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Review Article

A selective review of *dharana* and *dhyana* in healthy participants

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ABSTRACT

Attention is an important part of the process of meditation. Traditional Yoga texts describe two stages of meditation which follow each other in sequence. These are meditative focusing (*dharana* in *Sanskrit*) and effortless meditation (*dhyana* in *Sanskrit*). This review evaluated eight experimental studies conducted on participants in normal health, who practiced *dharana* and *dhyana*. The studies included evaluation of autonomic and respiratory variables, eLORETA and sLORETA assessments of the EEG, evoked potentials, functional magnetic resonance imaging, cancellation task performance and emotional intelligence. The studies differed in their sample size, design and the method of practicing *dharana* and *dhyana*. These factors have been detailed. The results revealed differences between *dharana* and *dhyana*, which would have been missed if the two stages of meditation had not been studied separately.

1. Introduction

Meditation practiced over a period of time changes perception, attention, and cognition [1]. The practice of meditation helps attain a mental state characterized by deep relaxation along with attention directed inwards [2].

Several studies have reported the effects of practicing meditation in practitioners who were inexperienced as well as those who were experienced [3,4]. Across meditation techniques it was interesting to observe that even though there is a common perception of vagal dominance and reduced arousal during meditation [5]; in different meditation techniques, practitioners of the same technique showed opposite trends of results. This has been detailed below.

The study by Wallace, Benson and Wilson (1971) [3], on 36 volunteers with an average of 29.4 months of experience of Transcendental Meditation (TM), showed that meditation practice was associated with a decrease in oxygen consumption, reduced heart and breath rates, decreased blood lactate levels and an increase in slow alpha and occasional theta in the EEG. Another early study suggested that TM practice was associated with greater autonomic stability based on the rate of GSR habituation, and multiple responses of the GSR as well as spontaneous fluctuations in the GSR [6].

However, a different effect of TM practice was suggested by another early study which reported changes in plasma noradrenaline after TM in long-term meditators (with 2–3 years experience of TM) and advanced meditators (with 4.1 years average experience of TM) [7]. Advanced meditators had higher 24-h urinary catecholamines compared to long term meditators. This is a single study and cannot in isolation be worth considering when questioning whether meditation increases or reduces relaxation.

However, contradictory effects were also reported for the eyes open, Zazen meditation. One report described an increase in heart rate during meditation [8]; while another report on the effects of the same meditation showed a decrease in oxygen consumption [9].

Two contradictory reports were also seen for Ananda Marga meditation which involves concentration and attention directed to an inward or outward focus. In one report, the basal skin conductance level increased during meditation with a trend of increase in heart rate from a mean of 69.4 bpm to 72.8 bpm [10]. Based on this the authors challenged the 'relaxation model of meditation'. This was despite the fact that an earlier published report of the effects of Ananda Marga meditation showed an increase in GSR, a decrease in breath rate and a more stable EEG with increased alpha and theta activity [11].

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Table 1
Description of the studies on *dharana* and *dhyana*.

