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Future directions in meditation research: Recommendations for expanding the field contemplative science

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Abstract

The science of meditation has grown tremendously in the last two decades. Most studies have f effectiveness of mindfulness-based interventions, neural and other physiological correlates of m and emotional aspects of meditation. Far less research has been conducted on more challengir group and relational, transpersonal and mystical, and difficult aspects of meditation; anomalous related to meditation; and post-conventional stages of development associated with meditation. meditation may be crucial to people's psychological and spiritual development, could represent mechanisms by which meditation confers benefits, and could themselves be important outcome addition, since large numbers of novices are being introduced to meditation, it is helpful to inves encounter that are not well understood. Over the last four years, a task force of meditation rese to develop recommendations for expanding the current meditation research field to include thes topics. These meetings led to a cross-sectional online survey to investigate the prevalence of a meditators. Results show that the majority of respondents report having had many of these ano experiences. While some of the topics are potentially controversial, they can be subjected to rig arenas represent largely uncharted scientific terrain and provide excellent opportunities for both We provide suggestions for future directions, with accompanying online materials to encourage

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Introduction

The field of meditation research has grown exponentially in the past two decades. A total of abo articles on the science of meditation existed in 1990. Today, there are over 4,000 (US National I About 25 papers were published per year in the 1990's, whereas over 400 were published in 20 is commendable and has led to a large increase in the knowledge of cognitive, psychological, a associated with meditative practices, as well as making important contributions to the current ps

Careful efforts by clinicians, theorists, and researchers to understand meditation have led to a s translating meditative practices into clinically relevant interventions, and examining their effects example, secularized mindfulness interventions such as MBSR (Mindfulness Based Stress Red Based Cognitive Therapy) have shown therapeutic benefit for managing pain [8–10] improving r 12], and addressing health behaviors such as overeating [13] and substance dependence [14–1 that contemplative practices infused into 8-week interventions can reduce stress and increase v psychotherapeutic control interventions [11, 18, 19]. Mindfulness has also been linked to increas related cognitive decline [21], and improved behavior and attention in youth educational settings

This burgeoning body of research has shed significant light on the effects of meditation practice perception, emotion and cognition [24–26]. A robust new field of contemplative neuroscience ha in brain function and structure associated with long-term meditation practice [3, 24] and short-te 30]. A growing body of literature has been exploring the biological and physiological mechanism modulation of inflammation, cell-mediated immunity, self-related processing, inhibitory control a markers of aging [31–33].

While these efforts in meditation science are deeply insightful, there are many outcomes, as we conscious and non-conscious processing, that have rarely been examined in the scientific litera

Numerous non-ordinary experiences during or as a result of meditation are described in the tex traditions [34–41]. Some examples of these include: "awakening" or "enlightenment" experience self-identity, self-narrative and clarity of perception; transcendence of the physical body or out o oneness and interconnectedness; spiritual transmission from teacher to student; dyadic, group, experiences of non-physical energies (e.g. chi, qi, shakti); mind to mind communication, precog distance or extra-sensory perception; past-life recall and reincarnation experiences; synchronici and other non-physical entities; and difficult stages of meditation, and periods of disorientation a

With some notable exceptions, most empirical research on meditation does not address these k components, outcomes, or mechanisms of meditation, in part because these non-ordinary state investigate in laboratory settings. However, anecdotal, survey, and interview data indicate that t more prevalent than is commonly recognized, could represent important mediators or mechanis beneficial cognitive, behavioral, and physiological outcomes [42–44], and could themselves be practice.

It is generally accepted that meditative practices engender a "witnessing awareness" [35] or me external stimuli that is distinct from ordinary consciousness. Researchers have investigated this mediators of the benefits of mindfulness training, including decentering (the ability to observe or temporary, objective events in the mind, as opposed to reflections of the self that are necessaril awareness (in which negative thoughts/feelings are experienced as mental events, rather than a (being able to disidentify from the contents of consciousness such as thoughts and view momer greater clarity and objectivity) [48]. But there are subjectively reported states of awareness that meditation that go beyond metacognition.

A small body of research has been conducted into mystical, transcendent, nonlocal or nondual a [49] pioneered scholarly examination of altered states of consciousness produced by meditatior psychological well-being. Goleman [50] surveyed several types of meditation philosophy and pr received scarce attention in psychology or empirical research, noting that most of them focused fostering an awakened state or a hypothesized "fifth state of consciousness" [51] characterized awareness" in waking life. Transpersonal psychology has explored mystical experiences in dept qualitative rather than experimental research [52–54]. William James [40], Carl Jung [55, 56], a these areas as well, although the spiritual or transcendent aspects of their contributions do not psychotherapeutic or scientific milieu.

More recently, both theoretical descriptions [58] and empirical investigations [59, 60] of subjecti sense of oneness, or a perceived dissolution of the distinction between the observer and the co emerged. These states are thought to occur when the silent background awareness encountere stabilized and integrated with the daily waking experience, so that the habitual reified dualities b other, in-group and out-group dissipate. These states are hypothesized to lead to a more spacio way of being [61], and appear to have a distinct neurophysiology [60, 62].

A large body of research exists on Transcendental Meditation (TM), a popular mantra-based co utilized in secular settings such as schools, hospitals, and business settings. TM is explicitly des transcendent states (as opposed to other forms of secularized meditation that are designed to r cognition, for example) [63]. TM proponents posit that a reduction in mental and physical activity engenders an experience of "transcendental consciousness," described as "self-awareness isol objects of experience…characterized by the absence of the very framework (time, space, and b inner and outer perception) that define waking experiences" (p. 77) [64]. The practice is theorize the body, particularly those that engage the sympathetic nervous system and associated hypoth adapting to environmental stressors [65]. Empirical evidence indicates that the transcendent sta usual waking, dreaming, or sleep states [66, 67], and it is hypothesized to be responsible for the

There have also been empirical studies of what have been termed "nonlocal" aspects of human meditation practice. During or as a result of meditation, people report experiences of perceiving limited to the typical five senses or seems to extend across space and time, such as precognitio interactions (described as "siddhis" in the Hindu yogic traditions) [68]. While controversial, these meditation practice increases the likelihood that laboratory measures of these extended forms o 71], indicating that there may be veridical elements of the subjective reports by meditators of tin inexplicable perceptual phenomena.

