# Meditation and De-Automatization

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Psychological interest in meditation played a key role in the "consciousness revolution" in psychology. Although the Abrahamic religions have their own meditative and mystical traditions (e.g., the Kabbalah of Hasidic Judaism; the contemplative prayer exemplified by Catholic mysticism; and the "Whirling Dervishes" of Sufism), most attention has focused on Eastern religions, particularly the Vedic-Hindu practice of yoga and Zen Buddhism. This emphasis may reflect a degree of "Orientalism" (Said, 1978) on the part of psychologists; but it also has to do with the emphasis of both Yoga and Zen on cognitive changes ostensibly brought about by meditative practice.

In America, Yoga was of interest to the 19th-century Transcendentalists: Thoreau, for one, practiced the discipline while living at Walden Pond. The official introduction of Eastern forms of meditation occurred at the Parliament of World Religions held in conjunction with the 1893 Columbian Exposition and World's Fair in Chicago. Thereafter, both Yoga and Zen were absorbed into American culture -- in the process gradually becoming secularized (dissociated from their religious and philosophical origins) and commodified (taught for a fee). Yoga was popularized by the Maharishi Mahesh Yogi (and the Beatles) as Transcendental Meditation (Orme-Johnson, Alexander, & Davies, 1990), and later brought into the clinic as the Relaxation Response (Benson, Beary, & Carol, 1974); it also became such a popular form of physical exercise that yoga studios now proliferate across the country. Zen meditation, initially popularized by D.T. Suzuki (1934/1948), Alan Watts (1957), and members of the "Beat Generation" (Ginsberg, 2017), formed the basis of Mindfulness-Based Stress Reduction (MBSR; Kabat-Zinn, 2003).

The emergence of Tenzin Gyatso, the XIVth Dalai Lama, as a Western cultural icon, as well as the introduction of Positive Psychology (Seligman & Csikszentmihalyi, 2000; Snyder et al., 2002), spurred interest in Tibetan Buddhism and its practice of "non-referential compassion". Whereas other popular forms of meditation emphasize cognitive changes, the goal of non-referential compassion is to achieve an objectless emotional state of "lovingkindness" – albeit one which is not directed toward any specific individual or group (Lutz, Dunne, & Davidson, 2007). A religious leader with a keen interest in science, the Dalai Lama has vigorously supported psychological and neuroscientific research on meditation, and many meditation researchers have been influenced by Tibetan doctrines and practices.

This is not the place for a discussion of doctrinal distinctions among different religious sects – Raja vs. Hatha Yoga, for example, Zen or Tibetan Buddhism, or Rinzai vs. Soto Zen. In general, the spiritual goal of Yoga is *Samadhi* – controlling and suppressing mental activity, ending one's attachment to material objects, and abolishing the distinction between the meditator and the object of the meditation. Likewise, the goal of Zen is *Satori* or *Nirvana* -- a sudden breakthrough in the boundaries of logical thought that is unexplainable, indescribable, and unintelligible to reason and logic. In *The Cloud of Unknowing*, the goal of contemplation is to achieve union with God by putting all thoughts except the love of God under a "Cloud of Forgetting". In the secular tradition of mindfulness meditation, a secular offshoot of Zen, the goal is to achieve a “beginner’s mind” that is alert to the here-and-now, characterized by non-elaborative and non-judgmental awareness.

## A Provisional Taxonomy of Meditation

Based on his reading of classical Vedic and Buddhist texts and accounts of Christian mysticism, Deikman (1966, 2000) proposed that meditative states came in two broad forms: sensate, in which there is an intensification of perceptual, cognitive, or motor activity; and transcendent, in which there is a suspension of mental activity, or an “emptying of the mind”. Whatever the category, Deikman proposed that the various meditative traditions typically involve the twin disciplines of contemplation and renunciation. C*ontemplation* is the nonanalytic apprehension of objects and ideas, which banishes discursive thought and empties the mind of everything but one percept. *Renunciation*, in turn, is a shift from "doing" to "allowing", which eliminates worldly goals and pleasures that might distract the practitioner from contemplation. Both contemplation and renunciation are woven into a *psychosocial system* -- the theology, philosophy, or "culture" of Yoga, or Zen, etc., or even the affiliation with a particular master or guru -- intended to support the desired cognitive changes.