Sl No	Citation	Sample size	Design	Variables	Results	Cohen's d	Interpretation
1	Telles et al. (2013)	30	Random allocation of participants to four sessions	Heart rate variability, respiration, photo-plethysmogram and skin resistance	During *dhyana* 1. skin resistance level increased 2. photo-plethysmogram amplitude increased 3. heart rate decrease 4. breath rate decreased 5. low frequency power decreased 6. high frequency power increased 7. NN50 count increased 8. pNN50 increased	1. 0.472 2. 0.223 3. 0.502 4. 0.938 5. 0.745 6. −0.733 7. −0.307 8. −0.260	The changes were suggestive of reduced sympathetic activity and/or increased vagal modulation
2	Travis (2011)	26	Random allocation of participants to two groups	Coherence, amplitude and eLORETA, sLORETA EEG analysis	TM-Sidhi practice was characterized by higher frontal alpha1 and beta1 amplitudes, and eLORETA-identified sources of alpha1 EEG in right hemisphere object recognition areas including the right parahippocampus gyrus, right fusiformgyrus, lingual gyrus, and inferior and medial temporal cortices	Alpha 1 (0.937), Beta 1 (0.872)	The observed brain patterns support the descriptions of *sanyama* as including both specificity (sutras or verses), as suggested by higher frontal beta1 EEG amplitude and by eLORETA sources in right-hemisphere object recognition areas, and holistic experience (pure consciousness) as suggested by higher frontal alpha1 EEG amplitude.
3	Kumar et al. (2010)	30	Random allocation of participants to four sessions	Short latency auditory evoked potentials	The peak latency of a component called wave V was significantly increased during *dharana*, random thinking and focusing, but not during *dhyana*	*Dharana* wave V peak latency (−*0.368*), random thinking (−0.343) and focusing (−0.378)	Information transmission along the auditory pathway was delayed during *dharana*, random thinking and focusing but there was no change during *dhyana*
4	Telles et al. (2012)	60	Random allocation of participants to four sessions	Mid-latency auditory evoked potentials	During *dhyana* latencies of the Na and Pa waves were prolonged	Na wave (−0.311) and Pa wave (−0.377)	The auditory transmission at the level of the medial geniculate and primary auditory cortex was delayed during *dhyana*.
5	Telles et al. (2015)	60 (48 final)	Random allocation of participants to four sessions	Long latency auditory evoked potentials	1. Peak latency of the P2 component decreased during and after meditation 2. Peak amplitudes of the P1, P2 and N2 components decreased during random thinking and non meditation focused thinking	1. Dhyana: During (0.614), Post (0.702) 2. Amplitude: random thinking P1 (0.675), P2 (0.656), N2 (0.679); non meditative focused thinking: P1 (0.540), P2 (0.615), N2 (0.561)	*Dhyana* facilitates the processing of auditory information in the auditory association cortex, whereas the number of neurons recruited was less in random thinking and non meditative focused thinking at the level of the secondary auditory cortex, auditory association cortex and anterior cingulated cortex

6	Telles et al. (2015)	26 (10 long term experienced meditators and 16 less experienced meditators)	Block design with random thinking, focusing, *dharana* and *dhyana* in a fixed sequence	Functional brain images	During *dhyana* the experienced meditators alone showed significant activation in the right middle temporal cortex (rMTC), right inferior frontal cortex (rIFC) and left lateral orbital gyrus (LOG)	Not available on the data in the manuscript	These changes suggest that *dhyana* is associated with sustained attention, memory, semantic cognition, creativity and an increased ability to detach mentally.
7	Adhia, Nagendra and Mahadevan (2010)	84 (42 in each group)	Two group study (Yoga group and physical exercise group)	Emotional intelligence, body mass index, blood pressure and blood sugar	Emotional intelligence improved only in the Yoga group	−0.839	The results indicate the importance of Yoga including *dharana* and *dhyana* as an integral element in improving managerial performance in organisations
8	Kumar and Telles (2009)	70 (35 in experimental group and 35 in control group)	Random allocation of participants in the experimental group to four sessions	Six letter cancellation	The net scores on the six-letter cancellation task were significantly higher after a session of *dharana* no significant change after *dhyana*	−0.406	*Dharana* may favorably influence selective attention, concentration, visual scanning abilities, and a repetitive motor response compared to other sessions

Hence these early studies did not support a single model of meditation as increasing arousal or relaxation. A subsequent study which used a self-as-control design, assessed each individual in both meditation and non-meditation sessions, each of which was repeated thrice [12]. Here, differences between subjects and differences in the repeat sessions of an individual were attributed to inherent individual differences between participants. It was considered that this could definitely influence the participant's physical response to Yoga. Another factor which was considered important is the fact that an individual's mental state varies from one day to another, or even within shorter time periods.

A similar trend of differences has been observed in other meditation techniques as well [13]. Despite these differences in reports, and possibly because they belong to the early scientific literature on meditation and were not followed up by further studies, there have been many subsequent reports of the effects of meditation using increasingly complex methods of investigation.

However it was considered worth examining the description of meditation in ancient Yoga texts and understanding whether this description would influence the effects observed experimentally. In particular, in Patanjali's Yoga *sutras*, two stages of meditation have been described, these are *dharana* and *dhyana.* To our knowledge there is no review of those studies which have examined meditation based on the *dharana*–*dhyana* model. This was the purpose of this selective review.

2. Concepts of meditation (*dharana* and *dhyana*) in ancient Yoga texts)

In ancient Yoga texts the way in which attention is engaged is unique [14]. Meditation is not considered to be associated with increased attention or even with awareness of an experience as it happens. In *Patanjali's Yoga Sutras* (*circa* 900 B.C.), two meditative states are described, which are supposed to follow a fixed sequence with one leading to the other [14]. The first state is *dharana* (or focusing with effort), confining the mental processes within a defined, limited area ('*desha-bandhashchittasya dharana*', Patanjali's Yoga *Sutras*, Chapter 3, Verse 1). The next state is *dhyana* or effortless expansion ('*tatra pratyayaikatanata dhyanam*', *Patanjali's Yoga Sutras*, Chapter 3, Verse 2). This state is characterized by the uninterrupted connection between the mind and the object chosen for meditation. The practice of *dharana* is supposed to precede *dhyana*.