It is possible that these experiences of self-transcendence (defined as the extent to which indivi integral parts of the universe as a whole [72]), are active ingredients in contemplative practices. meditation might engender a transformation from a body/ego-based self-identity to a world/univ tied to the local body or limited to the self-narrative of the individual practitioner [73]. Some emp emerge supporting this idea. For example, Bormann et al. [59] specifically investigated the spiri

repetition meditation intervention in veterans, showing that existential spiritual well-being media
symptoms. Another study showed that transcendental meditation decreased anxiety, improved
tolerance in comparison with secular forms of meditation [74].

Vago and Silbersweig [75] propose a framework for understanding the neurobiological mechani
referring to self-awareness, self-regulation, and self-transcendence. Their definition of self-trans
between self and other that transcends self-focused needs and increases prosocial characterist
definition, but comes close to the forms of transcendence we are proposing might bear further i
an understandable and careful emphasis on secularizing meditation practices for clinical use, it
transpersonal, or transcendent aspects of contemplative practices are not only epiphenomena,
meditation practice, or mechanisms of action that are in part responsible for positive outcomes
improved mood.

Between 2013 and 2016, a task force of meditation researchers and teachers met in a series of
identify the state of the current literature on this topic and discuss how to broaden the types of c
meditation research. The group ultimately identified several candidate domains that future resea
moving forward to recommend these domains, a cross-sectional survey was conducted to inves
significance of these under-studied experiences among meditation practitioners. The results of
recommendations for domains of experience most frequently encountered by real-world practiti

Materials and methods

Participants

Participants were recruited through social media and email distribution, academic list-servs, and
teachers and practitioners. Recruitment was not random, but a wide net was cast to achieve as
possible. In recruitment materials no mention was made of extraordinary, transcendent, or unus
the likelihood of interest in the topic biasing respondents. Instead, participants were told that the
prevalence of “personal experiences” during or related to meditation. The only inclusion criterion
meditation practice. If participants responded “no” to the survey question “Have you ever practic
below 18 years of age, they were excluded.

Online survey

Development of the online survey occurred during the third of four 2–3 day working group meet
comprehensive literature review prior to the meetings, to explore whether the domains of medita
understudied had received any substantive research attention. At the first two meetings, we eng
mapping the field to determine what domains of meditation research were experiencing growth
as compared to aspects of meditation experiences and outcomes that had received less interes
consensus building regarding which categories remained to be pursued with academic rigor. Se
but potentially important domains of meditation experience were identified, and our next step wa
experiences and outcomes associated with those domains were actually experienced by people
defined, existing measures identified, and items created for constructs without adequate measu
such experiences during, after, or related to meditation.

Mystical and transcendent experiences were measured with an adapted version of the Revis
Questionnaire (MEQ30). The MEQ30 is a thirty-item questionnaire originally used to measure m
other psychedelic compounds’ effects in laboratory studies [76, 77]. The scale has excellent inte
(alpha = .93), and good internal consistency for the four subscales: (1) Mystical, alpha = .93; (2)
Transcendence of Time and Space, alpha = .81; and (4) Ineffability, alpha = .80. The revised me

these experiences while meditating?" with respect to 30 experiences such as "Loss of your usu awesomeness," "Experience of amazement and ecstasy," or "Sense that the experience cannot Response options were 1 = This has never happened to me; 2 = This has happened once; 3 = This has happened many times; or 5 = This almost always happens to me. The maximum mean the minimum is 1. Mean scale scores with standard deviations and percentage of total possible and. percentages of respondents endorsing each item are also presented.

Extraordinary experiences.

To assess the prevalence of and response to other extraordinary experiences, the survey asked that emerged during the working meetings. Social/Relational items included items such as feeli meditation teacher, experiencing a sense of collective energy in group meditation, and whether a group, during a retreat, or in a sacred place. Anomalous Physical and Perceptual items includ apparently caused by the physical environment (e.g. heat, cold, tingling), altered sense of visio taste and breathing, an altered sense of time or space, an altered sense of awareness or identi (unlikely coincidences perceived as meaningful), and perception of nonphysical entities (such a divine beings or angels, demons or negative figures, guides, or other visitors). Experiences rela extended perception included external physical phenomena (objects moving without apparent p clairvoyance/telepathy (perceiving information that could not have been known to you by any kn turned out to be true)). Difficult States included items such as disturbing feelings of fear, and dre meditation.

Participants were also asked if they communicated any of those experiences to a meditation tea teacher was interested or willing to discuss the experiences, 2) how important the teacher thou whether the teacher gave any advice or insight into the experience, and the setting in which the perceived importance and valence of the extended perception experiences, because these exp considered distractions or non-meaningful side-effects of meditation, participants were also ask meaningful to them, how pleasant/unpleasant they found those experiences.

Data were also collected on demographics, current and past religious/spiritual beliefs and pract self-reported history of psychological disorders. The survey was administered with the SurveyM (http://www.surveymonkey.com) and took approximately 45 minutes to complete. Surveys were 10, 2014 and February 3, 2015. All research activities were approved by the Institute of Noetic S (IRB) and were conducted according to the principles expressed in the Declaration of Helsinki. obtained from all research participants. The survey instrument and codebook can be found in th information.

Statistical analysis

Data were retrieved from SurveyMonkey and each entry checked for appropriate values. Since prevalence, descriptive statistics were calculated, including means, standard deviations, freque on data type. Data were analyzed in Microsoft Excel 10.0 (Microsoft, Redmond, WA) and STAT Station, TX).