Deikman’s two types of meditation seem similar to two categories familiar in the more recent literature: Focused Attention (FA), also known as One Point (OP) meditation; and Open Monitoring (OM), also known as Open Source (OS). In FA, attention is focused on a single object, such as an external stimulus, an image or thought, or one's breathing, while avoiding distractions or drowsiness. In OM, the meditator may concentrate on some object or experience, but not on its “accidental” or contingent features; in this way, the goal of the meditation is to focus on subjectivity, dissolving the distinction between subject and object and achieving awareness of awareness itself. In some respects, OM is a further development of FA, and many meditators practice both forms in sequence. Reflecting the specific influence of Tibetan Buddhism, a third category of meditation, Non-Referential Compassion Meditation (CM), is intended to produce generalized feelings of “lovingkindness”. As in OM, CM is not directed toward any particular object, person, or group.

Based on both experimental research and personal experience with meditation, Lutz et al. (2015) have offered a 3-dimensional matrix for classifying various forms of meditation and related experiences (including mind-wandering). Lutz et al.'s cube resembles Hobson's (1992) AIM mode of sleep and dreaming, with different axes. There are three independent **primary dimensions** targeted by all "mindfulness practices", such as meditation: **Object Orientation** refers to whether the person's attention is focused on one particular thing, as is typical of meditation, or whether it wanders, such as in daydreaming or mind-wandering; **Dereification**, interpreting percepts and thoughts as mental states, and not as representations of objective reality; and **Meta-Awareness**, turning attention inward toward one's own mental processes. In principle, any form of meditation can be represented as a point in this three-dimensional space. Further differentiation is provided by four **secondary qualities**, more or less independent of the primary qualities: Aperture, or the breadth of the attentional spotlight; clarity, or vividness; stability, or the extent to which an experience persists over time;

and the amount extent of effort required to attain and sustain the state. The point of all of this is that there are lots of different kinds of "meditation". When we try to bring meditation into the laboratory, to study is scientifically, it's important to be clear about what kind of meditation we are studying. Yoga practiced to achieve *samadhi* may be quite different in its effects than yoga practiced to achieve six-pack abs. Contemplating a Zen koan may have quite different effects than contemplating the suffering of the world.

> **A Digression on Christian Prayer.** As noted earlier, meditation within the Abrahamic traditions has not been subject to much scientific research. One exception is Luhrmann’s (2012, 2020) participant-observation study of a particular Evangelical church known as the Vineyard Christian Fellowship, whose members engage in a disciplined form of prayer, acquired through training -- much like a yoga or Zen master -- in which they not only talk to God, but God talks back, to them, personally. From a materialist perspective, of course, this is all a product of imagination. But, Luhrmann argues, it is imagination of a very special sort, similar to absorption (Tellegen & Atkinson, 1974), in which the person comes "to treat the what the mind imagines as more real than the world one knows". Luhrmann argues that members of the Vineyard, as well as other like-minded and like-practiced evangelicals, have honed absorption into a cognitive skill that is put to the purpose of their religion.
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> Based on her observations, and reading in the Christian mystical tradition, Luhrmann has classified Christian prayer into three main

categories. *Rote prayer*, usually done as part of a ritual, includes saying the Rosary, and reciting the Lord's Prayer. The purpose of *apophatic prayer* more closely resembles Eastern meditation. Its purpose is to quiet the mind, and disengage from thought. This is the form of prayer taught in *The Cloud of Unknowing*, whose anonymous author wrote that "Thought cannot comprehend God. And so, I prefer to abandon all I can know, choosing rather to love Him whom I cannot know". A special form of apophatic prayer, in Luhrmann's analysis, is *glossolalia*, or speaking in tongues. *Kataphatic prayer* involves becoming absorbed in ideas and images derived from Holy Scripture., such as found in religious icons, stained-glass windows, statuary, and other objects (in the Roman Catholic tradition, a crucifix; in Protestant denominations, a simple cross). In some respects, apophatic and kataphatic prayer resemble Eastern meditative traditions.