Dharana and *dhyana* are the two stages of meditation described in Patanjali's Yoga *Sutras.* In addition to these two mental states, two more mental states when not in meditation have been described in another ancient text (the *Bhagavad Gita*, compiled *circa* 500 B.C.) [15]. The two states are random thinking; *Chancalata* (*Bhagavad Gita*, Chapter 6, Verse 34) and focusing; *Ekagrata* (*Bhagavad Gita*, Chapter 6, Verse 12). If a person chooses to focus their thoughts for meditation, the person would then be able to progress to the next two stages, *dharana* and *dhyana.*

3. Research on *dharana* and *dhyana*

Two databases, PubMed and Google Scholar were searched using the search words '*dharana*' and '*dhyana*. Carrying out the search in just two databases is a limitation of the review. PubMed yielded 8 articles, while from Google Scholar 28 citations were obtained. The search was carried out between January, 2000 and December, 2015.

In order to be included in the review, articles had to meet the following inclusion criteria (i) they had to include experimental data on practitioners of *dharana* and *dhyana* evaluating the two states separately, (ii) participants had to be in normal health, and (iii) the article should have been written in English. Exclusion criteria include (i) Experimental studies which included *dharana* and *dhyana* but were used for therapeutic benefit or in specific physiological conditions such as pregnancy or menopause (5 excluded from Google Scholar citations), (ii) reports which were anecdotal or described the philosophical basis of *dharana* and *dhyana* (1 excluded from PubMed, 12 excluded from the citations in Google Scholar), and (iii) also several citations were excluded which were chapters in books (3 citations in Google Scholar), as the review was intended to cover research articles published in journals.

The search showed that there are several articles which have attempted to understand meditation more thoroughly by understanding the stages of '*dharana*' and '*dhyana*' separately [16].

This review discusses eight articles which met the inclusion and exclusion criteria described above. The studies are summarized in Table 1.

Like most studies on meditation and autonomic variables [17], there is a report of changes in autonomic and respiratory variables during *dharana* and *dhyana* [18]. The participants were thirty healthy male volunteers who were assessed before, during, and after, four mental states (random thinking, focusing, *dharana* on 'OM' and *dhyana*). Participants were randomly allocated to the four sessions which were on four, not necessarily consecutive days. Data were analyzed with repeated measures ANOVA. The changes in electrodermal activity, cutaneous blood flow, heart and breath frequency, and in the HRV (frequency and time domain analysis), suggested lower sympathetic activity and arousal during *dhyana*. The limitations of the study were (i) the absence of a group of non-meditators, and (ii) the participants were all trained to practice the 4 conditions separately, however they may have inadvertently switched from one state to another during a session, despite their self-reports that they did not [19]. It would have been preferable to have four groups separately trained in the four states (random thinking, focusing, *dharana*, and *dhyana*). This would have had practical difficulties as it would be difficult and questionable to train a person in 'random thinking'.

Dharana and *dhyana* states have also been described as part of the Transcendental Meditation (TM) and TM-Sidhi programs [20]. TM practice is a process of systematically transcending the contents of experience to a state of pure consciousness. The TM-Sidhi program in contrast involves the simultaneous processes of *dharana* (fixity), *dhyana* (transcending) and *Samadhi* [21]. A study was carried out using standardized Low Resolution Electromagnetic Tomography (sLORETA) and exact Low Resolution Electromagnetic Tomography (eLORETA) to compare the EEG amplitude and coherence in TM practice and in TM-Sidhi practice.

The 26 participants were experienced in both Transcendental Meditation (TM) (average 25.6 years) and TM-Sidhi (average 19.4 years) methods. Participants were assigned to practice TM only, or TM followed by TM-Sidhi, as TM-Sidhi always follows TM practice. Repeated measures MANOVAs were used to test group differences in amplitude and coherence. TM-Sidhi practice when compared with TM was associated with higher frontal alpha1 and beta1 amplitudes, and eLORETA-identified sources of alpha1 EEG in cortical areas involved in specific/holistic representation of words. The higher frontal alpha1 amplitude was considered to be related to a holistic experience of pure consciousness, along with object recognition (higher beta1); both of which are considered parts of TM-Sidhi.