Results

Demographics

1,856 participants began the survey. 1,793 responded "yes" to having ever practiced meditation who responded "no" were not asked to continue). Of those, 1,130 participants completed the en completers are reported here. Participants were 59% female, and 41% male with an average ag

participants had some college education (8% high school or equivalent; 20% college/technical s master's degree; 15% doctoral degree/professional degree). Meditators from 66 countries arou survey. The most represented countries included the United States (57%), Canada (8%), Unitec India (2%), Portugal (2%), Germany (2%), and New Zealand, Norway, and Mexico (1%), with th with less than 1% of participants. Twenty-five percent of participants said "Yes" to having ever b psychological disorder, with depression and anxiety being the most prevalent disorders endorse Obsessive compulsive- 6%, Eating- 2%, Psychosis- 1%, Impulse control- 1%, Personality- 1%).

Religion/Spirituality

Participants were asked to indicate their childhood spiritual or religious affiliation. Christianity wa all participants (73%) with the next highest being None (11%) (see Table 1). Most had a single r 7% of participants endorsing multiple religions in childhood. Participants were asked how much influenced their upbringing or how much it was part of their family life growing up, with a Likert s Deeply. The responses were generally evenly distributed. (Not at all- 14%; 1–18%; 2–14%; 3–2 "*Spiritual but not religious*" was the most endorsed current spiritual or religious affiliation for all p spiritual practice was quite important in participants' current lives, in comparison to in childhood important is your religious or spiritual practice to you now?" 69% of participants rated their pract responding Somewhat Important, 6% A Little Bit Important, and 9% Not Important.

	Childhood		Current	
	1 Affiliation (n = 1047)	>1 Affiliation (n = 73)	1 Affiliation (n = 944)	>1 Affiliation (n = 176)
Agnostic	3%	38%	4%	28%
Atheist	4%	36%	3%	18%
Buddhist	1%	18%	11%	62%
Christianity	73%	75%	15%	49%
Hindu	2%	7%	3%	13%
Islamic	1%	1%	1%	2%
Jewish	2%	11%	1%	9%
None	11%	15%	24%	14%
Spiritual but not religious	3%	29%	36%	38%

Values listed are the percent of participants endorsing each affiliation. 7% of respondents reported more than one affiliation in childhood, and 16% reported more than one affiliation currently—for those who reported more than one affiliation, total percentages of respondents reporting each affiliation are reported in the second and fourth columns.

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Table 1. Childhood and current spiritual or religious affiliations.

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Meditation practice

The average number of years participants engaged in regular (at least once per week) meditatic 0–75). In the last six months, 71% of participants engaged in "daily" or "more than weekly" med than monthly—4%, Less than weekly, more than monthly—12%, Weekly- 11%, Less than daily, 41%). The most common type of meditation practice was breath-focused followed by open awa (participants could select more than one: Transcendental Meditation—28%, breath-focused—67 prayer—20%, mantra repetition—31%, open awareness/mindfulness—50%, visualization—38% posture was sitting (Sitting- 74%, Laying down- 20%, Walking- 2%, Other- 4%). Most people pra weekly, and more than half of the participants (56%) had completed a multiple-day meditation re

Mystical experiences

The Revised Mystical Experience Questionnaire (MEQ30) subscale scores are detailed in Table subdomains (Mystical (MYS), Positive Mood (PM), Transcendence of Time and Space (TTS), a 3.71 range, indicating frequencies between "2–5 times" (3) and "many times" (4). The Positive M experienced, followed by Ineffability, Transcendence, and Mystical experiences.

Mystical Experiences	Mean (range 1–5)	Standard Deviation
Mystical	3.26	1.04
Positive Mood	3.71	0.80
Transcendence	3.34	1.03
Ineffability	3.62	1.08
Total	3.39	0.89

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Table 2. Revised Mystical Experiences Questionnaire (MEQ30) scale scores.

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Frequencies for each item in the Mystical Experiences Questionnaire are shown in Fig 1. Over 4 experiencing all items except one (experience of ecstasy) “many times” or “almost always.”

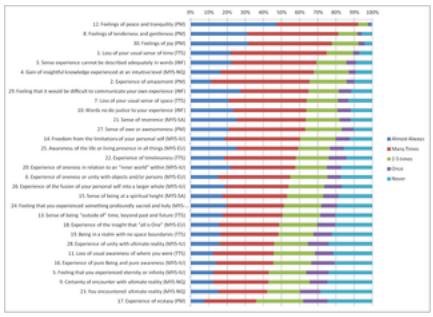


Fig 1. Frequencies of Mystical Experience Questionnaire items.

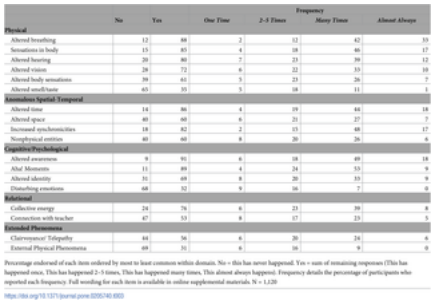
MEQ Subscales: PM = Positive Mood, TTS = Transcendence of Time and Space, INF = Ineff Mystical: MYS-NQ = Noetic Quality, MYS-SA = Sacredness, MYS-IU = Internal Unity, MYS-E have been truncated due to space. MEQ full items and MEQ subscale scores are available ir

https://doi.org/10.1371/journal.pone.0205740.g001

Extraordinary experiences

Extraordinary experiences were measured by items newly developed for this study by the worki including 1) extraordinary physical experiences, 2) spatial-temporal, 3) cognitive-psychological, phenomena. Categories were not combined into subscales, but were used for assessing preval therefore no factor analysis or internal consistency analysis was performed.

The frequencies of these experiences are displayed in Table 3. Altered breathing and sensation apparently caused by the physical environment (such as heat, cold, pressure, tingling or other b common physical experiences, with 88% and 85% of participants respectively reporting experie those 75% and 73% of people reporting that they had experienced this many times or almost al increased synchronicities were the most common spatio-temporal experiences, with 86% and 8 of those, 62% and 65% experiencing them many times or almost always. Altered awareness an common cognitive/psychological experiences, with 91% and 89% respectively reporting these e 62% many times or almost always. Sensing the collective energy of the group was the most cor reported at least once by 76% of respondents, and many times or always by 47%. Clairvoyance common extended perception experience, with 56% reporting experiencing this at least once ar least common, but still quite prevalent, experiences overall were external physical phenomena (apparent physical cause) (31%), and disturbing emotions (32%).