## Deikman's Analysis of Meditative States

The object of the meditative exercise, according to Deikman, is to shift from an *action mode* entailing the manipulation of the environment to a *receptive mode* of passive experience -- from *doing things* to *letting things be*. The action mode entails the active manipulation of the environment, increased muscle tension, focalized attention, logical thought, and firm ego boundaries. The receptive mode, by contrast, entails the passive experience of the environment, decreased muscle tension, diffuse attention, "alogical" (but not necessarily *illogical* or *irrational*) thought, and a merging of the self with the objects of perception. Deikman (1966) summarized the features of the mystical experience induced by meditation as single word: *de-automatization*: a re-organization of cognitive structures, which usually operate automatically, so that the meditator looks at the self and the world in new ways.

Deikman borrowed the concept of de-automatization from the tradition of psychoanalytic ego-psychology. In a description of motor skill learning that anticipated the work of Fitts and Posner (Anderson, 1982, 1981; Fitts & Posner, 1967), Hartmann (1958pp. 88-91) wrote that “in well-established achievements [motor apparatuses] function automatically…. With increasing exercise of the action the intermediate steps disappear from consciousness…. [N]ot only motor behavior but perception and thinking, too, show automatization…”. On the other hand, Gill and Brenman (1959, p. 178) defined *de-automatization* as “an undoing of the automatizations of apparatuses – both means and goal structures – directed toward the environment. De-automatization is, as it were, a shake-up which can be followed by an advance or a retreat in the level of organization…. Some manipulation of the attention directed toward the functioning of an apparatus is necessary if it is to be de-automatized”. For Deikman, “de-automatization may be conceptualized as the undoing of automatization, presumably by *reinvesting actions and percepts with attention* (p. 329, emphasis original).

To give some sense of what Deikman had in mind, consider two early psychophysiological studies of the EEG in novice and experienced Yoga and Zen meditators . Both studies found a high density of alpha activity (8-12 hz) in both novice and experienced practitioners, leading some proponents to argue that learning to produce high levels of alpha activity could in and of itself induce a meditative state (for a critique, see Plotkin, 1979). In the yoga experiment, Anand et al. (1961, not cited by Deikman) found that two experienced yogis showed no evidence of alpha blocking – an automatic, reflexive orienting response in which alpha activity disappears when the subject orients to a novel stimulus. The abolition of the blocking response was interpreted as consistent with the goal of yoga meditation, *samadhi*, which is to become oblivious to environmental stimuli. In the Zen experiment, Kasamatsu & Hirai (1966, actually cited by Deikman) studied Zen masters and students, all of whom were practicing the classic *zazen* form of meditation. In contrast to yoga, however, they observed that alpha blocking to the novel stimulus was not abolished; furthermore, blocking did not habituate with continued presentations of the stimulus. The persistence of blocking, and the abolition of habituation, was interpreted as consistent with the goal of Zen meditation, *satori*, which is to free the mind from preconceptions and be attuned to each new experience as it presents itself.

Unfortunately, the findings with respect to alpha blocking were not confirmed in a replication attempt by Becker and Shapiro (1981) with practitioners of Yoga, TM, and Zen, as well as control groups of nonmeditators who were instructed either to attend to or ignore the stimuli. Although the five groups all showed an increase in alpha activity, (for reviews, see Cahn & Polich, 2006; Plotkin, 1976, 1979), none of the meditation groups showed any particular effect on alpha blocking or on habituation.

## Automaticity, De-Automatization, and the Stroop Task

De-automatization implies the undoing of automatization. Although terms like *automatic* and *automatism* had been in use since the 19th century (Taylor, 1983, 1996), modern cognitive psychology did not adopt a technical distinction between automatic and controlled processes until the mid-to-late 1970s (for overviews, see De Neys, 2023; Kihlstrom, 2008; Moors, 2016). In principle, automatic processes display four characteristic features: (1) inevitable evocation by the appearance of a critical stimulus; (2) incorrigible completion such that, once started, the process runs off in a ballistic fashion and cannot be stopped; (3) efficient execution, meaning that the process consumes no (or very few) cognitive resources; and (4) parallel processing, leading to a absence (or at least diminution) of interference among simultaneous tasks. These features lie on continua, and they do not necessarily co-occur, but taken together they constitute a prototype of automaticity: the more of them that are present, to the extent that they are present, the more likely that the process is performed automatically. Automatic processes are unconscious, in the sense that they are executed outside phenomenal awareness and voluntary control (Kihlstrom, 2012). Some processes may be innately automatic, but for the most part, they are automatized through extensive practice.