The study offers an interesting comparison between two well-researched programs, TM and the TM-Sidhi program. One of the limitations is the small sample size (i.e., 26 persons randomized as two groups) and another limitation is that the TM-only group were also trained in the TM-Sidhi program. As in the previous study they may have inadvertently started practicing the TM-Sidhi practice. Despite these limitations, the study did show distinct changes during TM and during the TM-Sidhi program. There was no attempt to assess the *dharana*, *dhyana* and *samadhi* phases of the TM-Sidhi program, separately.

The next three articles which have been reviewed reported changes in short, middle and long latency evoked potentials before, during and after *dharana* and *dhyana* [22,23,26].

Short latency or brainstem auditory evoked potentials were recorded in thirty healthy, male participants [22]. Participants were assigned to *dharana*, *dhyana*, random thinking and focused attention sessions, randomly. As in the study mentioned earlier [18] the sessions were on separate days at the same time of the day. Data were analyzed using repeated measures analysis of variance. The peak latency of a component called wave V (with the neural regulator at the level of the inferior colliculus) was significantly increased during *dharana*, random thinking and focusing, but not during *dhyana*, suggesting an increase in time for sensory information processing during all states except *dhyana*. A limitation specific to this study is that short latency evoked potentials vary with the physical characteristics of the stimulus. The click stimuli were kept at the same intensity (80 dB nHL) for all participants, which may have influenced the results.

Middle latency auditory evoked potentials were assessed in 60 persons, who were randomly assigned to four sessions *dharana*, *dhyana*, random thinking and focusing [23]. As for the two studies cited above [18,22] the allocation to the four sessions was random, with sessions on separate days. Data were analyzed using repeated measures analysis of variance. The latencies of two components (the Na and Pa waves) were prolonged during *dhyana*, suggesting delayed transmission at the level of the medial geniculate (the generator of the Na wave) and primary auditory cortex (corresponding to the Pa wave) [24,25]. The limitations of the study as for earlier studies with a comparable design [18,22], was the absence of a control group.

The advantage of this study is that the neural generators of the middle latency EP components are relatively well worked out [22,23]. Also, the present study had a sample size of 60 which was larger than that of other studies reviewed so far.

Long-latency evoked potentials were recorded before, during and after *dharana*, *dhyana*, random thinking and focusing [26], there were 60 participants, all male, in normal health. None of them had participated in earlier studies on short latency EPs [22] or middle latency EPs [23]. The design however, was similar with participants randomly allocated to *dharana*, *dhyana*, random thinking and focusing sessions. Data were analyzed using repeated measures analysis of variance. The peak latency of the P2 component was significantly decreased during and after *dhyana*. The results were understood to imply that *dhyana* facilitates auditory transmission at the association auditory cortex level, which the P2 component is believed to correspond to. The changes during random thinking and focusing were suggestive of involvement of neurons in underlying generators. As in previous studies [18,22,23] the main limitation of this study was the lack of a control group of non-meditators.

Also for the three studies on short, middle and long latency evoked potentials there was one common limitation; the quality of practice was based on self-reports and recorded on an analog scale, which may not have been entirely reliable.

An attempt was made to localize the areas of activation during *dharana*, *dhyana*, random thinking and focusing using functional magnetic resonance imaging (fMRI) [27]. There were two groups of healthy participants of both genders (i) ten experienced practitioners (average age 37.7 ± 13.4 years; with 6048 h of experience in *dharana* and *dhyana*), and (ii) sixteen less experienced practitioners (average age 25.3 ± 2.3 years; *dharana* and *dhyana* experience of 288 h). During the fMRI recordings participants practiced random thinking, focusing, *dharana* and *dhyana*, for 2 min each in a fixed sequence based on descriptions in traditional Yoga texts [27]. The activation during focusing, *dharana* and *dhyana* were all compared to random thinking using an analysis of variance. During *dhyana*, experienced meditators alone showed significant activation in the right middle temporal cortex, right inferior frontal cortex and left lateral orbital gyrus. Activation in these areas was understood to suggest that *dhyana* is associated with sustained attention, memory, semantic cognition and an increased ability to detach mentally.