	No	Yes	Frequency			
			One Time	*2–5 Times*	*Many Times*	*Almost Always*
Physical						
Altered breathing	12	88	2	12	62	33
Sensations in body	15	85	4	18	46	17
Altered hearing	20	80	7	23	39	12
Altered vision	28	72	6	22	33	10
Altered body sensations	39	61	5	23	26	7
Altered smell/taste	65	35	5	18	11	1
Anomalous Spatial Temporal						
Altered time	14	86	4	19	44	18
Altered space	40	60	6	21	27	7
Increased synchronicities	18	82	2	13	48	17
Nonphysical entities	40	60	8	20	26	6
Cognitive/Psychological						
Altered awareness	9	91	6	18	49	18
Aha! Moments	11	89	4	24	53	9
Altered identity	31	69	8	20	33	9
Disturbing emotions	68	32	9	16	7	0
Relational						
Collective energy	24	76	6	23	39	8
Connection with teacher	47	53	8	17	23	5
Extended Phenomena						
Clairvoyance/ Telepathy	44	56	6	20	24	6
External Physical Phenomena	69	31	6	16	9	0

Percentage endorsed of each item ordered by most to least common within domain. No = this has never happened. Yes = sum of remaining responses (This has happened once, This has happened 2–5 times, This has happened many times, This almost always happened. Frequency details the percentage of participants who reported each frequency. Full wording for each item is available in online supplemental materials. N = 1,120

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Table 3. Percentage of participants reporting extraordinary experiences.

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Salience and valence of experiences

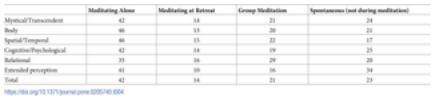
To control the length of the survey, and because these experiences have been often pointed to side effects, we asked follow-up questions regarding valence and salience of only the two exter shown in table). Participants who had clairvoyant or telepathic experiences (56%) rated the exp important" (mean = 4.01, SD = 1.11; Response Scale: 1 = Not at all, 2 = A little bit, 3 = Somewh and "somewhat pleasant" (mean = 4.10, SD = 1.10; Response scale: 1 = Very Unpleasant, 2 = 4 = Somewhat Pleasant, 5 = Very Pleasant). Participants who had experienced external physica experience as "quite meaningful or important" (mean = 4.01, SD = 1.11) and "somewhat pleasa

Sharing experiences with teachers

Participants were asked "Of the meditation experiences you reported on this survey, which did y spiritual teacher?" Participants could endorse sharing more than one experience. Six-hundred a participants reported sharing the following experiences with teachers Mystical/Transcendent n = Spatial/Temporal n = 352; Cognitive/psychological n = 426; Relational n = 358; Extended Perce participants did not report any experiences to a teacher. Teachers were mostly willing to discuss (11% Not at all, 8% A little bit, 20% Somewhat, 22% Quite a bit, 40% Very much). Many teacher experiences were important to address and reflect upon (15% Not at all, 10% A little bit, 22% So much). Also, many teachers provided insight and/or advice to help integrate and understand the Not at all, 12% A little bit, 22% Somewhat, 24% Quite a bit, 28% Very much).

Context of extraordinary experiences

For each extraordinary experience, participants were asked in what setting the experience occu experiences happened when the meditators were alone (Table 4).



	Meditating Alone	Meditating at Retreat	Group Meditation	Spontaneous (not during meditation)
Mystical/Transcendent	42	14	21	24
Body	46	13	20	21
Spatial/Temporal	46	15	22	17
Cognitive/Psychological	42	14	19	25
Relational	33	16	29	20
Extended perception	41	10	16	34
Total	42	14	21	23

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Table 4. Percentage of participants reporting mystical and extraordinary experiences by setting.

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Relationship of experiences to length of meditation practice

To explore whether length of meditation experience was related to the frequency with which res conducted Pearson correlations between the self-reported number of months of lifetime meditat of mystical and extraordinary experiences. There were small but significant correlations (p <.01· max R^2 = .09) for all but 7 of the 50 items, excluding “feeling of peace and tranquility,” “feelings body,” “altered breathing,: “disturbing feelings of fear, dread or terror,” and the importance or va extended perception items. None of the items were significantly negatively correlated with lengt correlations (p < .01) between self-reported length of meditation practice and mystical or extrao “clairvoyance or telepathy” (r = .30), “feeling that you experienced eternity or infinity” (r = .30), a guru who was not physically present, or did not interact with you in any physical way at the time

Discussion

The results of this survey indicate that mystical and extraordinary experiences are prevalent en enough to those who have them, to warrant further scientific inquiry.

Limitations of this study were that the sample was not randomly selected, and this could limit ge meditators. To address this concern, in addition to the masking of the topic of the survey in recru generalized lists of meditators rather than those known to have a special interest in these doma sample was different from the general population of modern meditators in their demographics, h religious/spiritual background and beliefs. Participants were generally middle-aged, gender-bala and well-educated. Though we are aware of no global population-based surveys of meditation p are similar to general survey populations who report meditating [78] and who utilize complemen U.S. [79]. Seventy-five percent of our respondents were from the United States, the UK, and Ca from 66 countries around the world. Our participants also represented a broad range of amount of practice, which may increase the global generalizability of our findings.

Participants reported slightly higher lifetime prevalence of depression than the general populatio vs. 19% in this sample) and higher rates of lifetime anxiety disorders (11.8% [81] vs. 14% for an been few formal studies of anxiety and depression prevalence in a general population of medita study examined depression and anxiety levels in meditators from Germany and Spain. They fou (19.9%) and anxiety (13.6%) to ours in the German sample, but levels lower than ours in the Sp and anxiety (7.1%)) [82].