Until recently, most theorists have shared the tacit assumption that automatization is permanent – much like riding a bicycle. However, Deikman proposed that automatization could be reversed -- “unringing the bell” as it were. However, the evidence he offered was informal, observational, and anecdotal. The formal distinction between automatic and controlled processes, as well as the development of methods to identify the occurrence (and thus modulation) of automaticity, makes it possible to test Deikman’s hypothesis under laboratory conditions.

In principle, every task reflects a combination of automatic and controlled processing (Jacoby, 1991), but the Stroop Color-Word Task has emerged as the benchmark example of automatic processing (MacLeod, 1991). The typical Stroop task consists of four phases. In the first, subjects are presented with a series of color words printed in black ink, and are asked to read the words aloud as fast as they can. In the second phase, they see meaningless string of letters, such as **XXXXX**, printed in different color inks, and are asked to name the color in which they are printed. In the third, the letter strings are color words, printed in the same color as they designate. In the third, the color names are printed in a different color. Compared to the control conditions, subjects in the same-color condition show a decrease in naming speed and errors, a phenomenon called Stroop facilitation. Those in the different-color condition show an increase in naming speed and errors, known as Stroop interference. The general idea is that even though they are instructed only to name the colors, skilled readers cannot help but decode the meanings of familiar words automatically. Because we have only a single vocal apparatus, generating interference with the task of color naming. If de-automatization occurs as a result of meditation, at the very least we should expect it to reduce if not eliminate Stroop interference (Kihlstrom, 2011).

The Stroop task comes in many alternate forms, including acoustic (Shor, 1975), spatial (Viviani, Visalli, Finos, Vallesi, & Ambrosini, 2024), number (Besner & Coltheart, 1979), and emotional or affective (Williams, Mathews, & MacLeod, 1996). Almost all of the research on meditation has employed the original color-word version: a standardized edition, with adult and child norms, has been published by Stoelting (Golden & Freshwater, 2002). There are also many different ways to evaluate Stroop interference – in terms of reading time, number of items read,  or number of errors, depending on precisely which control conditions are considered.

Most of the meditation research covered in this article involves between-subjects designs in which Stroop interference is compared between meditators with various levels of experience are compared to a control group that does not practice meditation at all.  For example, Chan and Woollacott (2007) recruited subjects routinely practicing either "concentrative" (e.g., TM) and "opening-up" (e.g., Vipassana Buddhist) meditation for periods varying from six to 150 minutes per day.  Compared to a control group of non-meditators similar in gender, age, and education level, the meditators showed a significant reduction in Stroop interference.  There was no difference between the two types of meditators.  Moreover, the reduction in Stroop interference was correlated with the amount of time spent meditating per day.

As another example, Moore and Malinowski (2009) tested a group of meditators enrolled in an intermediate-level class in Buddhist (mindfulness) meditation, and found reduced Strop interference compared to non-meditating controls.  The extent of reduction was generally correlated with the subjects' scores on the Kentucky Inventory of Mindfulness Skills (R. A. Baer, Smith, & Allen, 2004), a self-report measure of mindfulness.