The limitations of the study were (i) the fact that the sequence followed a fixed order for all participants, (ii) Also, participants had to switch between one state and another within 2 min. The only way of determining whether participants were able to do so, was their self-report on Visual Analog Scales, without any objective biological markers. A mitigating factor was that participants were trained to practice *dharana* and *dhyana* in a simulated scanner for one month prior to testing. Another limitation of the study is that no comparison was made between the data of experienced meditators compared to less experienced meditators during *dharana* or *dhyana*. However the study shows distinct activation during *dhyana* in specific areas in experienced meditators, which was not seen in those with less experience.

The studies reviewed above, examined the short-term or immediate effect of *dharana* and *dhyana* on a range of variables. A longitudinal study was carried out to identify the impact of Yoga (including *dharana* and *dhyana*) on emotional intelligence in managers [28]. The study was conducted in a manufacturing company in western India; a company which ranks among India's largest private sector companies. The average total work experience of the sample of 84 managers was 16.11 years. The managers were assigned to two groups, with 42 persons in each group. One group was given 30 h of Yoga practice and 25 h of theory about Yoga. The other (control) group was also given training in a normal physical workout and lectures on the factors determining success based on contemporary thinking for an equal number of hours. Both groups were assessed for emotional intelligence. Data were analyzed using paired *t*-test. Following 6 weeks of Yoga the managers showed a significant increase in emotional intelligence. *Dharana* and *dhyana* were part of the Yoga program but there was no attempt to separate them from other components.

The main advantage of this study over the other studies is that it reported the longitudinal effects of six weeks of practice. However there are several such studies, and though *dharana* and *dhyana* were a part of the program, there was no attempt to understand the effects of the two practices separately.

The last of the eight papers reviewed described changes in the performance in a letter cancellation task before and after *dharana*, *dhyana*, random thinking and focusing [29]. There were two groups of healthy male volunteers, with 35 participants in each. One group was of meditators (average age 28.0 years) while the other (control) group did not practice meditation (group average age 27.3 years).

The meditators were assessed at the beginning and end of four sessions (random thinking, focusing, *dharana* and *dhyana*), to which they were assigned randomly. The sessions were on different days. The control group was assessed before and after a control period of quiet sitting. To avoid test-retest effects parallel worksheets were prepared for each assessment. Data were analyzed using repeated measures analysis of variance. The net score on the cancellation task were significantly higher after a session of *dharana* and lower after random thinking [29]. These results were suggestive of better selective attention, concentration, visual scanning abilities and an improved repetitive motor response following *dharana*, but not after the other sessions.

The results were interesting as the effects of *dharana*, *dhyana*, random thinking and focusing were compared with a control period of quiet sitting. This was an improvement in the study design compared to the other studies reviewed. A limitation of the study is that there was no objective test to assess attention.

4. Discussion and conclusions

This review is of eight studies which included *dharana* (meditative focusing) and *dhyana* (meditation without effort), as described in traditional texts.

Two studies added *dharana* and *dhyana* meditation to their Yoga program and found benefits such as better emotional intelligence in persons doing managerial jobs in one study, and ability to attain a higher state of consciousness in another study. However *dharana* and *dhyana* were not evaluated separately.

When the effects of both *dharana* and *dhyana* were separately assessed on performance in a standard task for attention, *dharana* resulted in better scores, which implies better selective attention, visual scanning and ability to do a repetitive motor activity. In contrast assessing autonomic functions in both meditative states separately, showed that *dhyana* was associated with reduced sympathetic nervous system activity in sudomotor (apocrine sweat glands) activity, cutaneous vasomotor innervation and in innervation to the heart, especially influencing heart rate variability. There was also evidence of increased parasympathetic activity during *dhyana*; supporting this stage as one of 'rest and digest' rather than 'fight or flight'.

Auditory evoked potential studies also showed clear differences between *dharana* and *dhyana*. *Dharana* delays auditory transmission at a sub-cortical, midbrain level, whereas *dhyana* delays transmission sub-cortically at the thalamic level, but enhances auditory transmission at complex levels of processing in the association cortices. This can explain why the state of effortless meditation (*dhyana*) is considered to be associated with better perception.

Functional magnetic resonance imaging (fMRI) showed distinct areas of activation during dhyana, associated with complex functions including various dimensions of cognition as well as the ability to detach consciously.

The study designs and sample sizes studied differed between studies, as did the variables assessed. However what appears to be clear is that there are distinct differences between *dharana* and *dhyana*, though both are meditative states. Studying the effects separately is not easy, but if it can be done it allows a differentiation between focusing during meditation with pure meditation, devoid of effort.

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