There were differences between our respondents and the general population in terms of religiou “spiritual but not religious” (36%) as their current affiliation than any other organized religion, wh 15% endorsed Christianity, whereas global surveys list Christianity at 32% [83]. In general, we s similar enough to a general sample of meditators to make our results likely generalizable, thoug based random sampling.

Another limitation of our sample is that only 63% of eligible participants who started the survey c selection bias. There may also be inherent bias in those who complete a lengthy questionnaire selected population-based survey of meditators would be valuable for future research, as well a limitations include the self-report and retrospective nature of the survey. Future studies could in meditators using daily experience sampling or ecological momentary assessment to capture ex

Since the results of this survey show that experiences associated with the domains identified in and frequent, and there is little to no empirical research on them in the literature, the following s recommendations and future directions for scientifically pursuing these lines of inquiry.

Readers interested in pursuing any of these domains should refer to the Future of Meditation Re (http://noetic.org/fomr) website for links to papers which provide methods, measures, and proto

I. Mystical and transcendent experiences in meditation

Experiences that transcend ordinary perception are a common component of religious and spiri
They can occur spontaneously [84] or can be elicited by a variety of rituals, such as meditation,
as ingestion of naturally occurring substances (e.g. plants with psychoactive properties) [77, 85
rare as they might seem. In the general public, 30–50% of people report having had what they v
experience [88, 89]. Both historical and modern descriptions of mystical experiences reveal con
unity and interconnectedness with all people and things, a sense of sacredness, feelings of pea
normal time and space, ineffability, or an intuitive belief that the experience is a source of object
[89, 90].

Our respondents reported a high frequency of mystical experiences during or related to their me
reporting having them “2–5 times” or “many times” for almost all items. Increased scientific inve
be important to understanding the full range of human potential and well-being.

As reviewed earlier, a common component of many contemplative practices is the recognition o
and the contents of awareness (thoughts, feelings, sensations, etc.). In fact, an “altered sense o
going beyond the physical senses, an increased intensity of awareness, or awareness of aware
overall experience (91%) among our participants. Some traditional contemplative theories propo
from awareness recognizing itself [91], or the presence of a background non-conceptual awaren
subject-object dichotomy (i.e. “nondual”), and are thought to under certain circumstances be bro
experience through the practice of meditation [92]. In this mode, perceptions, emotions, cognitio
appear to this awareness as contents, whereas awareness is experienced as a contextual spac
the sky). While neuroscience research in this area is still in its very early stages, studies conduc
states are accompanied by increased large scale synchronization and connectivity in the brain [

Past experiments carried out with split brain patients indicate that the distinction between thoug
biological basis [96]. Recently, studies have focused on moments when meditators realize that t
meditation and are mind wandering, followed by re-orienting of attention on the meditation task
conscious processes are arguably related but different from the awareness responsible for mys

In addition, sacred texts in contemplative traditions such as Buddhism and Hinduism claim that
states of mind that have not been adequately explored or differentiated phenomenologically in t
the yoga tradition describes multiple kinds of *samadhi* (states of intense concentration, absorpti
differentiating between for example, *nirvikalpa samadhi* of pure awareness, and *sahaj samadhi*
experience both co-arise but are perceived as inseparable, nondual, or coessential [99]. Investi
new insights about cognition and perception that can only be reached through expanding conte

Mystical or transcendent aspects of meditation can be challenging to measure, and difficult to p
With rare exceptions, current research on mystical and transcendent experiences to date rely a
self-reports using face-valid measures, and are therefore highly open to recall bias and demanc
should focus on better conceptualization and measurement of mystical or transcendent experie
and first, second, and third-person measures. In addition, methods of reliable induction of mysti
investigations of those able to produce such experiences at will, may allow for more controlled i

Given the frequency and salience of mystical and transcendent experiences related to meditatio
fruitful area for future research. In particular, we suggest conducting studies that 1) investigate t
mystical and transcendent experiences, 2) develop improved methods and measures for invest
of these experiences on health, psychological and prosocial outcomes, 3) examine psychophys
mechanisms of such experiences (when, why and how do they happen?), and 4) determine acu
correlates of such experiences. For example, prospective studies of novice meditators could inc

transcendent experiences, examine the predictive value of the occurrence or type of such expe explore them as potential mechanisms of other psychological or physical changes, or correlate experiences with mood data from experience sampling or biomarkers.

II. Social and relational aspects of meditation

To date, most experimental studies of meditation have focused on cognitive, emotional, and phy practice within individual subjects. However, meditation has traditionally been taught in a relatio student or in a group of students. There are numerous meditation approaches that encourage n practice, and individuals often find that that meditating in the presence of others can deepen co meditation experience.

Practitioners from a wide variety of spiritual traditions have reported strong psychophysiological presence of a spiritual teacher who has achieved some level of mastery, particularly when the t toward the practitioner. These reports are common across spiritual traditions, being described n based in Hinduism and Buddhism. In these traditions, the phenomenon is thought to reflect a "t consciousness or a form of energy from teacher to student. Recipients also report subjective ex transmissions at a distance, or by listening to a recording or simply looking at a picture of the sp energy "many times" or "almost always" during meditation practice was endorsed by nearly half three-quarters reported this happening at least once. Connection with a teacher who was not ph "many times" or "almost always" by 28% of respondents, and 45% experienced this at least twic

Research on social norms and social influence suggests that the mere presence of other people individual's experience such that his or her motivations and behavioral choices occur in respons Simple examples of this can be found in the social conformity and social facilitation literature [1(meditation practice have just begun to be studied, such as comparing meditation programs taug [104], and long-term meditation retreats [60, 105]. Interestingly, our sample of meditators report extraordinary experiences happened more frequently when meditating alone (35–46% dependi vs. meditating in a group (16–29%) or on retreat (10–16%).