Between-group designs comparing meditators and nonmeditators, including pre-post comparisons of performance before and after meditating (or engaging in some control manipulation) have the advantage that their subjects, typically, are experienced, dedicated meditators.  But they have the disadvantage that the experimental and control groups may not be closely equated on relevant confounding variables – the so-called “third-variable problem” (Stanovich, 1992). For example, individuals who choose to enter a demanding meditation program, often with a spiritual orientation (e.g., towards Buddhism), may be cognitively predisposed to de-automatization before they even enter a meditation program. Of course, random assignment to experimental and control groups, as in the randomized clinical trials (RCT) familiar from medical research, allows more confident inferences about causality. The downside of RCTs, in the current context, is that subjects randomly assigned to a meditation group may not be as motivated to participate in the program as true devotees on a spiritual quest. There is a story, perhaps apocryphal, of an undergraduate who, having digested a lecture about the virtues of random assignment, proposed a study of sex differences in which subjects were to be randomly assigned to gender. Similar problems may attend randomly assigning subjects to practice Hatha Yoga or Zen meditation.

Still, such a design may be especially appropriate in studies of secular variants of meditation. For example, Wenk-Sormaz (2006) found that 15 minutes of (secular) breathing meditation reduced Stroop interference but had no significant effect on Stroop facilitation. Similarly, Fan et al. (2014) randomly assigned Chinese college students to 2-1/2 hours of Integrated Mind-Body Training (IMBT) spread out over 5 days, a program similar to MBSR. Compared to a control group who received relaxation training, the meditation group showed a significant reduction of interference on a Chinese version of the Stroop task. Fan et al. (2015) confirmed this observation in a later study comparing 5 hours of IBMT, compared with relaxation controls. They also observed changes in EEG event-related potentials.

Table 1 provides a brief characterization of articles (not including unpublished dissertations) published before July 1, 2024 identified through a search of the PsychInfo database for articles in which both *meditation* and *Stroop* occurred in either the title or the abstract (2020).

**De-Automatization and Two Systems of Attention**

Although the Stroop task is the classic example of automatic processing, other laboratory paradigms also bear on the question of de-automatization (for examples, see Paap et al., 2020). Many of these employ variants or elaborations on the Flanker Task (FT; Eriksen & Eriksen, 1974), in which subjects must press a button (right or left) corresponding to the direction in which an arrow (← or →) is pointed. On congruent or compatible trials, the target is surrounded by arrows pointing in the same direction (→ → → → →); on incongruent or incompatible trials, the flanking arrows point in the opposite direction (← ← → ← ←); on neutral trials, the flanking stimuli are irrelevant (-- -- → -- --). The opposite-pointing arrows in the incongruent condition automatically attract attention, and require the subject to ignore the distracting flankers, much as in the Stroop Effect. Andreu et al. (2017), comparing a group of experienced *vipassana* meditators with a control group of athletes, found that the meditators showed a significant reduction in errors on the flanker task. Norris et al. (2018) obtained similar results with naïve subjects randomly assigned to a 10-minute guided meditation tape.

Table 2 provides a brief characterization of articles (not including unpublished dissertations) published before July 1, 2024 identified through a search of the PsychInfo database for articles in which both *meditation* and *flanker* occurred in either the title or the abstract.

In the Attentional Network Test (ANT; J. Fan, McCandliss, Sommer, Raz, & Posner, 2002), the flanker task is combined with other cues which indicate when a trial will begin and where the arrows will appear on the screen.  The ANT allows attention to be decomposed into three components (Posner & Peterson, 1990): alerting and the interruption of ongoing behavior; orienting to and localizing cues; and executive control (itself consisting of three phases: disengaging from the current object of attention, shifting attention elsewhere, and engaging a new object) and conflict-resolution (such as required by the Stroop task).  In theory, each of these components is served by a different module in the attentional network system in the brain.

Tang et al. (2007) found that subjects who received IMBT for 20 minutes per day over 5 days) showed improved scores compared to relaxation controls on the conflict-resolution component of the ANT.  That is, they resolved the conflicts between cues more easily and efficiently, with less expenditure of cognitive effort and resources. Similar results were found by Becerra et al. (2017), with novice mindfulness meditators compared to waitlist controls.  Reflecting on these and similar studies, Tang et al. (2022) argued that the process of training attention – to ignore distractors, for example -- might not always be deliberate and effortful, as had been previously assumed. Instead, they proposed that meditative techniques like IMBT effectively yielded "effortless" training.  Rather, they argued that there is not just one attention system in the brain, as suggested by titles such as "*The* Attention System of the Human Brain"

(Peterson & Posner, 2012, emphasis added), but at least two. Whereas the effortful training of attention is supported by frontoparietal regions of the brain, neuroimaging studies indicate that effortless attention involves the anterior and posterior cingulate portions of the cortex, as well as the striatum.

