such as those used in the current studies might not be suitable to measure the postulated effects.

These methods (such as the questionnaires used in most of the present studies) that follow the ideal of measurement in the natural sciences are sometimes referred to as third-person methods because, in principle, any (third) person can perform the measurement (third person is seen in contrast to first person, i.e., the meditator him- or herself, or second person, who is related to the first person in a special way). However, if the predictions, say, about experiences in different states of meditation, are to be measured by interpreting the meditator's utterances, an arbitrary third person will not do. There are at least three reasons for this. First, it is not possible to devise a general fixed procedure of interrogation as would be required for a third-person approach. Second, important information might not be disclosed if there is not good rapport between the persons involved in this kind of research (see also Vermersch, 1999). Third, the meditator's utterances might not be understandable to an arbitrary third person because this person might lack adequate knowledge to interpret them. To overcome these problems, the first person could do the work him- or herself. This, however, raises serious issues of reliability. Moreover, for individuals who are not really well trained in introspection, simply directing their attention to their own mental states will usually change these states (Vermersch, 1999). Therefore, second-person methods might be most fruitful in further meditation research. These methods require a second person who is both knowledgeable in the subject matter and well trained in a suitable method of eliciting valid introspection from the meditator (e.g., Varela & Shear, 1999; Velmans, 2001).

However, even if one is interested in meditation not so much as a means for transformed consciousness but instead as a means for self-regulation, methods of measurement need to be improved. For instance, in the clinical context, many of the measurement devices used in the present collection of studies will be very relevant, but new psychometrically sound assessment measures that are more closely connected to existing predictions also need to be developed (Wallace & Shapiro, 2006). If more precise predictions can be derived, one might be able to custom-tailor corresponding methods of measurement.

Conclusion

We began by arguing that meditation may serve two different purposes that might often be intermixed: as a means for psychotherapy or/and for personal and spiritual advancement. Yet the boundary between these two purposes is not clear-cut, and we feel that it is perfectly all right to use meditation whenever it might have benefits.

The present article is only a first step in exploring the effects of meditation. Indeed, its specific effects are not fully clear, and even less so are the mechanisms that yield the effects. We believe that apart from a need to improve the methodological skills of many in the field, the two issues of theorizing and measurement are most important and warrant researchers' attention. Advancement in both might turn out to be quite difficult, but the potential fruits of this research make the endeavor worthwhile. The effects found in the current analyses show that meditation affects people in important ways. It now remains to be discovered what exactly the effects are, when and why they occur, how they relate to what we already know in psychology, and what we might learn from them to augment and enrich current psychological theories.

References

References marked with an asterisk indicate studies included in the meta-analysis. Among the references in the meta-analysis, those marked with a dagger (†) indicate studies that exclusively compared a meditation group against a relaxation group, those marked with a double dagger (‡) indicate studies that included both a no-treatment control and a relaxation control group, those marked with a double prime (″) indicate studies that used an active-treatment control group only, and those marked with an overline (¯) indicate studies that used both an active-treatment group and a no-treatment control group.

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