Some questions for future research on the social and relational aspects of meditation include: 1 alone vs. meditating in a group of people influence outcomes from biomarkers to mood to behav affect one's practice positively, negatively, or does it depend on the outcome? 3) do group effec to know others are meditating at the same time (or asynchronously) in different locations? 4) do personality (such an introversion/extroversion) or other baseline or contextual elements? 5) wha relationship in meditation? 6) are there reliable means of measuring group "energy" or spiritual t student? 7) what is the impact of meditating with all women or all men, vs. co-ed meditation? ar meditating with a significant other? These are intriguing research questions that have only bare opportunities to study dyadic or group outcomes of meditation practice, such as effects on intim classrooms, or organizations. Multiple simultaneous measures of biomarkers such as heart rate also be used investigate whether dyadic or group synchrony is detectable, and whether it enhar

Furthermore, many goals of meditation practice are specifically oriented toward developing pro- These include emotions such as love and joy, attitudes such as ethics and altruism, relational sk compassion, virtues such as patience and humility, as well as insights and wisdom about the se Contemplative science is growing rapidly in studying these prosocial emotions and behaviors re [108–112] as well as clinical outcomes of compassion and lovingkindness practices [113], but th which meditation cultivates them are just beginning to be investigated. There remains an enorm this promising area.

III. Physical and perceptual phenomena

Body-based meditation practices are some of the most commonly disseminated techniques in tl
particularly awareness of breathing, is a foundational practice across many contemplative tradit
“altered sense of breathing” was the body sensation most endorsed by respondents in our surv
always).

A large and growing amount of studies have been conducted on physiological correlates of med
clinical studies have focused on physical and perceptual outcomes following meditation training
measures [114, 115], tactile and pain perception [116–118], visual and auditory perception [119-
temperature at will in freezing conditions [123, 124]. In some meditation traditions, practitioners
physiology, such as respiration rate [125] and heart rate [126].

Physical and perceptual sensations not apparently caused by the physical environment were ex
our survey respondents, including: heat, cold, pressure, or tingling; seeing lights, visions, or ima
floating, out of body experiences, body parts disappearing, or feeling like the body changed in s
sounds, humming, or voices or music that were not in the physical environment. These are exp
examined in a scientific context, but were endorsed by 60–90% of our respondents. Smelling or
physically there was the least endorsed item, though still reported by 35% of those surveyed.

Some meditation practices focus attention on “energy” flowing through the body. Contemplative
understanding of what this subjectively experienced “energy” is, such as kundalini, chi, or subtle
detail energy pathways (such as meridians) or nodes (such as chakras) in the body. Many movi
gong, tai chi, and martial arts are designed for moving or balancing energy in the body, and wer
for, or used in conjunction with, sitting meditation. These physical phenomena associated with r
addressed by the scientific community, and future studies on these topics could not only help us
and outcomes of meditation, but also more about the connection between mind and body, and p
come to be known as the “biofield” and its role in our well-being [127].

Other outcomes of meditation practice have to do with a visceral sense of greater embodiment,
aware in one’s body. Repeatedly directing attention toward what are typically implicit or automat
the sense of embodied presence—in other words, experiencing oneself to be fully one’s body ir
awareness (awareness of signals from inside the body) is also an area of increasing interest [12
showed that meditators are no better at accurately assessing heart rate than non-meditators [12
found increased breath awareness [131], increased heartbeat detection accompanied by increa
and increased coherence between subjective assessment of emotion and heart period in traine
increasing evidence that humans can become aware of what were previously purely non-consc
implications, and provides a large and potentially valuable sphere of scientific inquiry.

Once again, these phenomena certainly provide challenges in terms of measurement and meth
inquiry that require ingenuity to operationalize. Future directions for rigorous research on anoma
phenomena during or as a result of meditation could include 1) qualitative measures to better u
experiences; 2) development of quantitative measures to assess subjective experiences of emb
tingling and prickling of the skin, “energy” surges, etc.; 3) objectively measuring physiological co
perceptual, or energy experiences; 4) investigations of whether meditative activities can result i
(e.g. strength, balance) or extraordinary capacities for physical performance; or 5) exploring hov
meditation practices influence human interactions with virtual or augmented reality (see [134]).

These and other areas of body sensations and perceptual phenomena that occur naturally in m
new research. These lines of inquiry not only provide an opportunity to learn more about the eff
more about mind-body interactions in the context of the special training that meditation practice
about the potential of the human body through Olympic level sports, we might learn more about
together by investigating those with extensive mental training through meditation.

IV. Spatial/Temporal phenomena

Contemplative practitioners anecdotally report experiencing time and space differently during or Indeed, an altered sense of time such as regular time seeming shorter or longer than usual, or e or in the future was reported by 86% of our survey participants, with over 60% reporting this "ma half of our respondents experienced an altered sense of space such as feeling something crack across a distance, or a sense of space being distorted from its usual mode, with over 30% repo "almost always." Increased synchronicities (meaningful coincidences, or events or information a for no apparent reason) were endorsed by 82% of the participants. Indeed, increased synchron experience among all those surveyed (82% having experienced it at least once), even higher th expect from meditation practice, such as altered body sensations.

Recommendations for future research in this domain include: 1) using qualitative research to as descriptive nature of meditators' altered perceptions of time, space, or synchronicities in their liv daily assessments, or questionnaires to evaluate the frequency and salience of such experienc physiological correlates of the subjective experience of timelessness [69] or connections with ot the sense of spaciousness or timelessness (see [136]); 4) assessing the effects of these experi mood regulation, or other clinical outcomes; and 5) developing methods for reliable induction of conditions.

V. Extended perception

Extended perception refers to perceptions people may have naturally, or develop over the lifesp understood notions of how information can be perceived. Advanced meditators have demonstra capacities that scientists once dismissed as impossible [107]. These capacities include, for exa nondream sleep, and heightened perceptual speed and sensitivity. What further capacities awa

Over half of the meditators in our sample reported experiencing clairvoyance or telepathy (perc have been known to them by any known physical means, but later turned out to be true) at leas majority also found the experience "somewhat pleasant" and "quite meaningful or important."