The idea of effortless attention training, involving what might be called the "effortless attention system", of the brain, may resolve the paradox of de-automatization. Attention usually entails cognitive effort (Kahneman, 1973), and it ordinarily takes considerable effort to overcome automatic processing as observed in situations such as the Stroop task. In much the same way, it may require a considerable amount of substitute one automatic process for another (Glaser & Kihlstrom, 2005). The opposite of automatic processing is effortful processing, but the outcome of de-automatization is not a resumption of effortful attentional activity. *Effortless attention training* is something of a misnomer because, as Deikman's analysis makes clear, meditation training is work; it takes disciplined concentration and renunciation. But the apparent result of meditation training is that attentional control is experienced as effortless.

Table 3 provides a brief characterization of articles (not including unpublished dissertations) published before July 1, 2024 identified through a search of the PsychInfo database for articles in which both *meditation* and *Attention Network Test* occurred in either the title or the abstract.

**Habit and Reflex**

Another way to think of automaticity is in terms of habit. In his chapter on "Habit" in the *Principles,* James noted that "any sequence of mental action which has been frequently repeated tends to perpetuate itself; so that we find ourselves automatically prompted to *think*, *feel*, or *do* what we have been before accustomed to think, feel, or do, under like circumstances, without any consciously formed *purpose*, or anticipation of results" (1890/1980, p. 113). Modern authorities continue to emphasize the automatic nature of habits, although they concede that habits can be initiated voluntarily as well – as when I routinely choose my car, as opposed to my wife's, to go grocery shopping (e.g., Ouellette & Wood, 1998; Wood, 2024; Wood, Labrecque, Lin, & Runger, 2014; Wood, Mazar, & Neal, 2022; Wood, Quinn, & Kashy, 2002).

Although there is an extensive literature on the problem of inculcating meditation as a habit (e.g., Miles, Matcham, Strauss, & Cavanagh, 2023), research on the effects of motivation *on* habits is more sparse. One early study found that TM was no more effective than a support group in treating smoking (Ottens, 1975); but then again, smoking is more of an addiction than a habit.

One linguistic habit is represented by performance on various word-production tasks, such as word-association, category-generation, and stem-completion. When presented with a cue such as *dog* and asked to respond with the first word that comes to mind, a typical subject will respond with *cat* as opposed to *puppy* or *house* (Palermo & Jenkins, 1964); when presented with a cue such as *four-footed animal* the vast majority of subjects will respond with *dog* or *cat* as opposed to *tiger* or *cow* (Battig & Montague, 1969); given the word-stem *cha*___, subjects are more likely to generate *chair* or *chase* than *chain* or *chart* (Graf & Williams, 1987). These sorts of norms reflect widely shared cognitive habits, raising the question of whether meditation can free people from making the dominant response on such tasks.

Wenk-Sormaz (2006) gave her subjects a category-generation test under two conditions. When instructed to give “typical” instances, subjects who had just completed a 15-minute breathing meditation performed no differently than relaxation controls. However, when asked to give “atypical” instances, their responses scored significantly lower in normative frequency. It would be interesting to explore how meditators perform on this and other word-production tasks when given no instructions, or following more extensive meditation experience. Still, this study illustrates the kind of experiment that could be done to explore the undoing, or at least modulation, or automatic, habitual, thoughts.

Most habits are acquired through learning, and strengthened though repetition. However, some investigators have pushed the limits of de-automatization, looking at the effects of meditation on hard-wired, reflexive responses to stimulation, similar to the studies of alpha blocking and habituation described earlier. Inevitably evoked by appropriate stimuli, and executed in the absence of (or even despite) conscious intent, in many ways reflexes are the model for automaticity, and therefore as candidates for de-automatization.

To cite an extreme example, Levenson, Ekman, and Ricard (2012) performed a study of the acoustic startle reflex in which one subject (Ricard himself), an adherent of Tibetan Buddhism with more than 40 years' experience in meditation, was subjected to repeated unannounced bursts of high amplitude white noise (115 db), a sound closely resembling a gunshot.  Pretesting showed that, under ordinary conditions, Ricard's startle response was no different from that of age-matched controls.  While meditating, however, Ricard showed a significantly reduced startle response, measured in terms of both physiological responses and facial expressions, compared to a distraction control condition.  This effect was observed in both FA and OM, although the effect was larger in the latter.

In another study,  Carter et al. (2005), employed a large number of, to explore the effects of meditation on another innate behavior, binocular rivalry (BR).  In the BR paradigm, subjects are presented with different images to each eye -- one a horizontal grating, the other vertical.  Normally, the visual system would fuse the separate 2-dimensional retinal images from each eye into a single 3-dimensional image, but with such radically disparate images this is impossible.  Instead, the subject experiences a random alternation between the images.  This phenomenon occurs automatically – it is caused by an intrinsic feature of the visual system.  But, it turns out, One-Point Meditation, a variant on FA, essentially abolished BR.  During meditation, a majority of Tibetan Buddhist monks and other experienced meditators showed a slowing of the rate of alternation, and some subjects actually experienced a stable image.  Even after the meditation period had ended, half the subjects continued to experience a slower rate of alternation -- though some experienced an even faster rate of alternation – a kind of rebound effect.  Compassion Meditation, by contrast, had no effects at all on BR.  That meditation can modulate something as hired-wired as BR is interesting -- as is the fact that the two types of meditation studied in this experiment led to quite different outcomes.

## Self-Report Measures of De-Automatization

At the other end of the spectrum from neuroelectric and neuroimaging paradigms are self-report questionnaires which are intended to tap subjects' experiences during meditation (R. F. Baer, 2016). For example, the Toronto Mindfulness Scale (TMS) contains scales of Curiosity and De-Centering, the latter of which contains items that seem relevant to de-automatization – e.g., "I was more invested in just watching my experiences as they arose, than in figuring out what they could mean" and "I was more concerned with being open to my experiences than controlling or changing them". In contrast to the "state" measurements of the TMS, the Five-Facet Mindfulness Scale (FFMS), a refinement of the Kentucky Inventory of Mindfulness Skills (KIMS) offers a somewhat more "trait-like" assessment of the consequences of meditative practice. Most of the FFMS items seem geared to stress reduction, as befits an instrument inspired by MBSR, but some of its items do seem to bear on de-automatization, such as "I perceive my feelings and emotions without having to react to them" (scored positively) and "I find myself doing things without paying attention" (scored negatively). Still, it must be stressed that self-report measures of de-automatization are no substitute for actual behavioral measurement such as afforded by the Stroop task or the ANT.

At the other end of the methodological spectrum, it is possible that event-related potentials (ERPs) recorded in the EEG, can serve as measures of automatic responding. ERP components such as N1 (which responds to the onset of a stimulus, P3 (which responds to unexpected or meaningful stimuli), and N4 (which responds to incongruous or anomalous stimuli) may provide additional evidence of de-automatization, along the lines of the studies of alpha-blocking and habituation described earlier.

## Towards Future Research

It should be noted that not every study has found that meditation reduces, much less eliminates, Stroop interference and other forms of automaticity. For example, Alexander et al. (1989) found no difference between meditators and controls in a study of TM in the elderly. Kozasa et al. (2018) tested experienced Buddhist meditators and non-meditator controls before and after both groups participated in an intensive 7-day meditation retreat (*sesshin*), and found no pre-post differences in Stroop interference in either group; nor did the meditators differ from the non-meditators at either point in testing. Paap et al. (2020) found no correlation between extent of meditation experience and either Stroop interference, the flanker effect, or ANT performance in a sample of undergraduates, but it is not clear how many of these subjects, if any, had extensive experience with meditation, or what kind of meditation they practiced.