Discussions of the relationship between meditation practice and advanced capacities of meditat back to Patanjali's Yoga Sutras, published roughly two thousand years ago [36]. Claims such as telepathy, and mind-matter interactions are still controversial, although a growing body of literatu could be supported by data [137–139]. External physical phenomena, or objects moving by a no appearing when they had not been there before, objects falling over, a light going out, psychoki objects by mental attention or intention alone), or other physical manifestations that seemed to discussed in historical literature. Approximately one-third of the meditators in our sample endors like this at least once.

People also reported sensing a connection with non-physical entities (defined as nonphysical e hearing, such as a God presence, higher powers, divine beings or angels, demons or negative even more often than experiencing a connection with real-life meditation teachers, with 32% rep always", and another 52% at least twice.

If new to this literature, scientists encountering these ideas for the first time might argue that if th they would have heard more about them. However, the vast majority of clinicians and researche experiences in their assessments of meditative practices, and given their controversial nature, r to share such experiences under non-anonymous conditions. However, many but not all respon extraordinary experiences to their meditation teachers. When they did share the experience, the "somewhat" to "very much" willing to discuss the experience with them, and 75% of teachers ga important to reflect upon, 40% "very much" so.

It is important to note here again that there did not appear to be a substantially higher rate of ps
than in the general population. While these experiences could be completely illusory, they also
potential and reality that challenge prevailing paradigms. Western scientists may hesitate to ent
possible explanation for these perceptions of non-local aspects of consciousness are that they
meditative traditions, whether they are considered real or not, these experiences are discounte
and others have cautioned that focusing on such experiencing can be seductive, cause egocen

At the same time, there are views within some contemplative traditions that such experiences c
compassion by experienced masters, and some highly respected practitioners of contemplative
research on such domains. For example, Buddhist monk and collaborator on several neuroscie
Ricard was asked at the Mind and Life Institute's International Symposium on Contemplative St
would be important for scientists to study next. He responded that reincarnation/past lives and t
frontiers to investigate [141], sharing his own personal experience of telepathy with a meditatior
strongest positive correlations between self-reported length of lifetime meditation practice were
guru who was not physically present" (r = .29, r^2 = .08, p < .01) and "clairvoyance or telepathy"

While respecting the concerns of both perspectives, it is possible that the time has arrived to ca
assumptions and for investigations to include some of these capacities. Methods currently exist
the areas described in this paper. Some empirical research already shows that those with a hist
demonstrate greater "psi" capacities [68, 69, 71, 142–144]. Future directions that intrepid resea
correlating different types, frequency, and length of meditation practice with a variety of rigorous
[145]; 2) testing for extended human capacities such as precognition, clairvoyance, telepathy, o
controlled conditions during or just following meditation; 3) utilizing implicit measures (i.e. those
choice but examine physiological or reaction-time measures) to investigate extended human ca
meditation practice; or 4) including extended human capacities variables or questionnaire items
meditation, to assess them as predictors, outcomes, or mediators, and 5) studies of people eng
meditation practices who have been reported to exhibit exceptional capacities, virtues, states of
postconventional stages of development.

VI. Other recommendations

Difficult experiences in meditation.

Meditation is usually considered a low risk intervention and adverse events are relatively rare. V
were the least commonly reported type of experience among respondents in our survey, this do
should be ignored. A full 32% of participants in our sample reported feeling disturbing feelings o
result of their meditation practice. A small but growing body of research on adverse effects from
there is opportunity to investigate this domain further.

For example, meditation practices have at times been associated with antisocial behavior, restle
stability [146]. Even long term meditators have reported adverse effects [147]. There have been
mania triggered by meditation in the scientific literature [148–150] [151] and in lay publications [
depersonalization [153], and case reports of brain activity correlated with seizures [154, 155]. G
consistent with the notion that meditative practices can have powerful effects on mind and body
worldview can be signs of psychospiritual progress, but can also be accompanied by significant
interventions, significant negative psychological side-effects may occur in a minority of individua
disposition towards mania or psychosis.

Among researchers who are enthusiastic about the benefits of meditation being discovered in c
hesitance to examine adverse events, negative side effects of meditation, for fear that this will e
lessen enthusiasm for the practice. Most studies do not include any items asking about difficult

practice. However, it is possible that difficult and distressing experiences may be involved in on research on meditation: adherence.

As mentioned earlier, Lindahl and Britton [156] have addressed these questions by collecting da impairing experiences associated with meditation, the resulting taxonomy of which should aid ir Building and extending this research using a variety of methodologies will only strengthen the fi addition, distressing or difficult states can be viewed as natural aspects of the trajectory of spirit when properly supported can catalyze positive outcomes [157, 158]. As one American Buddhist it:

> It is certainly the case that almost everyone who gets anywhere with meditation will pass through periods of negat and heightened sensitivity… for some duration of time, things may get worse before they get better…. This pheno sometimes referred to as "falling into the Pit of the Void." It entails an authentic and irreversible insight into Emptin Enlightenment's Evil Twin…In some cases it takes months or even years to fully metabolize, but in my experience positive.

Conducting more research on these difficult states and stages should help clinicians help their c leverage these experiences.

Context.

Though not included explicitly in our survey, we recommend that investigation of the role of the meditation practice occurs represents another essentially wide-open field for future researchers of objects, icons, rituals and sacred places have traditionally been thought to enhance meditatic perceptual cues such as incense, candles, images, music, bells, and the wearing of special clot or avoiding certain foods that are routine parts of contemplative traditions and have yet to be inv cases, these contextual elements are thought to help "carry" a person into deeper meditative pr

Environmental cues such as color [160], odor [161], and images [162] have been demonstrated processing, and behavior. This may account for the role that environmental cues play in meditat suggests that buildings, rooms, places, or objects in which many people have engaged in spiritu meditation feel qualitatively/subjectively different than objects or places that have not been assc example, some talk about the "stillness" or "vibration" of a temple or old church—but objective n perceived phenomenon are lacking. Only a small amount of research has been conducted on w space [163]," in other words, space that has been purported to be imprinted by intentions alone exploration.