Still, the bulk of experimental research is consistent with the hypothesis that the practice of meditation leads to de-automatization, in the form of a reduction in Stroop interference. The idea that de-automatization is possible, as indexed by the Stroop task, is supported by evidence from other domains. To take a dramatic example, Raz and his associates (e.g., 2002) found that a posthypnotic suggestion for agnosia or alexia, in which the stimulus words would appear as symbols in an unfamiliar foreign language, completely abolished Stroop interference in highly hypnotizable subjects. Along similar lines, Tang et al. (2009; 2022) have suggested that effortless attention is involved in jazz improvisation and other states of “flow” (see, e.g., Rosen, Oh, Chesebrough, Zhang, & Kounios, 2024), as well as the experience of “awe” induced by exposure to nature.

Still, there is much research left  to be done to explore the details and establish the limits of de-automatization.  For example, while the ANT comes in a standard form, there is wide variability in the particular version of the Stroop test employed across different studies, as well as in the way Stroop interference is scored.  Some investigators employ the full four-phase version described earlier, while others omit one or two phases.  Some investigators quantify Stroop interference in terms of reading errors, others in terms of time to complete the task.   In order to facilitate the comparison of results across laboratories, it would be helpful for different investigators laboratories to employ a standardize the version of the Stroop test itself, as well its scoring (e.g., Golden & Freshwater, 2002).  Investigators should also consider employing variants on the Stroop test, to determine the effects of meditation on automatic processing in auditory, emotional, and other domains.  For example, the effects of FA and OM meditation may affect performance on the standard “color-word” form of the Stroop test, while the effects of non-referential CM may be more apparent on the “emotional” Stroop.

Whether de-automatization is indexed by the Stroop, the ANT, or some other consensual, standardized protocol, some psychologists may wish to use such instruments as manipulation checks prior to searching for the neural substrates of de-automatization or the meditative experience itself, such as the network underlying “effortless attentional control” described earlier.

Research should also clarify any differences in the psychological effects of different meditative traditions -- for example, comparisons of Yoga vs. Buddhist meditation, as in the alpha-blocking studies described earlier; FA or OM vs. CM, probing for differential cognitive and emotional effects; and meditation practiced in the context of a spiritual tradition, such as Buddhism, and expressly secular versions, such as MBSR and IMBT.  The effects of meditation on consciousness may well differ depending on the purpose for which the individual meditates.

There is also the matter of practice.  Meditation, whether in spiritual or secular form, is a discipline, and considerable practice may be required before de-automatization and other effects can be observed (or, for that matter, felt).  Finally, there is the distinction between what might be termed the state vs. trait effects of meditation. While it may be too much to expect even experienced meditators to complete the Stroop task or ANT while they are meditating, it might be the case that such effects might be most apparent immediately after the conclusion of a meditation session, and dissipate slowly or quickly afterward.  Alternatively, meditation may inculcate a general, trait-like cognitive style (such as focused attention or open monitoring) that persists long after any particular meditation session has ended.  Even so, it must be possible to switch this style on and off, depending on the context.  Even the most diligent practitioner of OM needs to go to the drugstore to buy toothpaste.

## Science, Religion, and Meditation

Gould (1997) argued that science and religion constitute “nonoverlapping magisteria”, the former having to do with facts and the latter with values.  Nevertheless, at least since the time of Kepler, Copernicus, and Galileo, science and religion have been engaged in dialogue about both domains.  In the case of psychology, most of this conversation has been one-sided, with psychologists and other cognitive scientists explaining (or explaining away) some aspect of religion or religious behavior.  Research on meditation may reverse the direction of influence, by showing that automaticity can be reversed, and revealing a hitherto unappreciated “effortless” attentional system.  In this way, at least, meditation research can fulfill William James’s hope that the study of religious experience will tell us something about the mind.

**Author Note**

For alternative coverage of the scientific literature on meditation, see (Andresen & Forman, 2000; Fox, Kang, Lifshitz, & Christoff, 2016; Lutz et al., 2007; Sedlmeier et al., 2012; Vervaeke & Ferraro, 2016; Vieten et al., 2018).

An expanded version of this article, with a more complete reference list, is available at https://www.ocf.berkeley.edu/~jfkihlstrom/PDFs/2020s/2024/EncRel_Meditation.pdf.

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