In addition, the cultural context, intentions, purpose, and values held by the meditator's tradition practitioner) likely impact meditative experiences and outcomes. For example, a person who op orientation [164] might have different experiences of meditative benefit than those who come fr Many long term meditation practitioners hold rich worldviews, belief systems and ethical guideli meditative practice and quite possibly the phenomenology of their experiences in meditation. H ethical systems components has not been specifically measured in the bulk of the clinical and n The novices assayed in meditation research to date hold a broad range of worldviews, often po religious foundations of the meditative practices in which they are engaging. For better or worse practices have by and large been divorced from teachings about ethical guidelines or philosoph of self and relation of self to world and/or the sacred. There are benefits and drawbacks to this. for much larger dissemination of them, as well as practices unburdened by dogmas that may or However, some of the "built-in" ethical protections in traditional settings and teachings have alsc example, a meditation student being assigned to clean the temple to learn humility and service transcendent states), and practices run the risk of becoming superficial when decontextualized.

The field of meditation studies is likely to benefit from assessing even in a rudimentary way som meditation practice, and how they might impact outcomes. For example, researchers could ranc contextual environments for practice and then collect subjective and objective measurements. C persons meditate in a room with an object randomly selected as one that is regarded to deepen Alternatively, repeated measures designs could also be used in which the same person meditat differences in neurophysiological correlates are measured.

Psychological development.

One of the most dramatic findings of developmental psychology and neurobiology is that, contra can continue throughout much of adulthood [165, 166]. There are now more than 100 models o [167] stages of adult psychological development [168, 169]. Preliminary maps have been offere contemplatives, but a growing body of empirical research suggests that for moral, cognitive, anc wisdom and self-transcendence, development can continue well into the elder years [170–177]. studies of the effects of meditation on psychological development, even though accelerating su most important contributions the practice of meditation can make, and one of our contemporary

Ethical issues.

As the scope of meditation research is broadened, and extraordinary experiences are the increa important to identify and address ethical issues that may arise. Indeed, a barrier to including the field of meditation research may have been a concern that too much emphasis on these experie become distracted from the primary goals of meditation, foster experiences in meditation that cc clients, or bring to light experiences that clinicians were unequipped to address. However, simp not make them go away, does not preserve the ethical foundations of meditation practice, nor is [178]. Instead, we must create a set of clinical and ethical guidelines for helping clients, student integrate these experiences to enhance, rather than detract from, their well-being. Educating cli potential for these experiences to occur, including questions to screen for distress, depersonaliz related to meditation practice in assessments, and identifying a clinician with expertise in treatin consultation are all possible components of an ethical approach.

Conclusions

The goal of this paper and the accompanying online materials is to share the findings and concl Meditation Research working group. These include the findings of a survey investigating the pre experiences and recommendations for expanding future research on meditation. The survey de experiences—mystical/transcendent, social/relational, physical/perceptual, and spatial/tempora capacities are prevalent and salient to those who experience them, and that meditation teacher them with students.

One theoretical trajectory of psychological and spiritual development through meditation practic strokes as 1) participant comes in with distress or a desire for greater understanding or contentı mindfulness practices, the participant learns to stabilize attention, 3) the participant learns to de their awareness or experience rather than being completely fused with their experiences, 4) the make choices about how they wish to approach experiences (e.g. with acceptance, friendly inve simple non-reactive awareness, with compassion), 5) through both subtle and profound insights participant begins to see themselves and reality as less fixed, is better able to understand conte feels a sense of connectedness (less duality) between themselves and others, and 6) through tl compassionate for themselves and others, less reactive, less stressed, and observes improved

anxiety, and more happiness. The premise of this paper is that in addition to experiences recogı as signs of spiritual progress, such as decentering from individual ego-based concerns, the kinc have entertained in this paper may also be important parts of this process.

We propose that these experiences are important to study. They hold the potential not only to sl those who practice it, but may also illuminate new understandings about human potential and th experiences may be purely subjective or even illusory, but if this is the case, they remain worth their functional utility and transformative (or disruptive) potential. In addition, as meditation prac care settings, it will be important for clinicians to be aware of potentially important, distressing o patients may have.

Researchers wishing to explore some of these domains may encounter reluctance, resistance c and academic community. Many aspects of meditation have been excluded from scientific dialo to mature and be accepted as a field with scientific rigor. A focus on the cognitive and physiolog itself a highly unconventional topic of study, assured that the field of contemplative science wou rather than soft or pseudoscience. The field has understandably de-emphasized what may be e focusing on component parts that are easier to operationalize and more palatable to scientists.

But as shown by our survey results, there are deeper and more mysterious aspects of meditatic Our premise is that these important aspects of meditation are within the bounds of scientific inv studied with scientific rigor, and that their exclusion from scientific dialogue unnecessarily limits thus far, presenting this research to students and at professional meetings is that 1) researcher that emerging findings often map on to their personal experiences and observations of students as the spiritual traditions from which many of these practices emerged, and 3) they are gratified rigorous, and empirically sound methods to study them. Students and researchers who are inte domains of meditation may find it useful to visit the Future of Meditation Research website to fir recommendations, an online course expanding on the topics reviewed in this paper, and a comı pursuing these domains of inquiry.

The aim of this paper was to bring attention to some of the more controversial and less studied that these aspects of meditation may be crucial to people's psychological and spiritual developr effects, could represent important outcomes of meditation practice, or serve as mediators and/c confers benefits. These arenas represent largely uncharted scientific terrain and provide excelle experienced researchers. We hope this paper provided a foundation from which future researcl preliminary support to Maslow's [179] provocative claim that "what we call 'normal' in psycholog average, so undramatic and so widely spread that we don't even notice it ordinarily" (p. 16). The of us to step into a new paradigm from which to explore one of the greatest of human quests—t enhancement of the human mind.

Supporting information

S1 File. Meditation experiences survey.

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(PDF)

S2 File. Meditation experiences survey codebook.

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